MMPC
Mouse Metabolic Phenotyping Centers

# Catalog of Services

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# MMPC Mission

Our mission is to advance medical and biological research by providing the scientific community with standardized, high quality metabolic and physiologic phenotyping services for mouse models of diabetes, diabetic complications, obesity and related disorders.

The six Centers are housed at outstanding academic institutions, staffed by experts in state-of-the-art technology. Researchers can ship mice to one of the Centers and obtain on a fee-for-service basis a range of complex exams used to characterize mouse metabolism, blood composition including hormones, energy balance and physical activity, eating and exercise, insulin resistance, organ function, metabolic fluxes and morphology, physiology, histology and measures of diabetic complications in heart, kidney, vasculature, eye, etc. Many tests are done in living animals and are designed to elucidate subtle to complex traits that would define models of metabolic disease.

The development of transgenic technology and gene targeting protocols has resulted in numerous mouse lines with specific phenotypes and well-defined DNA structural changes. Candidate genes for diabetes, obesity and other disorders of metabolism have been identified and transgenic mice are being generated using this technology. By broadening the availability of sophisticated metabolic phenotyping, we hope to help investigators identify and study new mouse models that will lead to an improved understanding of these complex diseases.

In 2006, the MMPC formed a collaboration with the NIH-sponsored Diabetic Complications Consortium (DiaComp) in order to more thoroughly phenotype putative new mouse models of disease for a range of complications including cardiovascular disease, nephropathy, neuropathy, retinopathy. The MMPC is committed to improving access to existing tests, and to developing new technologies for this purpose.

**Goals**

1. Broaden the scope of metabolic phenotyping tests for mice available to investigators.
2. Standardize key methodologies.
3. Expedite the completion of research.
4. Compile a database of information relevant to mouse models of diabetes, obesity, and diabetic complications.

# Guidelines and Policies

The MMPC is sponsored by the National Institutes of Health as a resource to provide services to the community of scientists who use mice to study diabetes, obesity, diabetic complications, and other metabolic diseases. In order to accomplish this goal, the MMPC offers to researchers phenotyping tests that require specialized expertise or equipment. Modest fees for these test are set at or below actual cost. Researchers can arrange to ship mice or murine tissues to the Centers for analysis. Complete information is available at www.mmpc.org.

**Center Structure & Steering Committees**

Each Center has a structure that consists of an Executive Committee, an Administrative Core and Director, experimental and analytical Test Cores, an Animal Health and Welfare Core, and a Research & Development program. The MMPC program has a Coordinating and Bioinformatics Unit which houses the MMPC MICROMouse grant program, the MMPC website, and MMPC Database. This CBU is shared with the NIH-sponsored Diabetes Complications Consortium (DiaComp). Details for the structure and personnel at each MMPC can be obtained from the individual web sites. The six Centers share a National Steering Committee consisting of Center Directors, NIH personnel, and the External Scientific Panel.

**Application for Services**

After identifying the appropriate Center(s) from the individual web pages or test catalog, www.mmpc.org/shared/catalog.aspx, the applicant should first contact the Center Director or Core Director to discuss the mouse strain, determine the best set of tests to be conducted, and obtain an estimate of costs. The applicant then obtains a password protected account and completes an online request for services, www.mmpc.org/shared/orderTest.aspx, which is targeted to the appropriate Center. The request is reviewed by the Center Executive Committee. Acceptance is based on Center workload, relevance of the available and/or requested tests to the mouse model, and the perceived value of the animal to diabetes, obesity, and metabolic disease research. The applicant will be contacted with the decision. Following consultation with the Center and/or Core Director(s), a written estimate for all tests agreed upon, including the number of mice required for each test and a timeline for receipt and testing of the mice at the MMPC, will be sent to the applicant for his/her approval.

**Data**

Tests will be conducted using the experimental protocols found on the individual MMPC web sites or in the catalog. Detailed descriptions will be provided upon request. Upon completion of the requested tests, data in an appropriate form will be stored in the MMPC database and posted on MMPC's password protected web site, www.mmpc.org/secure/index.aspx, for viewing by the submitting investigator only. The Center personnel will be available to discuss experimental details, etc.

**Data Ownership**

All data generated from a submitted strain belongs to the submitting investigator and his/her institution.

Center personnel have no rights to use this data for personal or institutional research purposes unless a formal, documented arrangement of collaboration exists between Center personnel and the investigator.

The NIH strongly encourages the sharing of research data. NIH guidelines regarding data sharing can be found at http://grants1.nih.gov/grants/guide/notice-files/NOT-OD-03-032.html. This notice states,

*We believe that data sharing is essential for expedited translation of research results into knowledge, products, and procedures to improve human health. The NIH endorses the sharing of final research data to serve these*

*and other important scientific goals. The NIH expects and supports the timely release and sharing of final research data from NIH-supported studies for use by other researchers… [The] definition of "the timely release and sharing" [is] to be no later than the acceptance for publication of the main findings from the final data set. NIH continues to expect that the initial investigators may benefit from first and continuing use but not from prolonged exclusive use.*

All data collected at the Centers will be stored in the publicly available MMPC database. It is anticipated that the complete set of data generated by the MMPCs on all newly generated strains, taken together in a database, will be valuable for understanding diabetes, obesity and other metabolic diseases.

**Therefore, the NIH requests that investigators allow the data generated by an MMPC to be placed in a public MMPC database after the first of the following two conditions has been met:**

1. **The data have been published and are therefore in the public domain.**
2. **Two years have passed since the investigator received the data from the Center.**

Because it is sometimes not possible to publish or even interpret data within a two-year timeframe, investigators may request that specific data be withheld from the public database for an additional period of time.

The Center personnel and the investigator must read and sign a Conditions of Use Statement, which clearly states these rights and responsibilities.

**Fees**

Price information for each test is available on the individual Center web pages or by request from each MMPC. Applicants will receive a written estimate that must be acknowledged by the submitting investigator before animals can be shipped for testing. Fees are set as a fraction of the total costs incurred by the MMPC for that test, and are calculated based on the obtainment of revenue neutrality.

**Animal Guidelines**

Please see animal care and shipping section of this catalog or www.mmpc.org/shared/animalShipping.aspx. Specific instructions can be obtained from center personnel.

**Acknowledgements**

One index of success of the MMPC program is the contribution of data produced by the MMPC to publications and oral communications. Please acknowledge the MMPC when presenting data obtained using Center Services.

- Case Western Reserve University MMPC is supported by U24 DK076174
- University of California - Davis (UC Davis) MMPC is supported by U24 DK092993
- University of Cincinnati Medical Center MMPC is supported by U24 DK059630
- University of Massachusetts (UMass) MMPC is supported by U24 DK093000
- Yale University School of Medicine MMPC is supported by U24 DK059635

# Tests Listed by General Subject

The first letter of each Test No. denotes the center:

D = University of California Davis
C = University of Cincinnati Medical Center
M = University of Massachusetts Medical School
MI = University of Michigan Medical School
V = Vanderbilt University School of Medicine

## Amino Acid Metabolism

| Test No. | Test Name | Keywords |
|---|---|---|
| V3090 | Amino Acids - Full Profile (HPLC) | amino acids, hormone, HPLC, imaging, metabolite, modeling and simulation |
| V3009 | Amino acid kinetics | amino acid flux, amino acid kinetics, isotopes, metabolite |
| V3091 | Amino Acid - gluconeogenic profile | amino acids, HPLC, metabolite |
| D3412 | Metabolomics | amino acids, aromatics, carbohydrate, diabetes, exercise, free fatty acids, glycolysis, hormone, hydroxyl acids, lipids, liver, liver function, metabolism, metabolite, serum, sterol, sugar phosphates, TCA intermediates |
| M1011 | Protein metabolism | amino acid, amino acids, in vivo protein turnover, phenylalanine, protein, protein synthesis |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |

## Analytical Resources and Histology

| Test No. | Test Name | Keywords |
|---|---|---|
| V3090 | Amino Acids - Full Profile (HPLC) | amino acids, hormone, HPLC, imaging, metabolite, modeling and simulation |
| C1088 | GIP concentration (per set of 38 samples) | hormone, incretin, lipids, metabolism |
| C1052 | Lipid Profiles (TG, CHOL, PL, NEFA)(per set of 38 samples) | lipids, non-esterified fatty acid, obesity, phospholipids, total cholesterol, triglycerides |
| C1054 | Lipoprotein fractionation by FPLC (per sample) | apolipoproteins, cholesterol, fatty acids, FPLC, lipids, lipoproteins, obesity |
| C1055 | Metabolism of chylomicrons (per sample) | apolipoproteins, chylomicron, chylomicron remnants, lipids |
| C1057 | Free Fatty Acids (NEFA) Concentration (per set of 38 samples) | free fatty acids, lipids, non-esterified fatty acid, obesity, serum |
| C1081 | C-peptide concentration (per set of 38 samples) | diabetes, hormone, insulin, insulin secretion |
| C1085 | Glucagon concentration (per set of 38 samples) | counter-regulation, counterregulatory, hormone, lipids |

| Test No. | Test Name | Keywords |
|---|---|---|
| C1086 | GLP-1 concentration (per set of 38 samples) | counterregulatory, glucagon, hormone, incretin, lipids |
| C1087 | Glucose concentration (per set of 38 samples) | carbohydrate metabolism, diabetes, isotope, tracer |
| C1089 | Insulin Assay (per set of 38 samples) | carbohydrate, diabetes, hormone |
| C1090 | Leptin concentration (per set of 38 samples) | adipokine, diabetes, eating behaviour, feeding behavior, hormone, leptin, lipids, obesity |
| C1092 | Triglyceride concentration (per set of 38 samples) | lipids, metabolism, obesity |
| V3001 | Cannulation of cerebral ventricle | central control, CSF, surgery |
| V3002 | Jugular vein and carotid artery catheterization | artery, blood vessel, catheterization, chronic, insulin, insulin action, surgery, vein |
| V3030 | In vitro Morphology, Morphometrics and Histology (isolated heart) | cardiac function, isolated organ and cell perfusion, morphology |
| V3034 | Vascular morphology | atherosclerosis, blood vessel, circulation, histology, vascular, vascular function |
| V3050 | Insulin | carbohydrate, diabetes, hormone |
| V3051 | Glucagon - ELISA | counter-regulation, hormone, lipids |
| V3052 | Corticosterone | glucocorticoid, hormone, stress |
| V3053 | Catecholamines (epinephrine & norepinephrine only) | hormone, stress |
| V3054 | Leptin (Luminex assay) | adipokine, diabetes, feeding behavior, hormone, leptin, obesity |
| V3055 | C-peptide (Luminex assay) | hormone, insulin, insulin action, insulin secretion |
| V3059 | PRL (prolactin) | fertility, hormone, prolactin |
| V3060 | ACTH | adrenocorticotropic hormone, corticotropin, glucocorticoid, hormone, stress |
| V3070 | Plasma lipids | cholesterol, fatty acids, lipids, metabolism, obesity |
| V3072 | Fatty acid profiles of lipid esters by gas liquid chromatography | GCMS, lipids, metabolism |
| V3073 | Quantitation of individual phospholipid classes | cholesterol, lipids, metabolism, phospholipids |
| V3074 | Short chain fatty acid analysis by gas liquid chromatography | GCMS, lipids, metabolism, short chain fatty acid |
| V3075 | Fast Protein Liquid Chromatographic (FPLC) Lipoproteins Separations | cholesterol, fatty acids, lipids, lipoproteins, metabolism |
| V3076 | Morphometric determinations (aorta) | atherosclerosis, blood vessel, histology, vascular, vascular function |
| V3080 | Gross examinations and necropsy | gross examination, histology, necropsy, organs, tissue, tissues |
| V3081 | Tissue preparation, embedding, sectioning and routine staining | embedding, histology, organs, sectioning, staining, tissue, tissue preparation |
| V3082 | Tissue microdissection | diabetes, histology, immunology, insulin, insulin action, laser microdissection, organs, tissue, tissues |
| V3083 | Screen/optimize immunohistochemical protocols for mouse-specific commercial and | histology, immunohistochemistry, organs, tissue, tissues |

| Test No. | Test Name | Keywords |
|---|---|---|
| | custom-designed antisera | |
| V3091 | Amino Acid - gluconeogenic profile | amino acids, HPLC, metabolite |
| C1058 | ß-hydroxybutyrate concentration (per set of 38 samples) | Atkins, beta-hydroxybutyrate, diabetes, ketones, low carbohydrate, serum |
| C1060 | Phospholipids concentration (per set of 38 samples) | fatty acids, lipids, phospholipids |
| C1061 | Adiponectin concentration (per set of 38 samples) | adipokine, adiponectin, gut hormones, hormone, insulin, insulin action, insulin resistance, peptides, serum |
| C1071 | Glucose tolerance test GTT (oral) (per animal) | carbohydrate, diabetes, insulin, insulin resistance, insulin sensitivity, metabolism, serum |
| C1083 | Cholesterol (total) (per set of 38 samples) | atherosclerosis, cholesterol, lipids, metabolism, metabolite, obesity |
| V3067 | Testosterone | hormone, sex, steroid |
| V3098 | GFR-FITC-Inulin; HPLC Cr | glomerular filtration, HPLC |
| C1103 | Necropsy (tissue collection) (per animal/tissue) | necropsy, organs, tissue |
| C1104 | Lipid extraction via folch (per set of 12 samples) | fatty acids, folch, lipid extraction, lipids, obesity |
| C1105 | Fatty Acid analysis via GC (each) | fatty acid composition, fatty acids, lipid, obesity |
| D2004 | Genotyping (if needed) | animal husbandry, animal model, genetics, genotyping, mouse husbandry and transfer, mouse models |
| D3301 | Lipid extraction from liver | atherosclerosis, cholesterol, obesity, total cholesterol, triglycerides |
| D3302 | Lipid extraction from muscle | atherosclerosis, cholesterol, obesity, total cholesterol, triglycerides |
| D3401 | Glucose (urine/plasma) | carbohydrate, diabetes, glucose, hyperglycemia, hypoglycemia, insulin, insulin action, insulin effectiveness, liver, liver function, liver function enzymes, metabolite, urine |
| D3402 | Hemoglobin A1C | diabetes, glucose, Hemoglobin A1C, hyperglycemia, liver, liver function, liver function enzymes, metabolism |
| D3403 | beta-OH butyrate | Atkins, diabetes, insulin, ketones, liver, liver function, liver function enzymes, low carbohydrate, metabolism |
| D3405 | Total Cholesterol | atherosclerosis, cholesterol, lipids, liver, liver function, metabolism, metabolite, obesity, total cholesterol |
| D3406 | HDL-C and LDL-C/VLDL-C | atherosclerosis, cholesterol, lipids, liver, liver function, metabolism, metabolite, obesity |
| D3407 | HDL-TG and LDL-TG/VLDL-TG | atherosclerosis, cholesterol, lipids, liver, liver function, metabolism, metabolite, obesity |
| D3408 | Non esterified fatty acids | lipids, liver, liver function, liver function enzymes, metabolism, non-esterified fatty acid |
| D3412 | Metabolomics | amino acids, aromatics, carbohydrate, diabetes, exercise, free fatty acids, glycolysis, |

| Test No. | Test Name | Keywords |
|---|---|---|
| | | hormone, hydroxyl acids, lipids, liver, liver function, metabolism, metabolite, serum, sterol, sugar phosphates, TCA intermediates |
| D3413 | Complex lipid ratios | ceramides, diabetes, exercise, lipids, liver, liver function, lysophosphatidylcholines, mass spectrometry, obesity, phospholipids, serum, sphingomyelins |
| D3431 | Hormones - Generic ELISA Assay | hormone, liver, liver function |
| D3432 | Insulin | carbohydrate, diabetes, hormone, insulin, liver, liver function |
| D3433 | C-Peptide | hormone, insulin, insulin secretion, liver, liver function |
| D3434 | Proinsulin | carbohydrate, diabetes, hormone, insulin, liver function, liver function enzymes |
| D3435 | Leptin | adipokine, diabetes, feeding behavior, hormone, leptin, leptin measurement, liver, liver function, liver function enzymes, obesity |
| D3436 | Adiponectin (total) | adipokine, adiponectin, hormone, insulin, insulin resistance, lipids, liver, liver function, liver function enzymes |
| D3437 | Adiponectin (HMW) | adipokine, adiponectin, hormone, insulin, insulin resistance, lipids, liver, liver function, liver function enzymes |
| D3438 | Glucagon | counterregulatory, glucagon, hormone, lipids, liver, liver function, liver function enzymes |
| D3439 | Glucagon-like peptide 1 (active) | glucagon, hormone, incretin, lipids, liver, liver function, liver function enzymes |
| D3440 | Glucagon-like peptide 1 (total) | glucagon, hormone, incretin, lipids, liver, liver function, liver function enzymes |
| D3441 | Ghrelin | eating behavior, energy balance, hormone, liver, liver function, liver function enzymes |
| D3451 | Urinary Albumin Excretion | albumin, complications, kidney, kidney disease, renal, urinary albumin excretion (UAE), urine |
| D3452 | Creatinine | cardiovascular, creatinine, kidney, kidney disease, lesion, renal, urine |
| D3453 | Urea | kidney, kidney disease, renal, urea |
| D3461 | Markers of Inflammation - custom panel | diabetes, growth factors, immunology, inflammation, interleukins, oxidative stress |
| D3463 | HS CRP | CRP, diabetes, immunology, inflammation |
| D3464 | Serum Amyloid A1 | diabetes, immunology, inflammation, serum, serum metabolic panel |
| D3465 | sICAM | diabetes, immunology, inflammation |
| D3466 | sVCAM | diabetes, immunology, inflammation |
| D3467 | sE-Selectin | diabetes, hormone, immunology, inflammation |
| D3468 | sP-Selectin | diabetes, hormone, immunology, inflammation |
| D2013 | MMPC mouse gross necropsy with histology | histology, imaging, morphology, mouse husbandry and transfer, necropsy, organs, tissue |

| Test No. | Test Name | Keywords |
|---|---|---|
| M1016 | Chronic drug delivery | Drug, drug treatment, infusion, mouse husbandry and transfer, osmotic pump, surgery |
| M1021 | Surgery – jugular vein cannulation | catheterization, clamp, intravenous, surgery, vein |
| M1022 | Surgery – tail vein injection | AAV delivery, intravenous, mouse husbandry and transfer, surgery, vein |
| M1023 | Surgery – carotid artery cannulation | artery, blood sampling, catheterization, surgery |
| M2001 | Glucose | carbohydrate, diabetes, glucose, hyperglycemia, hypoglycemia, insulin resistance, metabolite |
| M2002 | Hemoglobin A1c | diabetes, glucose, hyperglycemia, insulin, insulin action, metabolite |
| M2003 | Lactate | acidosis, carbohydrate, diabetes, glucose, insulin, insulin action, metabolite |
| M2004 | Insulin | carbohydrate, diabetes, hormone, hyperinsulinemic clamp, insulin |
| M2005 | C-peptide | hormone, insulin, insulin secretion, islet function |
| M2006 | Glucagon | counter-regulation, gluconeogenesis, glucose, glucose production, hepatic, hormone, lipids |
| M2007 | Leptin | adipokine, diabetes, feeding behavior, food intake, hormone, leptin, obesity |
| M2008 | Adiponectin | adipokine, hormone, insulin resistance, lipids |
| M2009 | Resistin | adipokine, glucose metabolism, hormone, insulin resistance |
| M2010 | Triglyceride | cardiovascular disease, insulin, insulin resistance, lipids, metabolite, obesity, serum, serum chemicals, tissue |
| M2011 | Non-esterified fatty acids | insulin, insulin resistance, lipids, metabolite, obesity |
| M2012 | Cholesterol (total) | atherosclerosis, cardiovascular disease, lipids, metabolite, obesity |
| M2013 | Cholesterol (HDL) | atherosclerosis, cardiovascular disease, lipids, liver, liver function, liver function enzymes, metabolite, obesity |
| M2014 | Cholesterol (LDL) | atherosclerosis, cardiovascular disease, lipids, metabolite, obesity |
| M2015 | Ammonia | lipids, metabolite, nitrogen, serum chemicals |
| M2016 | Lipase | lipids, metabolite, obesity |
| M2017 | Amylase | carbohydrate, enzyme activity, GI function |
| M2018 | Creatine kinase | cardiovascular, enzyme activity, lesion |
| M2019 | Alkaline phosphatase | enzyme activity, serum chemicals |
| M2020 | Lactate dehydrogenase | enzyme activity, tissue damage |
| M2021 | Albumin | liver, liver function, liver function enzymes, metabolite, protein, serum albumin, serum chemicals |
| M2022 | Alanine transferase | ALT, liver, liver function, liver function |

| Test No. | Test Name | Keywords |
|---|---|---|
| | | enzymes, metabolite, serum chemicals |
| M2023 | Aspartate transferase | liver, liver function, liver function enzymes, metabolite, serum chemicals |
| M2024 | Bilirubin | liver, liver function, liver function enzymes, metabolite |
| M2025 | Gamma-glutamyl Transferase | liver, liver function, liver function enzymes, metabolite, serum chemicals |
| M2026 | Creatinine | cardiovascular, creatinine, kidney, kidney disease, lesion, metabolite |
| M2027 | C-reactive peptide | CRP, inflammation, liver, liver function, liver function enzymes, metabolite, obesity, serum chemicals |
| M2028 | Total protein | metabolite |
| M2029 | Urea/BUN | kidney, kidney disease, metabolite, renal |
| M2030 | Uric acid | kidney, kidney disease, metabolite, renal |
| M2031 | Electrolytes | electrolyte panel, electrolytes, metabolism, pH, potassium, renal function, serum chemicals, serum metabolic panel, sodium |
| M2032 | Cytokines Panel I - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin action, insulin resistance, monokines, obesity, serum samples, tissue lysates |
| M2033 | Cytokines Panel II - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin action, insulin resistance, monokines, obesity, serum samples, tissue lysates |
| D3495 | MISC Assay | custom |
| V3071 | Lipid extraction, separation, quantification | fatty acids, lipids, metabolism, obesity |
| M2036 | Cytokines Panel III - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin resistance, monokines, obesity |
| D5202 | Factor VIII Immunohistochemistry | imaging, immunohistochemistry |
| V4020 | Cortisol - Salivary | |
| V4021 | Creatinine | creatinine |
| MI2058 | Plasma glucose (using a colorimetric kit) | glucose, plasma |
| MI2059 | Plasma insulin (using a ELISA kit) | insulin, plasma |
| MI2060 | Plasma NEFA (using a colorimetric kit) | NEFA, plasma |
| MI2061 | Plasma TG (using a colorimetric kit) | plasma, triacylglycerides |
| MI2062 | Tissue glycogen content | glycogen synthesis, tissue |
| MI2063 | Tissue TG content | tissue, triacylglycerides |
| MI1031 | Histology - Trim/Cassette (Paraffin or OCT) | histology |
| MI1033 | Histology - Paraffin Process & Embed | histology |
| MI1034 | Histology - Tissue Sections, Paraffin Unstained Slide | histology |
| MI1035 | Histology - Tissue Sections, Paraffin H&E Stain | histology |
| MI1036 | Histology - Tissue Sections, Frozen Unstained Slide | histology |

| Test No. | Test Name | Keywords |
|---|---|---|
| MI1037 | Histology - Tissue Sections, Frozen H&E Stained | histology |
| MI1038 | Histology - Special Stain, Masson Trichrome (MTC) | histology |
| MI1040 | Histology - Special Stain, Toluidine Blue | histology |
| MI1041 | Histology - Special Stain, Prussian Blue | histology |
| MI1042 | Histology - Special Stain, Picrosirius Red | histology |
| MI1043 | Histology - Speical Stian, Verhoeff Van Gieson | histology |
| MI1044 | Histology - Special Stain, Gram | bacteria, histology |
| MI1045 | Histology - Speical Stain, Luxol Fast Blue (LFB) | histology |
| MI1046 | Histology - Special Stain, Warthin Starry | bacteria, histology |
| MI1047 | Histology - Special Stain, Other | histology |
| MI1053 | Histology Technician Labor | histology, immunohistochemistry |
| MI1054 | Pathologist Hourly | histology, immunohistochemistry |
| MI1055 | Aperio 20X scan, Semi-automated, >50 slides | histology, immunohistochemistry |
| MI1056 | Aperio 20X scan, Semi-automated, batch of 20-50 | histology, immunohistochemistry |
| MI1057 | Aperio 20X scan, Semi-automated, each | histology, immunohistochemistry |
| MI1058 | Aperio Technician Labor | histology, immunohistochemistry |
| C1083-CHEM | Cholesterol Assay in Tissue- Chemical Method (per set of 12) | cholesterol, tissue |
| C1083-FPLC | Cholesterol Assay- FPLC Fractions (per sample) | cholesterol, FPLC, HDL, LDL |
| C1092-CHEM | Triglyceride Assay in Tissue- Chemical Method (per set of 12 samples) | |
| C1092-FPLC | Triglyceride Assay- FPLC Fractions (per sample) | |
| M2041 | Estradiol (E2) | ELISA, estradiol, plasma, serum |
| M2043 | Triiodothyronine (T3) | ELISA, T3, triiodothyronine |
| M2044 | Thyroxine (T4) | T4, thyroxine |
| M2045 | Thyrotropin-releasing hormone (TRH) | thyrotropin-releasing hormone, TRH |
| M2046 | Apolipoprotein C3 (ApoC3) | Apolipoprotein C3, apolipoproteins |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| M2070 | Histology - lipid content | histology, lipid |
| M2071 | Histology - lipid droplet | histology, lipid |
| M2072 | Liver Histology - fibrosis | histology |

## Bariatric Surgery

| Test No. | Test Name | Keywords |
|---|---|---|
| V4024 | Bariatric Surgery (Roux-en-Y, VSG, biliopancreatic diversion, sham controls) | absorption, adipose, bacteria, body composition, body weight, food intake, gut, gut hormones, microbiome, surgery |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| MI2070 | APC Housing Per diem (Transfer of care from ULAM to APC) | mouse husbandry and transfer |
| MI2071 | Breeding Colony Care | mouse husbandry and transfer |
| MI2072 | Technician Time | mouse husbandry and transfer |
| MI2073 | Data Analysis | data analysis |

## Basic Vitals

| Test No. | Test Name | Keywords |
|---|---|---|
| MI2050 | Rectal Temperature Recording (YSI 4600 precision thermometer) | Temperature |
| MI30059 | Tail cuff Blood Pressure (BP) determination | blood pressure, tail-cuff |
| M1032 | Body Weight | body weight, obesity |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |

## Blood Count and Chemistry

| Test No. | Test Name | Keywords |
|---|---|---|
| MI1011 | Complete blood count (CBC) | CBC, Hb HT, MCH, MCHC, NCV, PLT, RBC, WBC |
| MI1012 | Blood smear (prep only) | blood |
| MI1013 | Reticulocyte count | RBC, reticulocytes |
| MI1014 | Blood Chemistry | ALB, ALP, ALT, AST, blood chemistry, BUN, Ca, cholesterol, CK, creatinine, electrolytes, glucose, T. Bili, T. Prot, triglycerides |
| MI1015 | Blood Chemistry - Mini Liver Panel | ALT, AST, serum |
| MI1016 | Blood Chemistry - Renal Panel | BUN, creatinine, serum |
| MI1017 | Blood Chemistry - Additional Chemistries per animal | blood chemistry, clinical chemistry |
| MI1025 | White Blood Cell (WBC) Differential Count | WBC |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |

| Test No. | Test Name | Keywords |
|---|---|---|
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| MI1059 | Histology - Negative Control (mouse tissue) | |
| MI1060 | Histology - Stain (mouse tissue) | |
| D6005 | Plasma/Serum Mouse Lipocalin-2 | inflammation, obesity |
| D6006 | Plasma/Serum Mouse Calprotectin | inflammation, obesity, secretion |
| M1045 | Tail Vein Blood Sampling | blood, blood sampling, plasma, serum, serum samples |
| M2053 | Bicarbonate | |
| M2054 | Calcium | Ca, Ca2+, plasma, serum, urine |
| M2055 | Magnesium | plasma, serum, urine |
| M2056 | Phosphate | plasma, serum, urine |

## Body Composition

| Test No. | Test Name | Keywords |
|---|---|---|
| C1041 | Body Composition / Carcass Analysis (per animal) | body composition, carcass analysis, food intake, lean, obesity, QMR, total body fat |
| V3012 | Indirect calorimetry / energy expenditure in the Promethion | Activity, basal metabolic rate, body composition, carbon dioxide, CO2 production, energy expenditure, food intake, gas exchange, indirect calorimetry, obesity, oxygen, oxygen consumption, respiratory quotient, water intake, wheel running |
| V4004 | Urine pH | pH, urine |
| D4001 | Gross Body Composition | body composition, fat free mass, fat-free mass, FFM, imaging, LBM, lean, mouse husbandry and transfer, obesity |
| D4002 | Adiposity (adipose depot weights) | body composition, obese, obesity, WAT |
| M1012 | Body composition (whole body) | 1H-MRS, body composition, fat mass, in vivo, lean muscle mass, obesity, whole animal |
| M1013 | Body composition (organs) | 1H-MRS, body composition, fat mass, in vivo, lean muscle mass, obesity |
| D4003 | Meal Pattern Analysis | eating behavior, food intake, meal pattern |
| V4024 | Bariatric Surgery (Roux-en-Y, VSG, biliopancreatic diversion, sham controls) | absorption, adipose, bacteria, body composition, body weight, food intake, gut, gut hormones, microbiome, surgery |
| V4026 | Body Composition Analysis by NMR | body composition |
| D4010 | Special Services | body composition, cardiac function, exercise, indirect calorimetry, meal pattern, metabolism, telemetry |
| MI2029 | Body Composition (Bruker Minispec LF 90II) | body composition |
| MI2030 | Body Temperature (microchips implanted) | body temperature |
| MI2046 | Body Weight Recording | body weight |

| Test No. | Test Name | Keywords |
|---|---|---|
| M1032 | Body Weight | body weight, obesity |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |

## Carbohydrate Metabolism

| Test No. | Test Name | Keywords |
|---|---|---|
| C1070 | Glucose tolerance test GTT (intraperitoneal) (per animal) | carbohydrate, diabetes, glucose disposal, glucose metabolism, glucose tolerance, insulin resistance, insulin secretion, insulin sensitivity, intraperitoneal glucose tolerance |
| C1088 | GIP concentration (per set of 38 samples) | hormone, incretin, lipids, metabolism |
| C1072 | Insulin Tolerance Test (per animal) | diabetes, insulin action, insulin effectiveness, insulin resistance, insulin sensitivity, metabolism |
| C1087 | Glucose concentration (per set of 38 samples) | carbohydrate metabolism, diabetes, isotope, tracer |
| C1089 | Insulin Assay (per set of 38 samples) | carbohydrate, diabetes, hormone |
| V3003 | Glucose Tolerance Test (Oral, i.p., Intravenous, or gastric catheter) | carbohydrate, diabetes, glucose intolerance, glucose tolerance, insulin, insulin action, insulin resistance, insulin sensitivity |
| V3004 | Glucose turnover | carbohydrate, clamp, diabetes, endogenous glucose production, flux, glucose flux, glucose kinetics, glucose turnover, insulin, insulin action, insulin resistance, isotopes, kinetics, liver, liver function, tracers |
| V3005 | Hyperinsulinemic clamp | clamp, diabetes, endogenous glucose production, glucose, glucose disposal, glucose uptake, hyperinsulinemic clamp, insulin, insulin action, insulin resistance |
| V3006 | Hyperglycemic clamp | clamp, diabetes, glucose, hyperglycemic clamp, insulin, insulin resistance, insulin secretion, insulin sensitivity |
| V3008 | Glycogen synthesis | carbohydrate, diabetes, flux, glycogen synthesis, isotope, liver, liver function, tracer |
| V3010 | Tissue specific glucose uptake | 2-deoxyglucose, carbohydrate, diabetes, glucose metabolic index, insulin, insulin action, insulin sensitivity, tissue specific glucose uptake |
| V3012 | Indirect calorimetry / energy expenditure in the Promethion | Activity, basal metabolic rate, body composition, carbon dioxide, CO2 production, energy expenditure, food intake, gas exchange, indirect calorimetry, obesity, oxygen, oxygen consumption, respiratory quotient, water intake, wheel running |
| V3050 | Insulin | carbohydrate, diabetes, hormone |

| Test No. | Test Name | Keywords |
|---|---|---|
| C1071 | Glucose tolerance test GTT (oral) (per animal) | carbohydrate, diabetes, insulin, insulin resistance, insulin sensitivity, metabolism, serum |
| V4005 | Glycemic Control using Minimed | glucose |
| D3101 | Intravenous Glucose Tolerance Test | carbohydrate, diabetes, insulin, insulin action, insulin resistance, insulin secretion, insulin sensitivity |
| D3103 | IN VIVO Insulin Tolerance Tests | carbohydrate, diabetes, insulin, insulin action, insulin resistance, insulin sensitivity |
| D3104 | IN VIVO Glucose Tolerance Tests | carbohydrate, diabetes, glucose, glucose metabolism, glucose tolerance, insulin resistance, insulin sensitivity |
| D3105 | IN VIVO Glucose-stimulates Insulin Secretion Test | carbohydrate, diabetes, glucose, glucose metabolism, insulin, insulin action, insulin resistance, insulin sensitivity |
| D3401 | Glucose (urine/plasma) | carbohydrate, diabetes, glucose, hyperglycemia, hypoglycemia, insulin, insulin action, insulin effectiveness, liver, liver function, liver function enzymes, metabolite, urine |
| D3412 | Metabolomics | amino acids, aromatics, carbohydrate, diabetes, exercise, free fatty acids, glycolysis, hormone, hydroxyl acids, lipids, liver, liver function, metabolism, metabolite, serum, sterol, sugar phosphates, TCA intermediates |
| D3432 | Insulin | carbohydrate, diabetes, hormone, insulin, liver, liver function |
| M1002 | Basal glucose metabolism | carbohydrate, clamp, diabetes, flux, glucose turnover, glucose uptake, insulin resistance, kinetics |
| M1003 | Organ-specific glucose uptake | carbohydrate, diabetes, glucose uptake, insulin, insulin resistance, insulin sensitivity |
| M1005 | Insulin clearance | carbohydrate, diabetes, hormone, insulin |
| M1006 | Glucose tolerance test | carbohydrate, diabetes, glucose clearance, glucose tolerance, insulin resistance, insulin sensitivity |
| M1007 | Glucose tolerance test with insulin secretion | carbohydrate, diabetes, glucose tolerance, insulin, insulin resistance, insulin sensitivity |
| M1009 | Hepatic gluconeogenesis | carbohydrate, diabetes, glucose, glucose production, insulin, insulin resistance, liver, liver function, liver function enzymes, pyruvate tolerance test |
| M2001 | Glucose | carbohydrate, diabetes, glucose, hyperglycemia, hypoglycemia, insulin resistance, metabolite |
| M2003 | Lactate | acidosis, carbohydrate, diabetes, glucose, insulin, insulin action, metabolite |
| M2004 | Insulin | carbohydrate, diabetes, hormone, hyperinsulinemic clamp, insulin |
| M2017 | Amylase | carbohydrate, enzyme activity, GI function |
| D3496 | Corticosterone | carbohydrate, carbohydrate metabolism, hormone, serum |

| Test No. | Test Name | Keywords |
|---|---|---|
| D4003 | Meal Pattern Analysis | eating behavior, food intake, meal pattern |
| D4008 | Energy Expenditure (CLAMS, Indirect Calorimetry) + Meal Pattern Analysis | basal metabolic rate, body composition, CO2 production, energetics, energy balance, energy expenditure, food intake, heat, indirect calorimetry, obesity, oxygen consumption, RER, respiratory exchange ratio, respiratory quotient, RQ, thermogenesis |
| M1027 | Drug trial study for therapeutic efficacy on insulin resistance | Drug, drug infusion, drug treatment, drug trial, glucose homeostasis, glucose kinetics, glucose metabolism, glucose uptake, insulin action, insulin sensitivity |
| M1028 | Drug trial study for therapeutic efficacy on metabolic profile | Drug, drug infusion, drug treatment, drug trial, glucose, lipid, liver, serum, serum metabolic panel |
| M1029 | Drug trial study for therapeutic efficacy on diabetic complications | cardiovascular disease, complications, diabetes, Drug, drug infusion, drug treatment, drug trial, insulin secretion, islets, pancreas |
| M5005 | Phenotypic assessment of transplanted human islets | beta cell, diabetes, glucose tolerance, insulin, islet, islets, pancreas |
| M5006 | Phenotypic assessment of transplanted stem cell-derived beta-cells | beta cell, diabetes, glucose, glucose tolerance, imaging, immunohistochemistry, insulin, islet, islets, pancreas |
| MI2010 | Glucose Tolerance Test (OGTT or IPGTT) including blood glucose and plasma insulin | blood, glucose, glucose tolerance, insulin |
| MI2011 | Glucose Tolerance Test (OGTT or IPGTT) w/o plasma insulin | glucose, glucose tolerance, insulin, plasma |
| MI2012 | Intravenous Glucose Tolerance Test (IVGTT with dual surgical catheterization) including blood glucose and plasma insulin | blood, catheterization, glucose, glucose tolerance, insulin |
| MI2013 | Intravenous Glucose Tolerance Test (IVGTT with dual surgical catheterization) w/o plasma insulin | catheterization, glucose, glucose tolerance |
| MI2015 | Intravenous Glucose Tolerance Test using portal vein delivery | glucose, glucose tolerance, portal, vein |
| MI2016 | Insulin or Pyruvate Tolerance Test | insulin, pyruvate tolerance test, tolerance |
| MI2017 | Hyperinsulinemic-euglycemic clamp (3H-glucose + 14C-2DG) | euglycemic clamp, hyperinsulinemic clamp |
| MI2018 | Hyperinsulinemic-euglycemic clamp (3H-glucose OR 14C-2DG) | hyperinsulinemic clamp |
| MI2019 | Hyperinsulinemic-euglycemic clamp w/o tracers | hyperinsulinemic clamp |
| MI2020 | Hyperinsulinemic-euglycemic clamp using portal vein infusion | hyperinsulinemic clamp, portal, vein |
| MI2021 | Hyperinsulinemic-euglycemic clamp + steady-state plasma NEFA | hyperinsulinemic clamp, NEFA, plasma |
| MI2022 | Hyperinsulinemic-euglycemic clamp + hepatic glycogen synthesis | glycogen synthesis, hepatic, hyperinsulinemic clamp |
| MI2023 | Hyperglycemic clamp | hyperglycemic clamp |
| MI2024 | Hyperinsulinemic-hypoglycemic clamp | hyperinsulinemic clamp |
| MI2062 | Tissue glycogen content | glycogen synthesis, tissue |
| D2016 | Additional Pathology Services | CT, histology, imaging, |

| Test No. | Test Name | Keywords |
|---|---|---|
| | | immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| C1143 | Blood Glucose (per run of 100 samples) | blood, glucose |
| C1144 | Blood Ketone (per run of 100 samples) | blood, ketones |
| M1047 | Glucose Flux Measurement Using Stable Isotope | flux, glucose, glucose flux, isotope |
| M2059 | Tissue Glycogen | Glycogen |
| M1049 | Glucose Uptake and Lipid Metabolism in additional organs | glucose, glucose uptake, lipid |
| M2061 | Insulin Signaling | Forkhead Box O1, insulin, insulin receptor, insulin receptor substrate-1, insulin receptor substrate-2, phosphorylation, protein kinase B, serine, threonine, tyrosine |
| M1056 | Hyperglucagonemic clamp | clamp |

## Cardiac Function

| Test No. | Test Name | Keywords |
|---|---|---|
| V3013 | Exercise capacity/Exercise Stress Test (metabolic response to exercise) | Activity, endurance, exercise capacity, exercise stress test, exercise tolerance |
| V3030 | In vitro Morphology, Morphometrics and Histology (isolated heart) | cardiac function, isolated organ and cell perfusion, morphology |
| V3031 | Echocardiography, in vivo morphology, systolic and diastolic function; Stress echocardiography | cardiac function, diastolic, ECG, echo, echocardiography, EKG, electrocardiography, morphology, pulsed Doppler, strain imaging, stress, systolic, vascular function |
| V3032 | Telemetry (in vivo chronic arterial blood pressure measurement) | Activity, blood pressure<br>heart rate<br>activity<br>temperature<br>blood glucose<br>arrhythmia, cardiac, cardiovascular disease, diastolic, ECG, echo, EKG, glucose, systolic, telemetry, vascular function |
| V3095 | Myocardial infarction | artery, cardiac injury, cardiac remodeling, coronary ligation, heart failure, infarct |
| V3096 | Myocardial ischemia reperfusion | artery, cardiac injury, ischemia, reperfusion injury |
| C1106 | Telemetry - Cardiac parameters (per 8 mice) | blood pressure, cardiovascular, diastolic, heart rate, systolic, telemetry |
| D5005 | BP measurement by tail cuff | blood pressure, cardiac function, circulation, diabetes, hypertension, hypotension, obesity, vascular function |
| D5011 | CT, MRI, PET, & combinations | cardiac function, central nervous system, circulation, CT, diabetes, imaging, magnetic, metabolism, MRI, obesity, PET, resonance, |

| Test No. | Test Name | Keywords |
|---|---|---|
| | | spectroscopy, vascular function |
| M4001 | Abdominal Ultrasound | cardiac function, cardiovascular, cardiovascular disease, heart, heart rate, in vivo |
| M4002 | Echocardiography | cardiac function, cardiac output, echocardiography, heart |
| M4003 | Heart Rate Measurement | cardiac function, cardiac output, cardiovascular, heart, heart rate |
| M4004 | Blood Pressure Measurement | blood pressure, cardiac function, cardiac output, cardiovascular disease, heart |
| M4005 | Endothelial Function | cardiovascular, endothelial denudation, vascular, vascular function, vascular tone |
| M4007 | Abdominal Aortic Aneurysm (AAA) Model | aortic reactivity, aortic ring, cardiovascular |
| M4008 | Coronary Artery Ligation (CAL) Model | artery, cardiac, cardiac function, cardiovascular, coronary ligation, heart |
| M4009 | Transverse Aortic Constriction (TAC) Model | aortic reactivity, cardiac function, cardiac hypertrophy, heart failure |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |

## Cardiovascular and Complications

| Test No. | Test Name | Keywords |
|---|---|---|
| C1052 | Lipid Profiles (TG, CHOL, PL, NEFA)(per set of 38 samples) | lipids, non-esterified fatty acid, obesity, phospholipids, total cholesterol, triglycerides |
| C1054 | Lipoprotein fractionation by FPLC (per sample) | apolipoproteins, cholesterol, fatty acids, FPLC, lipids, lipoproteins, obesity |
| C1055 | Metabolism of chylomicrons (per sample) | apolipoproteins, chylomicron, chylomicron remnants, lipids |
| C1057 | Free Fatty Acids (NEFA) Concentration (per set of 38 samples) | free fatty acids, lipids, non-esterified fatty acid, obesity, serum |
| C1092 | Triglyceride concentration (per set of 38 samples) | lipids, metabolism, obesity |
| V3001 | Cannulation of cerebral ventricle | central control, CSF, surgery |
| V3002 | Jugular vein and carotid artery catheterization | artery, blood vessel, catheterization, chronic, insulin, insulin action, surgery, vein |
| V3011 | Tissue specific fatty acid uptake | 125I-BMIPP, flux, isotope, lipids, obesity, tissue specific fatty acid uptake, tracer |
| V3030 | In vitro Morphology, Morphometrics and Histology (isolated heart) | cardiac function, isolated organ and cell perfusion, morphology |
| V3031 | Echocardiography, in vivo morphology, systolic and diastolic function; Stress echocardiography | cardiac function, diastolic, ECG, echo, echocardiography, EKG, electrocardiography, morphology, pulsed Doppler, strain imaging, stress, systolic, vascular function |

| Test No. | Test Name | Keywords |
|---|---|---|
| V3032 | Telemetry (in vivo chronic arterial blood pressure measurement) | Activity, blood pressure<br>heart rate<br>activity<br>temperature<br>blood glucose<br>arrhythmia, cardiac, cardiovascular disease, diastolic, ECG, echo, EKG, glucose, systolic, telemetry, vascular function |
| V3033 | Blood pressure measurements | blood pressure, blood vessel, cardiac function, circulation, hypertension, hypotension, tail-cuff, telemetry, vascular, vascular function |
| V3034 | Vascular morphology | atherosclerosis, blood vessel, circulation, histology, vascular, vascular function |
| V3036 | Tail vein injections | cardiac, drug infusion, vein |
| V3070 | Plasma lipids | cholesterol, fatty acids, lipids, metabolism, obesity |
| V3073 | Quantitation of individual phospholipid classes | cholesterol, lipids, metabolism, phospholipids |
| V3075 | Fast Protein Liquid Chromatographic (FPLC) Lipoproteins Separations | cholesterol, fatty acids, lipids, lipoproteins, metabolism |
| V3076 | Morphometric determinations (aorta) | atherosclerosis, blood vessel, histology, vascular, vascular function |
| V3080 | Gross examinations and necropsy | gross examination, histology, necropsy, organs, tissue, tissues |
| V3081 | Tissue preparation, embedding, sectioning and routine staining | embedding, histology, organs, sectioning, staining, tissue, tissue preparation |
| V3082 | Tissue microdissection | diabetes, histology, immunology, insulin, insulin action, laser microdissection, organs, tissue, tissues |
| C1060 | Phospholipids concentration (per set of 38 samples) | fatty acids, lipids, phospholipids |
| C1083 | Cholesterol (total) (per set of 38 samples) | atherosclerosis, cholesterol, lipids, metabolism, metabolite, obesity |
| V3094 | Direct jugular vein injection and blood sampling | blood sampling, blood vessel, conscious animal, drug infusion, vein |
| V3095 | Myocardial infarction | artery, cardiac injury, cardiac remodeling, coronary ligation, heart failure, infarct |
| V3096 | Myocardial ischemia reperfusion | artery, cardiac injury, ischemia, reperfusion injury |
| V3097 | Transverse aortic constriction | artery, cardiac injury, heart failure, hypertension, hypertrophy, pressure overload, TAC |
| V3098 | GFR-FITC-Inulin; HPLC Cr | glomerular filtration, HPLC |
| V3099 | Albuminuria | complications, diabetes, kidney, kidney disease, protein, urinary albumin excretion (UAE), urine |
| V4000 | Renal Blood Flow (Doppler) | blood flow, blood pressure |
| V4002 | Osmometer Plasma/Urine | osmolality, urine |
| V4003 | Urine Ca/Phosphorus Excretion | urine |
| V4004 | Urine pH | pH, urine |
| C1105 | Fatty Acid analysis via GC (each) | fatty acid composition, fatty acids, lipid, |

| Test No. | Test Name | Keywords |
|---|---|---|
| | | obesity |
| C1106 | Telemetry - Cardiac parameters (per 8 mice) | blood pressure, cardiovascular, diastolic, heart rate, systolic, telemetry |
| D3301 | Lipid extraction from liver | atherosclerosis, cholesterol, obesity, total cholesterol, triglycerides |
| D3402 | Hemoglobin A1C | diabetes, glucose, Hemoglobin A1C, hyperglycemia, liver, liver function, liver function enzymes, metabolism |
| D3404 | Triglyceride | liver, metabolism, triglycerides |
| D3405 | Total Cholesterol | atherosclerosis, cholesterol, lipids, liver, liver function, metabolism, metabolite, obesity, total cholesterol |
| D3406 | HDL-C and LDL-C/VLDL-C | atherosclerosis, cholesterol, lipids, liver, liver function, metabolism, metabolite, obesity |
| D3407 | HDL-TG and LDL-TG/VLDL-TG | atherosclerosis, cholesterol, lipids, liver, liver function, metabolism, metabolite, obesity |
| D3408 | Non esterified fatty acids | lipids, liver, liver function, liver function enzymes, metabolism, non-esterified fatty acid |
| D3413 | Complex lipid ratios | ceramides, diabetes, exercise, lipids, liver, liver function, lysophosphatidylcholines, mass spectrometry, obesity, phospholipids, serum, sphingomyelins |
| D3451 | Urinary Albumin Excretion | albumin, complications, kidney, kidney disease, renal, urinary albumin excretion (UAE), urine |
| D3452 | Creatinine | cardiovascular, creatinine, kidney, kidney disease, lesion, renal, urine |
| D3453 | Urea | kidney, kidney disease, renal, urea |
| D3461 | Markers of Inflammation - custom panel | diabetes, growth factors, immunology, inflammation, interleukins, oxidative stress |
| D3463 | HS CRP | CRP, diabetes, immunology, inflammation |
| D3464 | Serum Amyloid A1 | diabetes, immunology, inflammation, serum, serum metabolic panel |
| D3465 | sICAM | diabetes, immunology, inflammation |
| D3466 | sVCAM | diabetes, immunology, inflammation |
| D3467 | sE-Selectin | diabetes, hormone, immunology, inflammation |
| D3468 | sP-Selectin | diabetes, hormone, immunology, inflammation |
| D5005 | BP measurement by tail cuff | blood pressure, cardiac function, circulation, diabetes, hypertension, hypotension, obesity, vascular function |
| D5011 | CT, MRI, PET, & combinations | cardiac function, central nervous system, circulation, CT, diabetes, imaging, magnetic, metabolism, MRI, obesity, PET, resonance, spectroscopy, vascular function |
| M1010 | Lipid metabolism | fatty acids, in vivo, lipids, obesity, palmitate, triglycerides |
| M2002 | Hemoglobin A1c | diabetes, glucose, hyperglycemia, insulin, insulin action, metabolite |
| M2010 | Triglyceride | cardiovascular disease, insulin, insulin |

| Test No. | Test Name | Keywords |
|---|---|---|
| | | resistance, lipids, metabolite, obesity, serum, serum chemicals, tissue |
| M2011 | Non-esterified fatty acids | insulin, insulin resistance, lipids, metabolite, obesity |
| M2012 | Cholesterol (total) | atherosclerosis, cardiovascular disease, lipids, metabolite, obesity |
| M2013 | Cholesterol (HDL) | atherosclerosis, cardiovascular disease, lipids, liver, liver function, liver function enzymes, metabolite, obesity |
| M2014 | Cholesterol (LDL) | atherosclerosis, cardiovascular disease, lipids, metabolite, obesity |
| M2016 | Lipase | lipids, metabolite, obesity |
| M2021 | Albumin | liver, liver function, liver function enzymes, metabolite, protein, serum albumin, serum chemicals |
| M2026 | Creatinine | cardiovascular, creatinine, kidney, kidney disease, lesion, metabolite |
| M2027 | C-reactive peptide | CRP, inflammation, liver, liver function, liver function enzymes, metabolite, obesity, serum chemicals |
| M2029 | Urea/BUN | kidney, kidney disease, metabolite, renal |
| M2030 | Uric acid | kidney, kidney disease, metabolite, renal |
| M2031 | Electrolytes | electrolyte panel, electrolytes, metabolism, pH, potassium, renal function, serum chemicals, serum metabolic panel, sodium |
| M2032 | Cytokines Panel I - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin action, insulin resistance, monokines, obesity, serum samples, tissue lysates |
| M2033 | Cytokines Panel II - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin action, insulin resistance, monokines, obesity, serum samples, tissue lysates |
| V3071 | Lipid extraction, separation, quantification | fatty acids, lipids, metabolism, obesity |
| M2036 | Cytokines Panel III - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin resistance, monokines, obesity |
| D5101 | Cognitive Function - Radial Arm Water Maze | cognitive function |
| M4001 | Abdominal Ultrasound | cardiac function, cardiovascular, cardiovascular disease, heart, heart rate, in vivo |
| M4002 | Echocardiography | cardiac function, cardiac output, echocardiography, heart |
| M4003 | Heart Rate Measurement | cardiac function, cardiac output, cardiovascular, heart, heart rate |
| M4004 | Blood Pressure Measurement | blood pressure, cardiac function, cardiac output, cardiovascular disease, heart |
| M4005 | Endothelial Function | cardiovascular, endothelial denudation, vascular, vascular function, vascular tone |
| M4006 | Hind Limb Ischemia (HLI) Model | ischemia, vascular, vascular function |

| Test No. | Test Name | Keywords |
|---|---|---|
| M4007 | Abdominal Aortic Aneurysm (AAA) Model | aortic reactivity, aortic ring, cardiovascular |
| M4008 | Coronary Artery Ligation (CAL) Model | artery, cardiac, cardiac function, cardiovascular, coronary ligation, heart |
| M4009 | Transverse Aortic Constriction (TAC) Model | aortic reactivity, cardiac function, cardiac hypertrophy, heart failure |
| D4010 | Special Services | body composition, cardiac function, exercise, indirect calorimetry, meal pattern, metabolism, telemetry |
| C1083-CHEM | Cholesterol Assay in Tissue- Chemical Method (per set of 12) | cholesterol, tissue |
| C1083-FPLC | Cholesterol Assay- FPLC Fractions (per sample) | cholesterol, FPLC, HDL, LDL |
| C1092-CHEM | Triglyceride Assay in Tissue- Chemical Method (per set of 12 samples) | |
| C1092-FPLC | Triglyceride Assay- FPLC Fractions (per sample) | |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| D6005 | Plasma/Serum Mouse Lipocalin-2 | inflammation, obesity |
| D6006 | Plasma/Serum Mouse Calprotectin | inflammation, obesity, secretion |
| M4011 | Aortic morphometry studies | aorta, morphometry |

## Central Nervous System

| Test No. | Test Name | Keywords |
|---|---|---|
| D5011 | CT, MRI, PET, & combinations | cardiac function, central nervous system, circulation, CT, diabetes, imaging, magnetic, metabolism, MRI, obesity, PET, resonance, spectroscopy, vascular function |
| D5101 | Cognitive Function - Radial Arm Water Maze | cognitive function |
| D5102 | Cognitive Function - Morris Water Maze (Male Mice) | cognitive function |
| D5103 | Cognitive Function - Morris Water Maze (Female Mice) | cognitive function |
| D5104 | Cognitive Function - Y Maze | cognitive function |
| MI2500 | Spatial Object Recognition | behavior, cognitive function, learning, memory |
| MI2501 | Novel Objective Recognition | cognitive function |
| MI2502 | Morris Water Maze | water maze |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, |

| Test No. | Test Name | Keywords |
|---|---|---|
| | | cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| M4016 | Denervation: Surgical and chemical Models | nerve, surgery |

## Circulation

| Test No. | Test Name | Keywords |
|---|---|---|
| V3013 | Exercise capacity/Exercise Stress Test (metabolic response to exercise) | Activity, endurance, exercise capacity, exercise stress test, exercise tolerance |
| V3033 | Blood pressure measurements | blood pressure, blood vessel, cardiac function, circulation, hypertension, hypotension, tail-cuff, telemetry, vascular, vascular function |
| V3034 | Vascular morphology | atherosclerosis, blood vessel, circulation, histology, vascular, vascular function |
| D5005 | BP measurement by tail cuff | blood pressure, cardiac function, circulation, diabetes, hypertension, hypotension, obesity, vascular function |
| D5011 | CT, MRI, PET, & combinations | cardiac function, central nervous system, circulation, CT, diabetes, imaging, magnetic, metabolism, MRI, obesity, PET, resonance, spectroscopy, vascular function |
| M4002 | Echocardiography | cardiac function, cardiac output, echocardiography, heart |
| M4006 | Hind Limb Ischemia (HLI) Model | ischemia, vascular, vascular function |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| M4010 | Moor Laser Speckle Contrast Imaging | blood flow, ischemia, peripheral vascular disease, vascular disease |
| M4013 | Carotid Artery Ligation Models | artery, carotid |
| M4014 | Carotid Artery Restriction Models | artery, carotid |
| M4015 | Wire Myography Studies | artery, vascular |
| M4018 | Jugular vein and carotid artery catheterization | arterial, artery, carotid, catheterization, jugular |

## Cognitive function assays

| Test No. | Test Name | Keywords |
|---|---|---|
| D5101 | Cognitive Function - Radial Arm Water Maze | cognitive function |
| D5102 | Cognitive Function - Morris Water Maze (Male Mice) | cognitive function |
| MI2500 | Spatial Object Recognition | behavior, cognitive function, learning, memory |

| Test No. | Test Name | Keywords |
|---|---|---|
| MI2501 | Novel Objective Recognition | cognitive function |
| MI2502 | Morris Water Maze | water maze |
| MI2505 | Open Field Test (Ethovision or Photobeam) Anxiety | anxiety, behavior |
| MI2506 | Elevated Plus Maze (Ethovision) | anxiety, behavior |
| MI2507 | Novelty Suppressed Feeding Test | anxiety, behavior, depression |
| MI2508 | Forced Swim Test | anxiety, behavior, depression |
| MI2509 | Tail Suspension Test | anxiety, behavior, depression |
| MI2510 | Conditioned Place Preference | behavior, reward |
| MI2511 | Wheel Running (home cage, low profile RF running wheels) | behavior, reward |
| MI2512 | Operant Conditioning | behavior, reward |
| MI2513 | Locomotor sensitization/tolerance | behavior, reward |
| MI2514 | General Activity | behavior |
| MI2515 | Training | behavior |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| C1121 | C1121-Operant fixed ratio (per set of 8 mice) | cognitive function, learning |
| C1122 | C1122-Operant progressive ratio (per set of 8 mice) | cognitive function, learning |
| C1123 | C1123-5-choice serial reaction time trial(per set of 8 mice) | cognitive function |
| C1124 | C1124-Delayed discounting (per set of 8 mice) | cognitive function |
| C1125 | C1125-Social learning of food stimuli (per set of 8 mice) | learning |
| C1126 | C1126-Conditioned taste aversion (per set of 8 mice) | cognitive function, learning |
| C1127 | C1127-Conditioned place preference (per set of 8 mice) | cognitive function, learning, reward |
| C1128 | C1128-Radial arm maze (per set of 8 mice) | hippocampal function, learning, non spatial, spatial, specific activity |
| C1129 | C1129-Morris Water maze (per set of 8 mice) | learning, maze, non spatial, spatial, specific activity, water, water maze |
| C1130 | C1130-Hole-board maze (per set of 8 mice) | cognitive function, learning, memory |
| C1131 | C1131-Novel object recognition test (per set of 8 mice) | hippocampal function, memory |
| C1132 | C1132-Acute stress challenge (per run of 8 mice) | behavior, cognitive function, energy balance, metabolism, stress |
| C1133 | C1133-Chronic variable stress challenge (per run of 8 mice) | behavior, cognitive function, energy balance, metabolism, stress |
| C1134 | C1134-Collecting post-stress plasma samples (per run of 8 mice) | hormone, metabolite, stress |

| Test No. | Test Name | Keywords |
|---|---|---|
| C1135 | C1135-Active and passive avoidance (per set of 8 mice) | fear, learning, long term memory, memory |
| C1136 | C1136-Elevated plus maze (per run of 8 mice) | anxiety, behavior, stress |
| C1137 | C1137-Open field test (per run of 8 mice) | Activity, anxiety, locomotor, stress |
| C1138 | C1138-Forced Swim test (per run of 8 mice) | behavior, depression, swim |
| C1139 | C1139- Tail suspension test (per run of 8 mice) | behavior, depression |
| C1140 | C1140- Sucrose preference test (per run of 8 mice) | anhedonia, reward, taste discrimination |

## Diabetes

| Test No. | Test Name | Keywords |
|---|---|---|
| C1070 | Glucose tolerance test GTT (intraperitoneal) (per animal) | carbohydrate, diabetes, glucose disposal, glucose metabolism, glucose tolerance, insulin resistance, insulin secretion, insulin sensitivity, intraperitoneal glucose tolerance |
| C1072 | Insulin Tolerance Test (per animal) | diabetes, insulin action, insulin effectiveness, insulin resistance, insulin sensitivity, metabolism |
| C1087 | Glucose concentration (per set of 38 samples) | carbohydrate metabolism, diabetes, isotope, tracer |
| V3002 | Jugular vein and carotid artery catheterization | artery, blood vessel, catheterization, chronic, insulin, insulin action, surgery, vein |
| V3003 | Glucose Tolerance Test (Oral, i.p., Intravenous, or gastric catheter) | carbohydrate, diabetes, glucose intolerance, glucose tolerance, insulin, insulin action, insulin resistance, insulin sensitivity |
| V3004 | Glucose turnover | carbohydrate, clamp, diabetes, endogenous glucose production, flux, glucose flux, glucose kinetics, glucose turnover, insulin, insulin action, insulin resistance, isotopes, kinetics, liver, liver function, tracers |
| V3005 | Hyperinsulinemic clamp | clamp, diabetes, endogenous glucose production, glucose, glucose disposal, glucose uptake, hyperinsulinemic clamp, insulin, insulin action, insulin resistance |
| V3006 | Hyperglycemic clamp | clamp, diabetes, glucose, hyperglycemic clamp, insulin, insulin resistance, insulin secretion, insulin sensitivity |
| V3008 | Glycogen synthesis | carbohydrate, diabetes, flux, glycogen synthesis, isotope, liver, liver function, tracer |
| V3010 | Tissue specific glucose uptake | 2-deoxyglucose, carbohydrate, diabetes, glucose metabolic index, insulin, insulin action, insulin sensitivity, tissue specific glucose uptake |
| V3082 | Tissue microdissection | diabetes, histology, immunology, insulin, insulin action, laser microdissection, organs, tissue, tissues |
| C1071 | Glucose tolerance test GTT (oral) (per animal) | carbohydrate, diabetes, insulin, insulin resistance, insulin sensitivity, metabolism, serum |
| D3101 | Intravenous Glucose Tolerance Test | carbohydrate, diabetes, insulin, insulin action, |

| Test No. | Test Name | Keywords |
|---|---|---|
| | | insulin resistance, insulin secretion, insulin sensitivity |
| D3103 | IN VIVO Insulin Tolerance Tests | carbohydrate, diabetes, insulin, insulin action, insulin resistance, insulin sensitivity |
| D3104 | IN VIVO Glucose Tolerance Tests | carbohydrate, diabetes, glucose, glucose metabolism, glucose tolerance, insulin resistance, insulin sensitivity |
| D3105 | IN VIVO Glucose-stimulates Insulin Secretion Test | carbohydrate, diabetes, glucose, glucose metabolism, insulin, insulin action, insulin resistance, insulin sensitivity |
| D3401 | Glucose (urine/plasma) | carbohydrate, diabetes, glucose, hyperglycemia, hypoglycemia, insulin, insulin action, insulin effectiveness, liver, liver function, liver function enzymes, metabolite, urine |
| D3403 | beta-OH butyrate | Atkins, diabetes, insulin, ketones, liver, liver function, liver function enzymes, low carbohydrate, metabolism |
| D3404 | Triglyceride | liver, metabolism, triglycerides |
| D3405 | Total Cholesterol | atherosclerosis, cholesterol, lipids, liver, liver function, metabolism, metabolite, obesity, total cholesterol |
| D3406 | HDL-C and LDL-C/VLDL-C | atherosclerosis, cholesterol, lipids, liver, liver function, metabolism, metabolite, obesity |
| D3407 | HDL-TG and LDL-TG/VLDL-TG | atherosclerosis, cholesterol, lipids, liver, liver function, metabolism, metabolite, obesity |
| D3408 | Non esterified fatty acids | lipids, liver, liver function, liver function enzymes, metabolism, non-esterified fatty acid |
| D3412 | Metabolomics | amino acids, aromatics, carbohydrate, diabetes, exercise, free fatty acids, glycolysis, hormone, hydroxyl acids, lipids, liver, liver function, metabolism, metabolite, serum, sterol, sugar phosphates, TCA intermediates |
| D3413 | Complex lipid ratios | ceramides, diabetes, exercise, lipids, liver, liver function, lysophosphatidylcholines, mass spectrometry, obesity, phospholipids, serum, sphingomyelins |
| D3431 | Hormones - Generic ELISA Assay | hormone, liver, liver function |
| D3432 | Insulin | carbohydrate, diabetes, hormone, insulin, liver, liver function |
| D3433 | C-Peptide | hormone, insulin, insulin secretion, liver, liver function |
| D3434 | Proinsulin | carbohydrate, diabetes, hormone, insulin, liver function, liver function enzymes |
| D3435 | Leptin | adipokine, diabetes, feeding behavior, hormone, leptin, leptin measurement, liver, liver function, liver function enzymes, obesity |
| D3436 | Adiponectin (total) | adipokine, adiponectin, hormone, insulin, insulin resistance, lipids, liver, liver function, liver function enzymes |
| D3437 | Adiponectin (HMW) | adipokine, adiponectin, hormone, insulin, insulin resistance, lipids, liver, liver function, |

| Test No. | Test Name | Keywords |
|---|---|---|
| | | liver function enzymes |
| D3438 | Glucagon | counterregulatory, glucagon, hormone, lipids, liver, liver function, liver function enzymes |
| D3439 | Glucagon-like peptide 1 (active) | glucagon, hormone, incretin, lipids, liver, liver function, liver function enzymes |
| D3440 | Glucagon-like peptide 1 (total) | glucagon, hormone, incretin, lipids, liver, liver function, liver function enzymes |
| D3441 | Ghrelin | eating behavior, energy balance, hormone, liver, liver function, liver function enzymes |
| M1001 | Hyperinsulinemic-euglycemic clamp | awake mice, clamp, diabetes, glucose, glucose metabolism, in vivo, insulin, insulin action, insulin resistance, insulin secretion, insulin sensitivity |
| M1002 | Basal glucose metabolism | carbohydrate, clamp, diabetes, flux, glucose turnover, glucose uptake, insulin resistance, kinetics |
| M1003 | Organ-specific glucose uptake | carbohydrate, diabetes, glucose uptake, insulin, insulin resistance, insulin sensitivity |
| M1004 | Hyperglycemic clamp | awake mice, clamp, diabetes, glucose, in vivo, insulin, insulin resistance, insulin secretion |
| M1005 | Insulin clearance | carbohydrate, diabetes, hormone, insulin |
| M1006 | Glucose tolerance test | carbohydrate, diabetes, glucose clearance, glucose tolerance, insulin resistance, insulin sensitivity |
| M1007 | Glucose tolerance test with insulin secretion | carbohydrate, diabetes, glucose tolerance, insulin, insulin resistance, insulin sensitivity |
| M1008 | Insulin tolerance test | glucose, insulin effectiveness, insulin resistance, insulin sensitivity |
| M1009 | Hepatic gluconeogenesis | carbohydrate, diabetes, glucose, glucose production, insulin, insulin resistance, liver, liver function, liver function enzymes, pyruvate tolerance test |
| M1015 | Chronic high-fat feeding | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, insulin resistance, mouse husbandry and transfer, obesity, type 2 diabetes |
| M1017 | STZ-induced type 1 diabetes model | Drug, hyperglycemia, insulin, insulinopenia, streptozotocin, type 1 diabetes |
| M1019 | Chronic/acute phloridzin treatment | diabetes, Drug, glucose clearance, glycemia, insulin, insulin action, renal |
| M2001 | Glucose | carbohydrate, diabetes, glucose, hyperglycemia, hypoglycemia, insulin resistance, metabolite |
| M2002 | Hemoglobin A1c | diabetes, glucose, hyperglycemia, insulin, insulin action, metabolite |
| M2003 | Lactate | acidosis, carbohydrate, diabetes, glucose, insulin, insulin action, metabolite |
| M2004 | Insulin | carbohydrate, diabetes, hormone, hyperinsulinemic clamp, insulin |
| M2005 | C-peptide | hormone, insulin, insulin secretion, islet function |

| Test No. | Test Name | Keywords |
|---|---|---|
| M2006 | Glucagon | counter-regulation, gluconeogenesis, glucose, glucose production, hepatic, hormone, lipids |
| M2007 | Leptin | adipokine, diabetes, feeding behavior, food intake, hormone, leptin, obesity |
| M2010 | Triglyceride | cardiovascular disease, insulin, insulin resistance, lipids, metabolite, obesity, serum, serum chemicals, tissue |
| M2011 | Non-esterified fatty acids | insulin, insulin resistance, lipids, metabolite, obesity |
| M2032 | Cytokines Panel I - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin action, insulin resistance, monokines, obesity, serum samples, tissue lysates |
| M2033 | Cytokines Panel II - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin action, insulin resistance, monokines, obesity, serum samples, tissue lysates |
| M2036 | Cytokines Panel III - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin resistance, monokines, obesity |
| D2008 | Vertical Sleeve Gastrectomy (VSG) | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, mouse husbandry and transfer, obesity, type 2 diabetes |
| D2009 | Roux en Y Gastric Bypass (RYGB) | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, insulin resistance, mouse husbandry and transfer, obesity, type 2 diabetes |
| V4024 | Bariatric Surgery (Roux-en-Y, VSG, biliopancreatic diversion, sham controls) | absorption, adipose, bacteria, body composition, body weight, food intake, gut, gut hormones, microbiome, surgery |
| M1029 | Drug trial study for therapeutic efficacy on diabetic complications | cardiovascular disease, complications, diabetes, Drug, drug infusion, drug treatment, drug trial, insulin secretion, islets, pancreas |
| M3001 | Pancreas isolation and embedding | islets, pancreas, surgery |
| M3011 | Pancreatic beta-cell mass (comprehensive) | beta cell, islet, islets, pancreas |
| M3012 | Pancreas islet architecture analysis | beta cell, glucagon, imaging, immunohistochemistry, insulin, islet, islets, pancreas |
| M3013 | Pancreatic islet isolation | beta cell, islet, islets, pancreas, surgery |
| M3014 | Ex vivo islet analysis for insulin secretion | insulin, insulin secretion, islet, islets, pancreas |
| M3015 | Ex vivo islet molecular analyses | beta cell, islet, islets, pancreas, protein |
| M5001 | Humanized Mouse (normoglycemic NSG mouse) | mouse husbandry and transfer, mouse models |
| M5002 | Humanized Mouse (STZ-induced diabetic NSG mouse) | mouse husbandry and transfer, mouse models |
| M5003 | Humanized Mouse (spontaneous-diabetic NSG-Ins2 Akita mouse) | diabetes, mouse husbandry and transfer, mouse models |
| M5004 | Humanized Mouse (induced-diabetic NSG-RIP-DTR mouse) | diabetes, mouse husbandry and transfer, mouse models |
| M5005 | Phenotypic assessment of transplanted human | beta cell, diabetes, glucose tolerance, insulin, |

| Test No. | Test Name | Keywords |
|---|---|---|
| | islets | islet, islets, pancreas |
| M5006 | Phenotypic assessment of transplanted stem cell-derived beta-cells | beta cell, diabetes, glucose, glucose tolerance, imaging, immunohistochemistry, insulin, islet, islets, pancreas |
| MI2010 | Glucose Tolerance Test (OGTT or IPGTT) including blood glucose and plasma insulin | blood, glucose, glucose tolerance, insulin |
| MI2011 | Glucose Tolerance Test (OGTT or IPGTT) w/o plasma insulin | glucose, glucose tolerance, insulin, plasma |
| MI2012 | Intravenous Glucose Tolerance Test (IVGTT with dual surgical catheterization) including blood glucose and plasma insulin | blood, catheterization, glucose, glucose tolerance, insulin |
| MI2013 | Intravenous Glucose Tolerance Test (IVGTT with dual surgical catheterization) w/o plasma insulin | catheterization, glucose, glucose tolerance |
| MI2015 | Intravenous Glucose Tolerance Test using portal vein delivery | glucose, glucose tolerance, portal, vein |
| MI2016 | Insulin or Pyruvate Tolerance Test | insulin, pyruvate tolerance test, tolerance |
| MI2017 | Hyperinsulinemic-euglycemic clamp (3H-glucose + 14C-2DG) | euglycemic clamp, hyperinsulinemic clamp |
| MI2018 | Hyperinsulinemic-euglycemic clamp (3H-glucose OR 14C-2DG) | hyperinsulinemic clamp |
| MI2019 | Hyperinsulinemic-euglycemic clamp w/o tracers | hyperinsulinemic clamp |
| MI2020 | Hyperinsulinemic-euglycemic clamp using portal vein infusion | hyperinsulinemic clamp, portal, vein |
| MI2021 | Hyperinsulinemic-euglycemic clamp + steady-state plasma NEFA | hyperinsulinemic clamp, NEFA, plasma |
| MI2022 | Hyperinsulinemic-euglycemic clamp + hepatic glycogen synthesis | glycogen synthesis, hepatic, hyperinsulinemic clamp |
| MI2023 | Hyperglycemic clamp | hyperglycemic clamp |
| MI2024 | Hyperinsulinemic-hypoglycemic clamp | hyperinsulinemic clamp |
| MI2058 | Plasma glucose (using a colorimetric kit) | glucose, plasma |
| MI2059 | Plasma insulin (using a ELISA kit) | insulin, plasma |
| MI2060 | Plasma NEFA (using a colorimetric kit) | NEFA, plasma |
| MI2061 | Plasma TG (using a colorimetric kit) | plasma, triacylglycerides |
| MI2062 | Tissue glycogen content | glycogen synthesis, tissue |
| MI2063 | Tissue TG content | tissue, triacylglycerides |
| M2040 | Glucagon-like peptide 1 (GLP-1 ). | glucagon, liver, liver function, liver function enzymes, Luminex, peptides |
| D2010 | Vertical Sleeve Gastrectomy (VSG) Package | animal model, diabetes, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, mouse husbandry and transfer, obesity |
| D2011 | Roux en Y Gastric Bypass (RYGB) Package | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, insulin resistance, mouse husbandry and transfer, obesity, type 2 diabetes |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |

| Test No. | Test Name | Keywords |
|---|---|---|
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| M2034 | Amylin (Active) | Amylin |
| M2035 | Ghrelin | ghrelin |
| C1143 | Blood Glucose (per run of 100 samples) | blood, glucose |
| C1144 | Blood Ketone (per run of 100 samples) | blood, ketones |
| M1047 | Glucose Flux Measurement Using Stable Isotope | flux, glucose, glucose flux, isotope |
| M2059 | Tissue Glycogen | Glycogen |
| M1049 | Glucose Uptake and Lipid Metabolism in additional organs | glucose, glucose uptake, lipid |
| M2061 | Insulin Signaling | Forkhead Box O1, insulin, insulin receptor, insulin receptor substrate-1, insulin receptor substrate-2, phosphorylation, protein kinase B, serine, threonine, tyrosine |
| M1056 | Hyperglucagonemic clamp | clamp |

## Drug trials

| Test No. | Test Name | Keywords |
|---|---|---|
| M1025 | Drug trial study for PK/PD analysis | chronic, Drug, drug treatment, drug trial, pharmacodynamics, pharmacokinetics |
| M1026 | Drug trial study for therapeutic efficacy on obesity | Drug, drug infusion, drug treatment, drug trial, energy balance, energy expenditure, obese, obesity |
| M1027 | Drug trial study for therapeutic efficacy on insulin resistance | Drug, drug infusion, drug treatment, drug trial, glucose homeostasis, glucose kinetics, glucose metabolism, glucose uptake, insulin action, insulin sensitivity |
| M1028 | Drug trial study for therapeutic efficacy on metabolic profile | Drug, drug infusion, drug treatment, drug trial, glucose, lipid, liver, serum, serum metabolic panel |
| M1029 | Drug trial study for therapeutic efficacy on diabetic complications | cardiovascular disease, complications, diabetes, Drug, drug infusion, drug treatment, drug trial, insulin secretion, islets, pancreas |
| M1030 | Drug trial study for toxicity | Drug, drug infusion, drug treatment, drug trial, liver function, liver function enzymes, toxicity |
| MI1007 | Technician Service Fee / Special Procedures | animal husbandry, animal procedures, dosing, gavage, mouse husbandry and transfer, TST, venipuncture |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver |

| Test No. | Test Name | Keywords |
|---|---|---|
| | | function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| M1043 | Drug Treatment | Drug, drug treatment, drug trial |
| M1044 | Drug Preparation | Drug, drug treatment, drug trial |

## Endocrine Deficiency

| Test No. | Test Name | Keywords |
|---|---|---|
| C1088 | GIP concentration (per set of 38 samples) | hormone, incretin, lipids, metabolism |
| C1085 | Glucagon concentration (per set of 38 samples) | counter-regulation, counterregulatory, hormone, lipids |
| C1086 | GLP-1 concentration (per set of 38 samples) | counterregulatory, glucagon, hormone, incretin, lipids |
| C1089 | Insulin Assay (per set of 38 samples) | carbohydrate, diabetes, hormone |
| V3001 | Cannulation of cerebral ventricle | central control, CSF, surgery |
| V3002 | Jugular vein and carotid artery catheterization | artery, blood vessel, catheterization, chronic, insulin, insulin action, surgery, vein |
| V3003 | Glucose Tolerance Test (Oral, i.p., Intravenous, or gastric catheter) | carbohydrate, diabetes, glucose intolerance, glucose tolerance, insulin, insulin action, insulin resistance, insulin sensitivity |
| V3005 | Hyperinsulinemic clamp | clamp, diabetes, endogenous glucose production, glucose, glucose disposal, glucose uptake, hyperinsulinemic clamp, insulin, insulin action, insulin resistance |
| V3006 | Hyperglycemic clamp | clamp, diabetes, glucose, hyperglycemic clamp, insulin, insulin resistance, insulin secretion, insulin sensitivity |
| V3017 | Assess real time imaging of cellular metabolic events | imaging, metabolism, microcirculation, real time imaging |
| V3050 | Insulin | carbohydrate, diabetes, hormone |
| V3051 | Glucagon - ELISA | counter-regulation, hormone, lipids |
| V3052 | Corticosterone | glucocorticoid, hormone, stress |
| V3054 | Leptin (Luminex assay) | adipokine, diabetes, feeding behavior, hormone, leptin, obesity |
| V3055 | C-peptide (Luminex assay) | hormone, insulin, insulin action, insulin secretion |
| V3059 | PRL (prolactin) | fertility, hormone, prolactin |
| V3060 | ACTH | adrenocorticotropic hormone, corticotropin, glucocorticoid, hormone, stress |
| V3082 | Tissue microdissection | diabetes, histology, immunology, insulin, insulin action, laser microdissection, organs, tissue, tissues |
| C1061 | Adiponectin concentration (per set of 38 samples) | adipokine, adiponectin, gut hormones, hormone, insulin, insulin action, insulin resistance, peptides, serum |
| V3067 | Testosterone | hormone, sex, steroid |
| D3301 | Lipid extraction from liver | atherosclerosis, cholesterol, obesity, total cholesterol, triglycerides |

| Test No. | Test Name | Keywords |
|---|---|---|
| D3402 | Hemoglobin A1C | diabetes, glucose, Hemoglobin A1C, hyperglycemia, liver, liver function, liver function enzymes, metabolism |
| D3431 | Hormones - Generic ELISA Assay | hormone, liver, liver function |
| D3432 | Insulin | carbohydrate, diabetes, hormone, insulin, liver, liver function |
| D3433 | C-Peptide | hormone, insulin, insulin secretion, liver, liver function |
| D3434 | Proinsulin | carbohydrate, diabetes, hormone, insulin, liver function, liver function enzymes |
| D3435 | Leptin | adipokine, diabetes, feeding behavior, hormone, leptin, leptin measurement, liver, liver function, liver function enzymes, obesity |
| D3436 | Adiponectin (total) | adipokine, adiponectin, hormone, insulin, insulin resistance, lipids, liver, liver function, liver function enzymes |
| D3437 | Adiponectin (HMW) | adipokine, adiponectin, hormone, insulin, insulin resistance, lipids, liver, liver function, liver function enzymes |
| D3438 | Glucagon | counterregulatory, glucagon, hormone, lipids, liver, liver function, liver function enzymes |
| D3439 | Glucagon-like peptide 1 (active) | glucagon, hormone, incretin, lipids, liver, liver function, liver function enzymes |
| D3440 | Glucagon-like peptide 1 (total) | glucagon, hormone, incretin, lipids, liver, liver function, liver function enzymes |
| D3441 | Ghrelin | eating behavior, energy balance, hormone, liver, liver function, liver function enzymes |
| M1005 | Insulin clearance | carbohydrate, diabetes, hormone, insulin |
| M2001 | Glucose | carbohydrate, diabetes, glucose, hyperglycemia, hypoglycemia, insulin resistance, metabolite |
| M2002 | Hemoglobin A1c | diabetes, glucose, hyperglycemia, insulin, insulin action, metabolite |
| M2004 | Insulin | carbohydrate, diabetes, hormone, hyperinsulinemic clamp, insulin |
| M2005 | C-peptide | hormone, insulin, insulin secretion, islet function |
| M2006 | Glucagon | counter-regulation, gluconeogenesis, glucose, glucose production, hepatic, hormone, lipids |
| M2007 | Leptin | adipokine, diabetes, feeding behavior, food intake, hormone, leptin, obesity |
| M2008 | Adiponectin | adipokine, hormone, insulin resistance, lipids |
| M2009 | Resistin | adipokine, glucose metabolism, hormone, insulin resistance |
| M2027 | C-reactive peptide | CRP, inflammation, liver, liver function, liver function enzymes, metabolite, obesity, serum chemicals |
| M2032 | Cytokines Panel I - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin action, insulin resistance, monokines, obesity, serum samples, tissue lysates |

| Test No. | Test Name | Keywords |
|---|---|---|
| M2033 | Cytokines Panel II - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin action, insulin resistance, monokines, obesity, serum samples, tissue lysates |
| V4024 | Bariatric Surgery (Roux-en-Y, VSG, biliopancreatic diversion, sham controls) | absorption, adipose, bacteria, body composition, body weight, food intake, gut, gut hormones, microbiome, surgery |
| M1027 | Drug trial study for therapeutic efficacy on insulin resistance | Drug, drug infusion, drug treatment, drug trial, glucose homeostasis, glucose kinetics, glucose metabolism, glucose uptake, insulin action, insulin sensitivity |
| M1028 | Drug trial study for therapeutic efficacy on metabolic profile | Drug, drug infusion, drug treatment, drug trial, glucose, lipid, liver, serum, serum metabolic panel |
| M2040 | Glucagon-like peptide 1 (GLP-1 ). | glucagon, liver, liver function, liver function enzymes, Luminex, peptides |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |

## Energetics

| Test No. | Test Name | Keywords |
|---|---|---|
| V3012 | Indirect calorimetry / energy expenditure in the Promethion | Activity, basal metabolic rate, body composition, carbon dioxide, CO2 production, energy expenditure, food intake, gas exchange, indirect calorimetry, obesity, oxygen, oxygen consumption, respiratory quotient, water intake, wheel running |
| V3013 | Exercise capacity/Exercise Stress Test (metabolic response to exercise) | Activity, endurance, exercise capacity, exercise stress test, exercise tolerance |
| D4007 | Energy Expenditure (CLAMS, Indirect Calorimetry) | basal metabolic rate, CO2 production, energetics, energy balance, energy expenditure, food intake, heat, indirect calorimetry, obesity, oxygen consumption, RER, respiratory quotient, RQ, thermogenesis |
| D4008 | Energy Expenditure (CLAMS, Indirect Calorimetry) + Meal Pattern Analysis | basal metabolic rate, body composition, CO2 production, energetics, energy balance, energy expenditure, food intake, heat, indirect calorimetry, obesity, oxygen consumption, RER, respiratory exchange ratio, respiratory quotient, RQ, thermogenesis |
| D4006-C | Gut Microbiome Analysis (Illumina method-2X300bp- 20,000 avg seq read depth) | bacteria, cecum, energetics, feces, gastrointestinal tract, microbe, microbiome, sequence based species quantitation |
| V4024 | Bariatric Surgery (Roux-en-Y, VSG, biliopancreatic diversion, sham controls) | absorption, adipose, bacteria, body composition, body weight, food intake, gut, gut hormones, microbiome, surgery |
| M1026 | Drug trial study for therapeutic efficacy on | Drug, drug infusion, drug treatment, drug |

| Test No. | Test Name | Keywords |
|---|---|---|
| | obesity | trial, energy balance, energy expenditure, obese, obesity |
| M1031 | Temperature (rectal measurement) | Temperature |
| D4010 | Special Services | body composition, cardiac function, exercise, indirect calorimetry, meal pattern, metabolism, telemetry |
| MI2503 | Home Cage (Ethovision or Photobeam) | Activity, behavior, Motor |
| MI2504 | Open Field Test (Ethovision or Photobeam) Moto Activity | Activity, behavior, Motor, physical activity |
| D4012 | Core body temperature (temperature recorder) | body temperature, Temperature, thermogenesis, thermoneutrality |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |

## Energy Expenditure & Exercise

| Test No. | Test Name | Keywords |
|---|---|---|
| C1041 | Body Composition / Carcass Analysis (per animal) | body composition, carcass analysis, food intake, lean, obesity, QMR, total body fat |
| C1042 | Energy Expenditure Measurements | basal metabolic rate, calorimetry, CO2 production, energy expenditure, obesity, oxygen consumption, respiratory quotient |
| C1051 | Intestinal lipid absorption in the conscious mouse-lymph fistula (per animal) | absorption, energy balance, fistula, gastrointestinal tract, lipids, lymph |
| V3001 | Cannulation of cerebral ventricle | central control, CSF, surgery |
| V3012 | Indirect calorimetry / energy expenditure in the Promethion | Activity, basal metabolic rate, body composition, carbon dioxide, CO2 production, energy expenditure, food intake, gas exchange, indirect calorimetry, obesity, oxygen, oxygen consumption, respiratory quotient, water intake, wheel running |
| V3013 | Exercise capacity/Exercise Stress Test (metabolic response to exercise) | Activity, endurance, exercise capacity, exercise stress test, exercise tolerance |
| V3014 | Spontaneous exercise activity | Activity, exercise, running wheel, spontaneous exercise activity, wheel running |
| V3015 | Food Consumption | energy balance, food intake, ingestion, spontaneous exercise activity, wheel running |
| V3016 | Exploratory locomotor activity | energy expenditure, exercise, exploratory locomotor activity |
| C1044 | Meal Pattern Analysis - Food Intake Procedure | energy balance, food intake, ingestion, meal pattern |
| C1059 | Non-invasive measurement of intestinal fat absorption (each) | energy balance, fatty acids, fecal fat absorption, lipid, lipids, obesity |
| D4001 | Gross Body Composition | body composition, fat free mass, fat-free mass, FFM, imaging, LBM, lean, mouse husbandry and transfer, obesity |

| Test No. | Test Name | Keywords |
|---|---|---|
| D4002 | Adiposity (adipose depot weights) | body composition, obese, obesity, WAT |
| D4007 | Energy Expenditure (CLAMS, Indirect Calorimetry) | basal metabolic rate, CO2 production, energetics, energy balance, energy expenditure, food intake, heat, indirect calorimetry, obesity, oxygen consumption, RER, respiratory quotient, RQ, thermogenesis |
| M1012 | Body composition (whole body) | 1H-MRS, body composition, fat mass, in vivo, lean muscle mass, obesity, whole animal |
| M1013 | Body composition (organs) | 1H-MRS, body composition, fat mass, in vivo, lean muscle mass, obesity |
| M1014 | Energy balance – food intake, energy expenditure, physical activity | basal metabolic rate, CO2 production, energy expenditure, food intake, in vivo, indirect calorimetry, metabolism, noninvasive, obesity, oxygen consumption, physical activity, respiratory exchange ratio, respiratory quotient, VCO2 production, VO2 consumption, water intake |
| M1020 | Exercise study using cage running wheels | Activity, Cage Activity, exercise |
| M2007 | Leptin | adipokine, diabetes, feeding behavior, food intake, hormone, leptin, obesity |
| D4008 | Energy Expenditure (CLAMS, Indirect Calorimetry) + Meal Pattern Analysis | basal metabolic rate, body composition, CO2 production, energetics, energy balance, energy expenditure, food intake, heat, indirect calorimetry, obesity, oxygen consumption, RER, respiratory exchange ratio, respiratory quotient, RQ, thermogenesis |
| V4026 | Body Composition Analysis by NMR | body composition |
| M1024 | Exercise study using treadmill | endurance, energy expenditure, energy metabolism, exercise, exercise stress test, exertion |
| M1026 | Drug trial study for therapeutic efficacy on obesity | Drug, drug infusion, drug treatment, drug trial, energy balance, energy expenditure, obese, obesity |
| D4010 | Special Services | body composition, cardiac function, exercise, indirect calorimetry, meal pattern, metabolism, telemetry |
| MI2025 | VO2 &VCO2 with spontaneous activity and food intake @Room temperature (22 °C) | VCO2 production, VO2 consumption |
| MI2026 | VO2 &VCO2 with spontaneous activity and food intake, Thermoneutrality (30 °C) and/or cold (as low as 4 °C) | VCO2 production, VO2 consumption |
| MI2027 | VO2 &VCO2 with spontaneous activity and food intake, plus body temperature (implantable BMDS electronic transponder) | VCO2 production, VO2 consumption |
| MI2028 | Non-shivering thermogenesis using injection of norepinephrine (including 24hours acclimation at 30°C) | thermogenesis |
| MI2029 | Body Composition (Bruker Minispec LF 90II) | body composition |
| MI2030 | Body Temperature (microchips implanted) | body temperature |
| MI2031 | Digestible Energy Content | fecal matter, food intake |
| MI2041 | Exercise Training | exercise, training |
| MI2042 | Test of Running Capacity (run to exhaustion), | exercise, exercise stress test, Running |

| Test No. | Test Name | Keywords |
|---|---|---|
| | Without measuring VO2 and VCO2 | Capacity |
| MI2043 | Test of Running Capacity (run to exhaustion), With measuring VO2 and VCO2 (VO2max) | exercise, exercise capacity, exercise stress test, Running Capacity, VCO2 production, VO2 consumption |
| MI2044 | Running Wheel Activity (Med Associates) | Activity, exercise, running wheel, wheel running |
| D4011 | Voluntary wheel running (activity and/or exercise) | Activity, exercise, running wheel, wheel running |
| MI2503 | Home Cage (Ethovision or Photobeam) | Activity, behavior, Motor |
| MI2504 | Open Field Test (Ethovision or Photobeam) Moto Activity | Activity, behavior, Motor, physical activity |
| MI2505 | Open Field Test (Ethovision or Photobeam) Anxiety | anxiety, behavior |
| MI2511 | Wheel Running (home cage, low profile RF running wheels) | behavior, reward |
| C1043 | CLAMS- Activity Measurements (per run of 16 mice) | energy expenditure |
| C1045 | CLAMS- Simultaneous Energy Expenditure, Activity, and Food Intake Measurements (per run of 16 mice) | energy expenditure |
| M1035 | Energy Balance at Thermoneutrality | energy expenditure, food intake, physical activity, thermoneutrality |
| M1036 | Energy Balance at Cold Temperature | cold challenge, energy expenditure, food intake, physical activity |
| D4012 | Core body temperature (temperature recorder) | body temperature, Temperature, thermogenesis, thermoneutrality |
| D2014 | Surgery - Data Recorder or Simple Telemetry (without cannulation) | surgery, telemetry |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| C1119 | C1119-TSE(per run of 8 mice per day in TSE apparatus) | Activity, feeding, feeding behavior, food intake, metabolic flux, metabolism, water intake |
| C1120 | C1120-Running Wheel Cages (per run of 8 mice per day) | Running Capacity, running wheel |
| C1132 | C1132-Acute stress challenge (per run of 8 mice) | behavior, cognitive function, energy balance, metabolism, stress |
| C1133 | C1133-Chronic variable stress challenge (per run of 8 mice) | behavior, cognitive function, energy balance, metabolism, stress |
| M1048 | Energy Balance at Altered Light/Dark Cycle | energy balance |

## Enzymatic Activity

| Test No. | Test Name | Keywords |
|---|---|---|

| Test No. | Test Name | Keywords |
|---|---|---|
| D3402 | Hemoglobin A1C | diabetes, glucose, Hemoglobin A1C, hyperglycemia, liver, liver function, liver function enzymes, metabolism |
| M2017 | Amylase | carbohydrate, enzyme activity, GI function |
| M2018 | Creatine kinase | cardiovascular, enzyme activity, lesion |
| M2019 | Alkaline phosphatase | enzyme activity, serum chemicals |
| M2020 | Lactate dehydrogenase | enzyme activity, tissue damage |
| M2021 | Albumin | liver, liver function, liver function enzymes, metabolite, protein, serum albumin, serum chemicals |
| M2022 | Alanine transferase | ALT, liver, liver function, liver function enzymes, metabolite, serum chemicals |
| M2023 | Aspartate transferase | liver, liver function, liver function enzymes, metabolite, serum chemicals |
| D3414 | Alanine Transaminase (ALT) | Alanine transferase, plasma |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |

## Eye Function

| Test No. | Test Name | Keywords |
|---|---|---|
| MI30001 | Optokinetic measurements of visual acuity and contrast sensitivity | contrast sensitivity, visual acuity |
| MI30002 | Retinal microstructure imaging by optical coherence tomography (OCT) | OCT, retinal layer |
| MI30003 | Retinal vascular permeability | permeability, retinal layer |
| MI30004 | Retinal cell death | apoptosis, retinal layer |
| MI30005 | Electroretinogram (ERG) | neural control |
| MI30006 | Fundus imaging | imaging, retinal layer |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |

## Food/Water Intake

| Test No. | Test Name | Keywords |
|---|---|---|
| C1041 | Body Composition / Carcass Analysis (per | body composition, carcass analysis, food |

| Test No. | Test Name | Keywords |
|---|---|---|
| | animal) | intake, lean, obesity, QMR, total body fat |
| V3012 | Indirect calorimetry / energy expenditure in the Promethion | Activity, basal metabolic rate, body composition, carbon dioxide, CO2 production, energy expenditure, food intake, gas exchange, indirect calorimetry, obesity, oxygen, oxygen consumption, respiratory quotient, water intake, wheel running |
| V3015 | Food Consumption | energy balance, food intake, ingestion, spontaneous exercise activity, wheel running |
| C1044 | Meal Pattern Analysis - Food Intake Procedure | energy balance, food intake, ingestion, meal pattern |
| D4007 | Energy Expenditure (CLAMS, Indirect Calorimetry) | basal metabolic rate, CO2 production, energetics, energy balance, energy expenditure, food intake, heat, indirect calorimetry, obesity, oxygen consumption, RER, respiratory quotient, RQ, thermogenesis |
| M1014 | Energy balance – food intake, energy expenditure, physical activity | basal metabolic rate, CO2 production, energy expenditure, food intake, in vivo, indirect calorimetry, metabolism, noninvasive, obesity, oxygen consumption, physical activity, respiratory exchange ratio, respiratory quotient, VCO2 production, VO2 consumption, water intake |
| M1015 | Chronic high-fat feeding | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, insulin resistance, mouse husbandry and transfer, obesity, type 2 diabetes |
| M2007 | Leptin | adipokine, diabetes, feeding behavior, food intake, hormone, leptin, obesity |
| D4003 | Meal Pattern Analysis | eating behavior, food intake, meal pattern |
| D4008 | Energy Expenditure (CLAMS, Indirect Calorimetry) + Meal Pattern Analysis | basal metabolic rate, body composition, CO2 production, energetics, energy balance, energy expenditure, food intake, heat, indirect calorimetry, obesity, oxygen consumption, RER, respiratory exchange ratio, respiratory quotient, RQ, thermogenesis |
| D4006-C | Gut Microbiome Analysis (Illumina method-2X300bp- 20,000 avg seq read depth) | bacteria, cecum, energetics, feces, gastrointestinal tract, microbe, microbiome, sequence based species quantitation |
| D2007 | Chronic high-fat feeding | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, mouse husbandry and transfer, obesity, type 2 diabetes |
| D2008 | Vertical Sleeve Gastrectomy (VSG) | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, mouse husbandry and transfer, obesity, type 2 diabetes |
| D2009 | Roux en Y Gastric Bypass (RYGB) | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, insulin resistance, mouse husbandry and transfer, obesity, type 2 diabetes |
| V4024 | Bariatric Surgery (Roux-en-Y, VSG, biliopancreatic diversion, sham controls) | absorption, adipose, bacteria, body composition, body weight, food intake, gut, gut hormones, microbiome, surgery |
| V4026 | Body Composition Analysis by NMR | body composition |

| Test No. | Test Name | Keywords |
|---|---|---|
| D4010 | Special Services | body composition, cardiac function, exercise, indirect calorimetry, meal pattern, metabolism, telemetry |
| MI2025 | VO2 &VCO2 with spontaneous activity and food intake @Room temperature (22 °C) | VCO2 production, VO2 consumption |
| MI2026 | VO2 &VCO2 with spontaneous activity and food intake, Thermoneutrality (30 °C) and/or cold (as low as 4 °C) | VCO2 production, VO2 consumption |
| MI2027 | VO2 &VCO2 with spontaneous activity and food intake, plus body temperature (implantable BMDS electronic transponder) | VCO2 production, VO2 consumption |
| MI2047 | Manual Food or Water Recording | food intake, water intake |
| MI2048 | Orogastric Gavage | gavage, orogastric |
| MI2049 | Pair-Feeding | feeding, pair-feeding |
| D2010 | Vertical Sleeve Gastrectomy (VSG) Package | animal model, diabetes, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, mouse husbandry and transfer, obesity |
| D2011 | Roux en Y Gastric Bypass (RYGB) Package | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, insulin resistance, mouse husbandry and transfer, obesity, type 2 diabetes |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| C1117 | C1117 Feeding & Weighing food intake (per run of 8 mice) | feeding, feeding behavior |
| C1118 | C1118-Food Preference Tests (per run of 8 mice) | feeding, feeding behavior |
| C1119 | C1119-TSE(per run of 8 mice per day in TSE apparatus) | Activity, feeding, feeding behavior, food intake, metabolic flux, metabolism, water intake |
| M1041 | Paired Feeding Regimen Analysis | feeding, feeding behavior |
| M1042 | Paired Feeding Study | feeding, feeding behavior |
| M1048 | Energy Balance at Altered Light/Dark Cycle | energy balance |

## Gastrointestinal

| Test No. | Test Name | Keywords |
|---|---|---|
| C1088 | GIP concentration (per set of 38 samples) | hormone, incretin, lipids, metabolism |
| C1051 | Intestinal lipid absorption in the conscious mouse-lymph fistula (per animal) | absorption, energy balance, fistula, gastrointestinal tract, lipids, lymph |
| C1055 | Metabolism of chylomicrons (per sample) | apolipoproteins, chylomicron, chylomicron remnants, lipids |
| C1086 | GLP-1 concentration (per set of 38 samples) | counterregulatory, glucagon, hormone, incretin, lipids |

| Test No. | Test Name | Keywords |
|---|---|---|
| C1044 | Meal Pattern Analysis - Food Intake Procedure | energy balance, food intake, ingestion, meal pattern |
| C1059 | Non-invasive measurement of intestinal fat absorption (each) | energy balance, fatty acids, fecal fat absorption, lipid, lipids, obesity |
| M2010 | Triglyceride | cardiovascular disease, insulin, insulin resistance, lipids, metabolite, obesity, serum, serum chemicals, tissue |
| M2012 | Cholesterol (total) | atherosclerosis, cardiovascular disease, lipids, metabolite, obesity |
| M2013 | Cholesterol (HDL) | atherosclerosis, cardiovascular disease, lipids, liver, liver function, liver function enzymes, metabolite, obesity |
| M2014 | Cholesterol (LDL) | atherosclerosis, cardiovascular disease, lipids, metabolite, obesity |
| M2022 | Alanine transferase | ALT, liver, liver function, liver function enzymes, metabolite, serum chemicals |
| M2023 | Aspartate transferase | liver, liver function, liver function enzymes, metabolite, serum chemicals |
| M2024 | Bilirubin | liver, liver function, liver function enzymes, metabolite |
| M2025 | Gamma-glutamyl Transferase | liver, liver function, liver function enzymes, metabolite, serum chemicals |
| D4003 | Meal Pattern Analysis | eating behavior, food intake, meal pattern |
| D4008 | Energy Expenditure (CLAMS, Indirect Calorimetry) + Meal Pattern Analysis | basal metabolic rate, body composition, CO2 production, energetics, energy balance, energy expenditure, food intake, heat, indirect calorimetry, obesity, oxygen consumption, RER, respiratory exchange ratio, respiratory quotient, RQ, thermogenesis |
| D4006-C | Gut Microbiome Analysis (Illumina method-2X300bp- 20,000 avg seq read depth) | bacteria, cecum, energetics, feces, gastrointestinal tract, microbe, microbiome, sequence based species quantitation |
| D2008 | Vertical Sleeve Gastrectomy (VSG) | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, mouse husbandry and transfer, obesity, type 2 diabetes |
| D2009 | Roux en Y Gastric Bypass (RYGB) | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, insulin resistance, mouse husbandry and transfer, obesity, type 2 diabetes |
| V4024 | Bariatric Surgery (Roux-en-Y, VSG, biliopancreatic diversion, sham controls) | absorption, adipose, bacteria, body composition, body weight, food intake, gut, gut hormones, microbiome, surgery |
| D6001 | Ex vivo assessment of barrier function/gut permeability (minimum of 8 samples) | barrier function, gastrointestinal tract, GI function, gut, intestinal permeability, intestine, microbiome |
| D6002 | Lipopolysaccharide Binding Protein (LBP)/Endotoxemia Assay | bacteria, endotoxemia, endotoxin, LBP, lipopolysaccharide, lipopolysaccharide binding protein, LPS, plasma |
| MI2052 | 24-hour Urine and/or Fecal Collection | fecal matter, feces, urine |
| MI4001 | Study design consultation | consultation, study design |
| MI4002 | DNA extraction single plate with controls | DNA, extraction, isolation |

| Test No. | Test Name | Keywords |
|---|---|---|
| MI4003 | Illumina 16S rRNA gene sequencing, V4 region 0.25 run | gene sequencing, RNA |
| MI4004 | Analysis of Sequencing Data - Mothur pipeline | gene sequencing, RNA |
| MI1063 | Germ Free Mice - C57BL/6 | free, germ, germ free, germ-free |
| MI1064 | Germ Free Mice - Swiss Webster | free, germ, germ free, germ-free |
| MI1065 | Germ Free Mice - BALB/c | free, germ, germ free, germ-free |
| MI1066 | Germ Free Mice - IL-10 Knockout | free, germ, germ free, germ-free |
| MI1067 | Germ Free Mice - Rag1 Knockout | free, germ, germ free, germ-free |
| MI1069 | Germ Free Mice - Shipping | free, germ, germ free, germ-free |
| MI1071 | Germ Free - Technician Time | free, germ, germ free, germ-free, mouse husbandry and transfer |
| MI1068 | Germ Free - Per Diem | free, germ, germ free, germ-free |
| MI1070 | Germ Free - Rederivation | free, germ, germ free, germ-free |
| MI1072 | Germ Free - Microbial community establishment | free, germ, germ free, germ-free |
| MI1073 | Germ Free - Surgical manipulation | free, germ, germ free, germ-free |
| MI1074 | Germ Free - Experimental Design and consultation | free, germ, germ free, germ-free |
| M1034 | Fecal Sample Collection for Intestinal Flora Analysis | fecal matter, feces, microbiome |
| D2010 | Vertical Sleeve Gastrectomy (VSG) Package | animal model, diabetes, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, mouse husbandry and transfer, obesity |
| D2011 | Roux en Y Gastric Bypass (RYGB) Package | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, insulin resistance, mouse husbandry and transfer, obesity, type 2 diabetes |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| D6003 | Fecal Mouse Lipocalin-2 | gastrointestinal tract, gut, inflammation, intestinal permeability, intestine |
| D6004 | Fecal Mouse Calprotectin | gastrointestinal tract, gut, inflammation, intestinal permeability, intestine |
| D6007 | Special Services | consultation, data analysis, gut, intestinal permeability, intestine, microbiome, study design |

## Genitourinary Deficiency

| Test No. | Test Name | Keywords |
|---|---|---|
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |

| Test No. | Test Name | Keywords |
|---|---|---|
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |

## Hormone Measurements

| Test No. | Test Name | Keywords |
|---|---|---|
| V3090 | Amino Acids - Full Profile (HPLC) | amino acids, hormone, HPLC, imaging, metabolite, modeling and simulation |
| C1088 | GIP concentration (per set of 38 samples) | hormone, incretin, lipids, metabolism |
| C1081 | C-peptide concentration (per set of 38 samples) | diabetes, hormone, insulin, insulin secretion |
| C1085 | Glucagon concentration (per set of 38 samples) | counter-regulation, counterregulatory, hormone, lipids |
| C1086 | GLP-1 concentration (per set of 38 samples) | counterregulatory, glucagon, hormone, incretin, lipids |
| C1089 | Insulin Assay (per set of 38 samples) | carbohydrate, diabetes, hormone |
| C1090 | Leptin concentration (per set of 38 samples) | adipokine, diabetes, eating behaviour, feeding behavior, hormone, leptin, lipids, obesity |
| V3006 | Hyperglycemic clamp | clamp, diabetes, glucose, hyperglycemic clamp, insulin, insulin resistance, insulin secretion, insulin sensitivity |
| V3050 | Insulin | carbohydrate, diabetes, hormone |
| V3051 | Glucagon - ELISA | counter-regulation, hormone, lipids |
| V3052 | Corticosterone | glucocorticoid, hormone, stress |
| V3053 | Catecholamines (epinephrine & norepinephrine only) | hormone, stress |
| V3054 | Leptin (Luminex assay) | adipokine, diabetes, feeding behavior, hormone, leptin, obesity |
| V3055 | C-peptide (Luminex assay) | hormone, insulin, insulin action, insulin secretion |
| V3059 | PRL (prolactin) | fertility, hormone, prolactin |
| V3060 | ACTH | adrenocorticotropic hormone, corticotropin, glucocorticoid, hormone, stress |
| C1061 | Adiponectin concentration (per set of 38 samples) | adipokine, adiponectin, gut hormones, hormone, insulin, insulin action, insulin resistance, peptides, serum |
| V3067 | Testosterone | hormone, sex, steroid |
| D3412 | Metabolomics | amino acids, aromatics, carbohydrate, diabetes, exercise, free fatty acids, glycolysis, hormone, hydroxyl acids, lipids, liver, liver function, metabolism, metabolite, serum, sterol, sugar phosphates, TCA intermediates |
| D3431 | Hormones - Generic ELISA Assay | hormone, liver, liver function |
| D3432 | Insulin | carbohydrate, diabetes, hormone, insulin, liver, liver function |

| Test No. | Test Name | Keywords |
|---|---|---|
| D3433 | C-Peptide | hormone, insulin, insulin secretion, liver, liver function |
| D3434 | Proinsulin | carbohydrate, diabetes, hormone, insulin, liver function, liver function enzymes |
| D3435 | Leptin | adipokine, diabetes, feeding behavior, hormone, leptin, leptin measurement, liver, liver function, liver function enzymes, obesity |
| D3436 | Adiponectin (total) | adipokine, adiponectin, hormone, insulin, insulin resistance, lipids, liver, liver function, liver function enzymes |
| D3437 | Adiponectin (HMW) | adipokine, adiponectin, hormone, insulin, insulin resistance, lipids, liver, liver function, liver function enzymes |
| D3438 | Glucagon | counterregulatory, glucagon, hormone, lipids, liver, liver function, liver function enzymes |
| D3439 | Glucagon-like peptide 1 (active) | glucagon, hormone, incretin, lipids, liver, liver function, liver function enzymes |
| D3440 | Glucagon-like peptide 1 (total) | glucagon, hormone, incretin, lipids, liver, liver function, liver function enzymes |
| D3441 | Ghrelin | eating behavior, energy balance, hormone, liver, liver function, liver function enzymes |
| D3467 | sE-Selectin | diabetes, hormone, immunology, inflammation |
| D3468 | sP-Selectin | diabetes, hormone, immunology, inflammation |
| M1005 | Insulin clearance | carbohydrate, diabetes, hormone, insulin |
| M2004 | Insulin | carbohydrate, diabetes, hormone, hyperinsulinemic clamp, insulin |
| M2005 | C-peptide | hormone, insulin, insulin secretion, islet function |
| M2006 | Glucagon | counter-regulation, gluconeogenesis, glucose, glucose production, hepatic, hormone, lipids |
| M2007 | Leptin | adipokine, diabetes, feeding behavior, food intake, hormone, leptin, obesity |
| M2008 | Adiponectin | adipokine, hormone, insulin resistance, lipids |
| M2009 | Resistin | adipokine, glucose metabolism, hormone, insulin resistance |
| D3496 | Corticosterone | carbohydrate, carbohydrate metabolism, hormone, serum |
| V4010 | Ghrelin - Active (RIA) | hormone |
| V4011 | Ghrelin - Total (RIA) | hormone |
| V4012 | Glucose (Enzymatic) | hormone |
| V4014 | Purine Nucleotides (HPLC) | hormone |
| V4015 | T3 (RIA) | hormone |
| V4016 | T4 (RIA) | hormone |
| V4017 | Luminex Assays | hormone, Luminex |
| V4018 | Acetaminophen | assay, hormone |
| V4020 | Cortisol - Salivary | |
| V4021 | Creatinine | creatinine |

| Test No. | Test Name | Keywords |
|---|---|---|
| M1033 | Surgery – Ovariectomy | surgery |
| M2040 | Glucagon-like peptide 1 (GLP-1 ). | glucagon, liver, liver function, liver function enzymes, Luminex, peptides |
| M2041 | Estradiol (E2) | ELISA, estradiol, plasma, serum |
| M2043 | Triiodothyronine (T3) | ELISA, T3, triiodothyronine |
| M2044 | Thyroxine (T4) | T4, thyroxine |
| M2045 | Thyrotropin-releasing hormone (TRH) | thyrotropin-releasing hormone, TRH |
| M2046 | Apolipoprotein C3 (ApoC3) | Apolipoprotein C3, apolipoproteins |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| M2034 | Amylin (Active) | Amylin |
| M2035 | Ghrelin | ghrelin |
| M2037 | Gastric inhibitory peptide (GIP; Total) | Gastric inhibitory peptide |
| M2038 | Pancreatic Polypeptide (PP) | Pancreatic Polypeptide |
| M2039 | Peptide YY (PYY; Total) | Peptide YY |
| M2047 | Adrenocorticotropic hormone (ACTH) | ACTH, adrenocorticotropic hormone |
| M2048 | Growth Hormone (GH) | GH, Growth hormone |
| M2049 | Prolactin (PRL) | PRL, prolactin |
| M2050 | Thyroid-stimulating hormone (TSH) | Thyroid-stimulating hormone, TSH |
| C1134 | C1134-Collecting post-stress plasma samples (per run of 8 mice) | hormone, metabolite, stress |
| C1141 | Cortisol RIA (per run of 200 tubes) | cortisol, radioimmunoassay, RIA |
| C1142 | ACTH RIA (per run of 200 tubes) | ACTH, adrenocorticotropic hormone, radioimmunoassay |
| M2051 | Progesterone | ELISA, Progesterone |
| M2052 | Testosterone | ELISA, Testosterone |
| M2057 | Aldosterone | Aldosterone, hormone |
| M2058 | Renin | Renin |
| M2060 | Insulin-like growth factor 1 (IGF-1) | hormone |

## Imaging

| Test No. | Test Name | Keywords |
|---|---|---|
| V3090 | Amino Acids - Full Profile (HPLC) | amino acids, hormone, HPLC, imaging, metabolite, modeling and simulation |
| V3017 | Assess real time imaging of cellular metabolic events | imaging, metabolism, microcirculation, real time imaging |
| V3018 | In vivo optical imaging of gene expression | Function, gene expression, GFP, imaging, luciferase, transcription |

| Test No. | Test Name | Keywords |
|---|---|---|
| D4001 | Gross Body Composition | body composition, fat free mass, fat-free mass, FFM, imaging, LBM, lean, mouse husbandry and transfer, obesity |
| D5011 | CT, MRI, PET, & combinations | cardiac function, central nervous system, circulation, CT, diabetes, imaging, magnetic, metabolism, MRI, obesity, PET, resonance, spectroscopy, vascular function |
| D2013 | MMPC mouse gross necropsy with histology | histology, imaging, morphology, mouse husbandry and transfer, necropsy, organs, tissue |
| D5201 | IBA Immunohistochemistry | immunohistochemistry |
| D5202 | Factor VIII Immunohistochemistry | imaging, immunohistochemistry |
| M3007 | Islet histology – beta-cell proliferation and cell death | beta cell, imaging, immunohistochemistry, insulin, islet, islets, pancreas, staining |
| M3008 | Islet microscopy – islet images | histology, imaging, islet, islets, pancreas |
| M3009 | Islet microscopy – exocrine pancreas images | histology, imaging, islets, pancreas |
| M3010 | Islet microscopy – beta-cell mass | beta cell, imaging, islets, pancreas |
| M3011 | Pancreatic beta-cell mass (comprehensive) | beta cell, islet, islets, pancreas |
| M3012 | Pancreas islet architecture analysis | beta cell, glucagon, imaging, immunohistochemistry, insulin, islet, islets, pancreas |
| M5006 | Phenotypic assessment of transplanted stem cell-derived beta-cells | beta cell, diabetes, glucose, glucose tolerance, imaging, immunohistochemistry, insulin, islet, islets, pancreas |
| MI1031 | Histology - Trim/Cassette (Paraffin or OCT) | histology |
| MI1033 | Histology - Paraffin Process & Embed | histology |
| MI1034 | Histology - Tissue Sections, Paraffin Unstained Slide | histology |
| MI1035 | Histology - Tissue Sections, Paraffin H&E Stain | histology |
| MI1036 | Histology - Tissue Sections, Frozen Unstained Slide | histology |
| MI1037 | Histology - Tissue Sections, Frozen H&E Stained | histology |
| MI1038 | Histology - Special Stain, Masson Trichrome (MTC) | histology |
| MI1040 | Histology - Special Stain, Toluidine Blue | histology |
| MI1041 | Histology - Special Stain, Prussian Blue | histology |
| MI1042 | Histology - Special Stain, Picrosirius Red | histology |
| MI1043 | Histology - Speical Stian, Verhoeff Van Gieson | histology |
| MI1044 | Histology - Special Stain, Gram | bacteria, histology |
| MI1045 | Histology - Speical Stain, Luxol Fast Blue (LFB) | histology |
| MI1046 | Histology - Special Stain, Warthin Starry | bacteria, histology |
| MI1047 | Histology - Special Stain, Other | histology |
| MI1048 | Immunohistochemistry - Tier 1 (ALDH1, Amylase, aSMA, CD45R-B220, CD3, Caspase-3, F4/80, GFAP, GFP, Insulin, Ki67, Ly-6G, Lyve-1, Mac2, Neurofilament) | immunohistochemistry |

| Test No. | Test Name | Keywords |
|---|---|---|
| MI1049 | Immunohistochemistry - Tier 2 Tier 2 (AE1/AE3 + 8/18, CD4, CD8a, CD31, Estrogen Receptor, Glucagon, c-erbB2/HER2, Progesterone, Von Willebrand Factor) | immunohistochemistry |
| MI1053 | Histology Technician Labor | histology, immunohistochemistry |
| MI1054 | Pathologist Hourly | histology, immunohistochemistry |
| MI1055 | Aperio 20X scan, Semi-automated, >50 slides | histology, immunohistochemistry |
| MI1056 | Aperio 20X scan, Semi-automated, batch of 20-50 | histology, immunohistochemistry |
| MI1057 | Aperio 20X scan, Semi-automated, each | histology, immunohistochemistry |
| MI1058 | Aperio Technician Labor | histology, immunohistochemistry |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| M4010 | Moor Laser Speckle Contrast Imaging | blood flow, ischemia, peripheral vascular disease, vascular disease |
| MI1080 | Histology - Special Stain, Oil Red O (ORO) | histology, immunohistochemistry |
| MI1081 | Immunohistochemistry - Stain, Negative Control | histology, immunohistochemistry |
| MI1082 | Immunohistochemistry - Stain, Non-IVAC Primary Antibody | histology, immunohistochemistry |
| MI1083 | Immunohistochemistry - Stain, Titration Slide | histology, immunohistochemistry |
| MI1084 | Immunohistochemistry - Stain, Frozen IHC or Immunofluorence Slide | histology, immunohistochemistry |
| M1053 | 3D-Imaging for In Vivo Assessment of NAFL and NASH | fatty liver, fibrosis, liver, mouse models |
| M1055 | 3D-Imaging for In Vivo Assessment of Tumor | tumor |

## Immunology of Diabetes

| Test No. | Test Name | Keywords |
|---|---|---|
| V3082 | Tissue microdissection | diabetes, histology, immunology, insulin, insulin action, laser microdissection, organs, tissue, tissues |
| D3461 | Markers of Inflammation - custom panel | diabetes, growth factors, immunology, inflammation, interleukins, oxidative stress |
| D3463 | HS CRP | CRP, diabetes, immunology, inflammation |
| D3464 | Serum Amyloid A1 | diabetes, immunology, inflammation, serum, serum metabolic panel |
| D3465 | sICAM | diabetes, immunology, inflammation |
| D3466 | sVCAM | diabetes, immunology, inflammation |
| D3467 | sE-Selectin | diabetes, hormone, immunology, inflammation |

| Test No. | Test Name | Keywords |
|---|---|---|
| D3468 | sP-Selectin | diabetes, hormone, immunology, inflammation |
| M2032 | Cytokines Panel I - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin action, insulin resistance, monokines, obesity, serum samples, tissue lysates |
| M2033 | Cytokines Panel II - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin action, insulin resistance, monokines, obesity, serum samples, tissue lysates |
| M2036 | Cytokines Panel III - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin resistance, monokines, obesity |
| M3002 | Islet histology – paraffin pancreas sections | histology, immunohistochemistry, islets, pancreas |
| M3003 | Islet histology – H&E stained pancreas sections | histology, islets, pancreas, staining |
| M3004 | Islet histology – insulin immunohistochemistry | histology, immunohistochemistry, insulin, islets |
| M3005 | Islet histology – insulin immunofluorescence | histology, immunohistochemistry, insulin, islet, islet function, islets |
| M3006 | Islet histology – insulin and glucagon immunofluorescence | glucagon, histology, immunohistochemistry, insulin, islet, islets, pancreas |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| M2062 | Inflammatory Signaling | phosphorylation, serine, threonine, tyrosine |

## Infusion and Blood Sampling

| Test No. | Test Name | Keywords |
|---|---|---|
| MI2038 | Automated Arterial Blood Sampling and/or Intravenous Infusion in undisturbed and unrestrained mice, Blood sampling only | arterial, artery, blood sampling, intravenous |
| MI2039 | Automated Arterial Blood Sampling and/or Intravenous Infusion in undisturbed and unrestrained mice, Intravenous Infusion only | arterial, artery, blood sampling, infusion, intravenous |
| MI2040 | Automated Arterial Blood Sampling and/or Intravenous Infusion in undisturbed and unrestrained mice, Blood sampling AND intravenous infusion | arterial, artery, blood sampling, intravenous |
| MI2054 | Tail Vein Blood Sampling (plasma or serum) | blood sampling, plasma, serum |
| MI2055 | Retro-orbital bleeding (under isoflurane anesthesia) | blood sampling |
| MI2056 | Tail Vein Injection | injection, tail vein |
| MI2057 | IP Injection | injection |

| Test No. | Test Name | Keywords |
|---|---|---|
| MI1007 | Technician Service Fee / Special Procedures | animal husbandry, animal procedures, dosing, gavage, mouse husbandry and transfer, TST, venipuncture |
| M3017 | Chronic intravenous infusion | cannulation, chronic, infusion, intravenous |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| M1045 | Tail Vein Blood Sampling | blood, blood sampling, plasma, serum, serum samples |

## Insulin and Insulin Function

| Test No. | Test Name | Keywords |
|---|---|---|
| C1070 | Glucose tolerance test GTT (intraperitoneal) (per animal) | carbohydrate, diabetes, glucose disposal, glucose metabolism, glucose tolerance, insulin resistance, insulin secretion, insulin sensitivity, intraperitoneal glucose tolerance |
| C1072 | Insulin Tolerance Test (per animal) | diabetes, insulin action, insulin effectiveness, insulin resistance, insulin sensitivity, metabolism |
| C1081 | C-peptide concentration (per set of 38 samples) | diabetes, hormone, insulin, insulin secretion |
| V3002 | Jugular vein and carotid artery catheterization | artery, blood vessel, catheterization, chronic, insulin, insulin action, surgery, vein |
| V3003 | Glucose Tolerance Test (Oral, i.p., Intravenous, or gastric catheter) | carbohydrate, diabetes, glucose intolerance, glucose tolerance, insulin, insulin action, insulin resistance, insulin sensitivity |
| V3004 | Glucose turnover | carbohydrate, clamp, diabetes, endogenous glucose production, flux, glucose flux, glucose kinetics, glucose turnover, insulin, insulin action, insulin resistance, isotopes, kinetics, liver, liver function, tracers |
| V3005 | Hyperinsulinemic clamp | clamp, diabetes, endogenous glucose production, glucose, glucose disposal, glucose uptake, hyperinsulinemic clamp, insulin, insulin action, insulin resistance |
| V3006 | Hyperglycemic clamp | clamp, diabetes, glucose, hyperglycemic clamp, insulin, insulin resistance, insulin secretion, insulin sensitivity |
| V3010 | Tissue specific glucose uptake | 2-deoxyglucose, carbohydrate, diabetes, glucose metabolic index, insulin, insulin action, insulin sensitivity, tissue specific glucose uptake |
| V3055 | C-peptide (Luminex assay) | hormone, insulin, insulin action, insulin secretion |
| V3082 | Tissue microdissection | diabetes, histology, immunology, insulin, insulin action, laser microdissection, organs, tissue, tissues |

| Test No. | Test Name | Keywords |
|---|---|---|
| C1061 | Adiponectin concentration (per set of 38 samples) | adipokine, adiponectin, gut hormones, hormone, insulin, insulin action, insulin resistance, peptides, serum |
| C1071 | Glucose tolerance test GTT (oral) (per animal) | carbohydrate, diabetes, insulin, insulin resistance, insulin sensitivity, metabolism, serum |
| D3101 | Intravenous Glucose Tolerance Test | carbohydrate, diabetes, insulin, insulin action, insulin resistance, insulin secretion, insulin sensitivity |
| D3103 | IN VIVO Insulin Tolerance Tests | carbohydrate, diabetes, insulin, insulin action, insulin resistance, insulin sensitivity |
| D3104 | IN VIVO Glucose Tolerance Tests | carbohydrate, diabetes, glucose, glucose metabolism, glucose tolerance, insulin resistance, insulin sensitivity |
| D3105 | IN VIVO Glucose-stimulates Insulin Secretion Test | carbohydrate, diabetes, glucose, glucose metabolism, insulin, insulin action, insulin resistance, insulin sensitivity |
| D3401 | Glucose (urine/plasma) | carbohydrate, diabetes, glucose, hyperglycemia, hypoglycemia, insulin, insulin action, insulin effectiveness, liver, liver function, liver function enzymes, metabolite, urine |
| D3403 | beta-OH butyrate | Atkins, diabetes, insulin, ketones, liver, liver function, liver function enzymes, low carbohydrate, metabolism |
| D3432 | Insulin | carbohydrate, diabetes, hormone, insulin, liver, liver function |
| D3433 | C-Peptide | hormone, insulin, insulin secretion, liver, liver function |
| D3434 | Proinsulin | carbohydrate, diabetes, hormone, insulin, liver function, liver function enzymes |
| D3436 | Adiponectin (total) | adipokine, adiponectin, hormone, insulin, insulin resistance, lipids, liver, liver function, liver function enzymes |
| D3437 | Adiponectin (HMW) | adipokine, adiponectin, hormone, insulin, insulin resistance, lipids, liver, liver function, liver function enzymes |
| M1001 | Hyperinsulinemic-euglycemic clamp | awake mice, clamp, diabetes, glucose, glucose metabolism, in vivo, insulin, insulin action, insulin resistance, insulin secretion, insulin sensitivity |
| M1002 | Basal glucose metabolism | carbohydrate, clamp, diabetes, flux, glucose turnover, glucose uptake, insulin resistance, kinetics |
| M1003 | Organ-specific glucose uptake | carbohydrate, diabetes, glucose uptake, insulin, insulin resistance, insulin sensitivity |
| M1004 | Hyperglycemic clamp | awake mice, clamp, diabetes, glucose, in vivo, insulin, insulin resistance, insulin secretion |
| M1005 | Insulin clearance | carbohydrate, diabetes, hormone, insulin |
| M1006 | Glucose tolerance test | carbohydrate, diabetes, glucose clearance, glucose tolerance, insulin resistance, insulin sensitivity |

| Test No. | Test Name | Keywords |
|---|---|---|
| M1007 | Glucose tolerance test with insulin secretion | carbohydrate, diabetes, glucose tolerance, insulin, insulin resistance, insulin sensitivity |
| M1008 | Insulin tolerance test | glucose, insulin effectiveness, insulin resistance, insulin sensitivity |
| M1009 | Hepatic gluconeogenesis | carbohydrate, diabetes, glucose, glucose production, insulin, insulin resistance, liver, liver function, liver function enzymes, pyruvate tolerance test |
| M1015 | Chronic high-fat feeding | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, insulin resistance, mouse husbandry and transfer, obesity, type 2 diabetes |
| M1017 | STZ-induced type 1 diabetes model | Drug, hyperglycemia, insulin, insulinopenia, streptozotocin, type 1 diabetes |
| M1018 | Acute lipid infusion | animal model, fatty acids, FFA, insulin, insulin action, insulin resistance, lipids, obesity |
| M1019 | Chronic/acute phloridzin treatment | diabetes, Drug, glucose clearance, glycemia, insulin, insulin action, renal |
| M2001 | Glucose | carbohydrate, diabetes, glucose, hyperglycemia, hypoglycemia, insulin resistance, metabolite |
| M2002 | Hemoglobin A1c | diabetes, glucose, hyperglycemia, insulin, insulin action, metabolite |
| M2003 | Lactate | acidosis, carbohydrate, diabetes, glucose, insulin, insulin action, metabolite |
| M2004 | Insulin | carbohydrate, diabetes, hormone, hyperinsulinemic clamp, insulin |
| M2005 | C-peptide | hormone, insulin, insulin secretion, islet function |
| M2008 | Adiponectin | adipokine, hormone, insulin resistance, lipids |
| M2009 | Resistin | adipokine, glucose metabolism, hormone, insulin resistance |
| M2010 | Triglyceride | cardiovascular disease, insulin, insulin resistance, lipids, metabolite, obesity, serum, serum chemicals, tissue |
| M2011 | Non-esterified fatty acids | insulin, insulin resistance, lipids, metabolite, obesity |
| M2032 | Cytokines Panel I - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin action, insulin resistance, monokines, obesity, serum samples, tissue lysates |
| M2033 | Cytokines Panel II - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin action, insulin resistance, monokines, obesity, serum samples, tissue lysates |
| M2036 | Cytokines Panel III - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin resistance, monokines, obesity |
| D2007 | Chronic high-fat feeding | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, mouse husbandry and transfer, obesity, type 2 diabetes |

| Test No. | Test Name | Keywords |
|---|---|---|
| D2008 | Vertical Sleeve Gastrectomy (VSG) | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, mouse husbandry and transfer, obesity, type 2 diabetes |
| D2009 | Roux en Y Gastric Bypass (RYGB) | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, insulin resistance, mouse husbandry and transfer, obesity, type 2 diabetes |
| V4024 | Bariatric Surgery (Roux-en-Y, VSG, biliopancreatic diversion, sham controls) | absorption, adipose, bacteria, body composition, body weight, food intake, gut, gut hormones, microbiome, surgery |
| M1027 | Drug trial study for therapeutic efficacy on insulin resistance | Drug, drug infusion, drug treatment, drug trial, glucose homeostasis, glucose kinetics, glucose metabolism, glucose uptake, insulin action, insulin sensitivity |
| M1030 | Drug trial study for toxicity | Drug, drug infusion, drug treatment, drug trial, liver function, liver function enzymes, toxicity |
| M3004 | Islet histology – insulin immunohistochemistry | histology, immunohistochemistry, insulin, islets |
| M3005 | Islet histology – insulin immunofluorescence | histology, immunohistochemistry, insulin, islet, islet function, islets |
| M3006 | Islet histology – insulin and glucagon immunofluorescence | glucagon, histology, immunohistochemistry, insulin, islet, islets, pancreas |
| M3014 | Ex vivo islet analysis for insulin secretion | insulin, insulin secretion, islet, islets, pancreas |
| M5005 | Phenotypic assessment of transplanted human islets | beta cell, diabetes, glucose tolerance, insulin, islet, islets, pancreas |
| M5006 | Phenotypic assessment of transplanted stem cell-derived beta-cells | beta cell, diabetes, glucose, glucose tolerance, imaging, immunohistochemistry, insulin, islet, islets, pancreas |
| D2010 | Vertical Sleeve Gastrectomy (VSG) Package | animal model, diabetes, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, mouse husbandry and transfer, obesity |
| D2011 | Roux en Y Gastric Bypass (RYGB) Package | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, insulin resistance, mouse husbandry and transfer, obesity, type 2 diabetes |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| M2061 | Insulin Signaling | Forkhead Box O1, insulin, insulin receptor, insulin receptor substrate-1, insulin receptor substrate-2, phosphorylation, protein kinase B, serine, threonine, tyrosine |

## Isolated Organ and Cell Perfusion

| Test No. | Test Name | Keywords |
|---|---|---|

| Test No. | Test Name | Keywords |
|---|---|---|
| V3030 | In vitro Morphology, Morphometrics and Histology (isolated heart) | cardiac function, isolated organ and cell perfusion, morphology |
| M3013 | Pancreatic islet isolation | beta cell, islet, islets, pancreas, surgery |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |

## Kidney Function

| Test No. | Test Name | Keywords |
|---|---|---|
| V3098 | GFR-FITC-Inulin; HPLC Cr | glomerular filtration, HPLC |
| V3099 | Albuminuria | complications, diabetes, kidney, kidney disease, protein, urinary albumin excretion (UAE), urine |
| V4000 | Renal Blood Flow (Doppler) | blood flow, blood pressure |
| D3451 | Urinary Albumin Excretion | albumin, complications, kidney, kidney disease, renal, urinary albumin excretion (UAE), urine |
| D3452 | Creatinine | cardiovascular, creatinine, kidney, kidney disease, lesion, renal, urine |
| D3453 | Urea | kidney, kidney disease, renal, urea |
| M2026 | Creatinine | cardiovascular, creatinine, kidney, kidney disease, lesion, metabolite |
| M2029 | Urea/BUN | kidney, kidney disease, metabolite, renal |
| M2030 | Uric acid | kidney, kidney disease, metabolite, renal |
| D3414 | Alanine Transaminase (ALT) | Alanine transferase, plasma |
| M1030 | Drug trial study for toxicity | Drug, drug infusion, drug treatment, drug trial, liver function, liver function enzymes, toxicity |
| MI2052 | 24-hour Urine and/or Fecal Collection | fecal matter, feces, urine |
| MI30050 | Qualitative light microscopic renal histopathology | histology, microscopy |
| MI30051 | Quantitative mesangial matrix evaluation | Mesangial matrix |
| MI30052 | Quantitative electron microscopic measurement of glomerular basement membrane | GBM thickness, Glomeruli, microscopy |
| MI30053 | Podocyte counts/glomerulus | Glomeruli, Podocyte |
| MI30054 | Glomerular harvest for protein or RNA | Glomeruli, protein, RNA |
| MI30055 | Immunoblot for glomerular lysates | Glomerular protein, Glomeruli, protein |
| MI30056 | 24 hour urine collection for albumin and creatinine | Albuminuria, creatinine, urinalysis, urinary albumin excretion (UAE), urine |
| MI30057 | Spot urine collection for albumin and creatinine | kidney, urinalysis, urinary albumin excretion (UAE), urine |

| Test No. | Test Name | Keywords |
|---|---|---|
| MI30058 | Glomerular filtration rate (GFR) determination with minipump inulin clearance | glomerular filtration, kidney |
| MI30059 | Tail cuff Blood Pressure (BP) determination | blood pressure, tail-cuff |
| MI1018 | Urinalysis - Complete Panel | urinalysis, urine |
| MI1019 | Urinalysis - Routine Panel | urinalysis, urine |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| M1054 | 3D-Imaging for In Vivo Assessment of Kidney Morphology & Volume | kidney, morphology |

## Lipid Metabolism

| Test No. | Test Name | Keywords |
|---|---|---|
| C1051 | Intestinal lipid absorption in the conscious mouse-lymph fistula (per animal) | absorption, energy balance, fistula, gastrointestinal tract, lipids, lymph |
| C1052 | Lipid Profiles (TG, CHOL, PL, NEFA)(per set of 38 samples) | lipids, non-esterified fatty acid, obesity, phospholipids, total cholesterol, triglycerides |
| C1054 | Lipoprotein fractionation by FPLC (per sample) | apolipoproteins, cholesterol, fatty acids, FPLC, lipids, lipoproteins, obesity |
| C1055 | Metabolism of chylomicrons (per sample) | apolipoproteins, chylomicron, chylomicron remnants, lipids |
| C1057 | Free Fatty Acids (NEFA) Concentration (per set of 38 samples) | free fatty acids, lipids, non-esterified fatty acid, obesity, serum |
| V3011 | Tissue specific fatty acid uptake | 125I-BMIPP, flux, isotope, lipids, obesity, tissue specific fatty acid uptake, tracer |
| V3070 | Plasma lipids | cholesterol, fatty acids, lipids, metabolism, obesity |
| V3072 | Fatty acid profiles of lipid esters by gas liquid chromatography | GCMS, lipids, metabolism |
| V3073 | Quantitation of individual phospholipid classes | cholesterol, lipids, metabolism, phospholipids |
| V3074 | Short chain fatty acid analysis by gas liquid chromatography | GCMS, lipids, metabolism, short chain fatty acid |
| V3075 | Fast Protein Liquid Chromatographic (FPLC) Lipoproteins Separations | cholesterol, fatty acids, lipids, lipoproteins, metabolism |
| C1059 | Non-invasive measurement of intestinal fat absorption (each) | energy balance, fatty acids, fecal fat absorption, lipid, lipids, obesity |
| C1060 | Phospholipids concentration (per set of 38 samples) | fatty acids, lipids, phospholipids |
| C1061 | Adiponectin concentration (per set of 38 samples) | adipokine, adiponectin, gut hormones, hormone, insulin, insulin action, insulin resistance, peptides, serum |
| C1104 | Lipid extraction via folch (per set of 12 samples) | fatty acids, folch, lipid extraction, lipids, obesity |

| Test No. | Test Name | Keywords |
|---|---|---|
| C1105 | Fatty Acid analysis via GC (each) | fatty acid composition, fatty acids, lipid, obesity |
| D3301 | Lipid extraction from liver | atherosclerosis, cholesterol, obesity, total cholesterol, triglycerides |
| D3302 | Lipid extraction from muscle | atherosclerosis, cholesterol, obesity, total cholesterol, triglycerides |
| D3403 | beta-OH butyrate | Atkins, diabetes, insulin, ketones, liver, liver function, liver function enzymes, low carbohydrate, metabolism |
| D3404 | Triglyceride | liver, metabolism, triglycerides |
| D3405 | Total Cholesterol | atherosclerosis, cholesterol, lipids, liver, liver function, metabolism, metabolite, obesity, total cholesterol |
| D3406 | HDL-C and LDL-C/VLDL-C | atherosclerosis, cholesterol, lipids, liver, liver function, metabolism, metabolite, obesity |
| D3407 | HDL-TG and LDL-TG/VLDL-TG | atherosclerosis, cholesterol, lipids, liver, liver function, metabolism, metabolite, obesity |
| D3408 | Non esterified fatty acids | lipids, liver, liver function, liver function enzymes, metabolism, non-esterified fatty acid |
| D3412 | Metabolomics | amino acids, aromatics, carbohydrate, diabetes, exercise, free fatty acids, glycolysis, hormone, hydroxyl acids, lipids, liver, liver function, metabolism, metabolite, serum, sterol, sugar phosphates, TCA intermediates |
| D3413 | Complex lipid ratios | ceramides, diabetes, exercise, lipids, liver, liver function, lysophosphatidylcholines, mass spectrometry, obesity, phospholipids, serum, sphingomyelins |
| D3431 | Hormones - Generic ELISA Assay | hormone, liver, liver function |
| D3435 | Leptin | adipokine, diabetes, feeding behavior, hormone, leptin, leptin measurement, liver, liver function, liver function enzymes, obesity |
| D3436 | Adiponectin (total) | adipokine, adiponectin, hormone, insulin, insulin resistance, lipids, liver, liver function, liver function enzymes |
| D3437 | Adiponectin (HMW) | adipokine, adiponectin, hormone, insulin, insulin resistance, lipids, liver, liver function, liver function enzymes |
| D3438 | Glucagon | counterregulatory, glucagon, hormone, lipids, liver, liver function, liver function enzymes |
| M1010 | Lipid metabolism | fatty acids, in vivo, lipids, obesity, palmitate, triglycerides |
| M1018 | Acute lipid infusion | animal model, fatty acids, FFA, insulin, insulin action, insulin resistance, lipids, obesity |
| M2010 | Triglyceride | cardiovascular disease, insulin, insulin resistance, lipids, metabolite, obesity, serum, serum chemicals, tissue |
| M2011 | Non-esterified fatty acids | insulin, insulin resistance, lipids, metabolite, obesity |
| M2012 | Cholesterol (total) | atherosclerosis, cardiovascular disease, lipids, metabolite, obesity |

| Test No. | Test Name | Keywords |
|---|---|---|
| M2013 | Cholesterol (HDL) | atherosclerosis, cardiovascular disease, lipids, liver, liver function, liver function enzymes, metabolite, obesity |
| M2014 | Cholesterol (LDL) | atherosclerosis, cardiovascular disease, lipids, metabolite, obesity |
| M2015 | Ammonia | lipids, metabolite, nitrogen, serum chemicals |
| M2016 | Lipase | lipids, metabolite, obesity |
| V3071 | Lipid extraction, separation, quantification | fatty acids, lipids, metabolism, obesity |
| D4003 | Meal Pattern Analysis | eating behavior, food intake, meal pattern |
| D4008 | Energy Expenditure (CLAMS, Indirect Calorimetry) + Meal Pattern Analysis | basal metabolic rate, body composition, CO2 production, energetics, energy balance, energy expenditure, food intake, heat, indirect calorimetry, obesity, oxygen consumption, RER, respiratory exchange ratio, respiratory quotient, RQ, thermogenesis |
| V4024 | Bariatric Surgery (Roux-en-Y, VSG, biliopancreatic diversion, sham controls) | absorption, adipose, bacteria, body composition, body weight, food intake, gut, gut hormones, microbiome, surgery |
| M1028 | Drug trial study for therapeutic efficacy on metabolic profile | Drug, drug infusion, drug treatment, drug trial, glucose, lipid, liver, serum, serum metabolic panel |
| MI2032 | Fat Tolerance Test, Oral gavage (olive or corn oil) | corn oil, fat tolerance, gavage, olive oil |
| MI2033 | Fat Tolerance Test, Intravenous injection (20% Intralipid) | carotid, catheterization, fat tolerance, jugular |
| MI2034 | Hepatic TG Secretion (Poloxamer 407 or Triton WR-1339) | hepatic, secretion, triacylglycerides |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| M1049 | Glucose Uptake and Lipid Metabolism in additional organs | glucose, glucose uptake, lipid |

## Liver Function

| Test No. | Test Name | Keywords |
|---|---|---|
| V3003 | Glucose Tolerance Test (Oral, i.p., Intravenous, or gastric catheter) | carbohydrate, diabetes, glucose intolerance, glucose tolerance, insulin, insulin action, insulin resistance, insulin sensitivity |
| V3004 | Glucose turnover | carbohydrate, clamp, diabetes, endogenous glucose production, flux, glucose flux, glucose kinetics, glucose turnover, insulin, insulin action, insulin resistance, isotopes, kinetics, liver, liver function, tracers |
| V3005 | Hyperinsulinemic clamp | clamp, diabetes, endogenous glucose production, glucose, glucose disposal, glucose |

| Test No. | Test Name | Keywords |
|---|---|---|
| | | uptake, hyperinsulinemic clamp, insulin, insulin action, insulin resistance |
| V3008 | Glycogen synthesis | carbohydrate, diabetes, flux, glycogen synthesis, isotope, liver, liver function, tracer |
| D3301 | Lipid extraction from liver | atherosclerosis, cholesterol, obesity, total cholesterol, triglycerides |
| D3302 | Lipid extraction from muscle | atherosclerosis, cholesterol, obesity, total cholesterol, triglycerides |
| D3401 | Glucose (urine/plasma) | carbohydrate, diabetes, glucose, hyperglycemia, hypoglycemia, insulin, insulin action, insulin effectiveness, liver, liver function, liver function enzymes, metabolite, urine |
| D3402 | Hemoglobin A1C | diabetes, glucose, Hemoglobin A1C, hyperglycemia, liver, liver function, liver function enzymes, metabolism |
| D3403 | beta-OH butyrate | Atkins, diabetes, insulin, ketones, liver, liver function, liver function enzymes, low carbohydrate, metabolism |
| D3404 | Triglyceride | liver, metabolism, triglycerides |
| D3405 | Total Cholesterol | atherosclerosis, cholesterol, lipids, liver, liver function, metabolism, metabolite, obesity, total cholesterol |
| D3406 | HDL-C and LDL-C/VLDL-C | atherosclerosis, cholesterol, lipids, liver, liver function, metabolism, metabolite, obesity |
| D3407 | HDL-TG and LDL-TG/VLDL-TG | atherosclerosis, cholesterol, lipids, liver, liver function, metabolism, metabolite, obesity |
| D3408 | Non esterified fatty acids | lipids, liver, liver function, liver function enzymes, metabolism, non-esterified fatty acid |
| D3412 | Metabolomics | amino acids, aromatics, carbohydrate, diabetes, exercise, free fatty acids, glycolysis, hormone, hydroxyl acids, lipids, liver, liver function, metabolism, metabolite, serum, sterol, sugar phosphates, TCA intermediates |
| D3413 | Complex lipid ratios | ceramides, diabetes, exercise, lipids, liver, liver function, lysophosphatidylcholines, mass spectrometry, obesity, phospholipids, serum, sphingomyelins |
| D3431 | Hormones - Generic ELISA Assay | hormone, liver, liver function |
| D3432 | Insulin | carbohydrate, diabetes, hormone, insulin, liver, liver function |
| D3433 | C-Peptide | hormone, insulin, insulin secretion, liver, liver function |
| D3434 | Proinsulin | carbohydrate, diabetes, hormone, insulin, liver function, liver function enzymes |
| D3435 | Leptin | adipokine, diabetes, feeding behavior, hormone, leptin, leptin measurement, liver, liver function, liver function enzymes, obesity |
| D3436 | Adiponectin (total) | adipokine, adiponectin, hormone, insulin, insulin resistance, lipids, liver, liver function, liver function enzymes |
| D3437 | Adiponectin (HMW) | adipokine, adiponectin, hormone, insulin, |

| Test No. | Test Name | Keywords |
|---|---|---|
| | | insulin resistance, lipids, liver, liver function, liver function enzymes |
| D3438 | Glucagon | counterregulatory, glucagon, hormone, lipids, liver, liver function, liver function enzymes |
| D3439 | Glucagon-like peptide 1 (active) | glucagon, hormone, incretin, lipids, liver, liver function, liver function enzymes |
| D3440 | Glucagon-like peptide 1 (total) | glucagon, hormone, incretin, lipids, liver, liver function, liver function enzymes |
| D3441 | Ghrelin | eating behavior, energy balance, hormone, liver, liver function, liver function enzymes |
| M1009 | Hepatic gluconeogenesis | carbohydrate, diabetes, glucose, glucose production, insulin, insulin resistance, liver, liver function, liver function enzymes, pyruvate tolerance test |
| M2013 | Cholesterol (HDL) | atherosclerosis, cardiovascular disease, lipids, liver, liver function, liver function enzymes, metabolite, obesity |
| M2021 | Albumin | liver, liver function, liver function enzymes, metabolite, protein, serum albumin, serum chemicals |
| M2022 | Alanine transferase | ALT, liver, liver function, liver function enzymes, metabolite, serum chemicals |
| M2023 | Aspartate transferase | liver, liver function, liver function enzymes, metabolite, serum chemicals |
| M2024 | Bilirubin | liver, liver function, liver function enzymes, metabolite |
| M2025 | Gamma-glutamyl Transferase | liver, liver function, liver function enzymes, metabolite, serum chemicals |
| M2027 | C-reactive peptide | CRP, inflammation, liver, liver function, liver function enzymes, metabolite, obesity, serum chemicals |
| V4024 | Bariatric Surgery (Roux-en-Y, VSG, biliopancreatic diversion, sham controls) | absorption, adipose, bacteria, body composition, body weight, food intake, gut, gut hormones, microbiome, surgery |
| D3414 | Alanine Transaminase (ALT) | Alanine transferase, plasma |
| D3415 | Aspartate Aminotransferase (AST) | |
| M1030 | Drug trial study for toxicity | Drug, drug infusion, drug treatment, drug trial, liver function, liver function enzymes, toxicity |
| MI2034 | Hepatic TG Secretion (Poloxamer 407 or Triton WR-1339) | hepatic, secretion, triacylglycerides |
| M2040 | Glucagon-like peptide 1 (GLP-1 ). | glucagon, liver, liver function, liver function enzymes, Luminex, peptides |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |

| Test No. | Test Name | Keywords |
|---|---|---|
| M4012 | Nash Models (nonalcoholic fatty liver disease) | |
| M1051 | Diet-induced mouse model of Non-Alcoholic Fatty Liver (NAFL) | mouse models |
| M1052 | Diet-induced mouse model of Non-Alcoholic Steatohepatitis (NASH) | mouse models |
| M1053 | 3D-Imaging for In Vivo Assessment of NAFL and NASH | fatty liver, fibrosis, liver, mouse models |

## Magnetic Resonance Spectroscopy & Imaging

| Test No. | Test Name | Keywords |
|---|---|---|
| D5011 | CT, MRI, PET, & combinations | cardiac function, central nervous system, circulation, CT, diabetes, imaging, magnetic, metabolism, MRI, obesity, PET, resonance, spectroscopy, vascular function |
| V4026 | Body Composition Analysis by NMR | body composition |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |

## Metabolism and Metabolomics

| Test No. | Test Name | Keywords |
|---|---|---|
| V3090 | Amino Acids - Full Profile (HPLC) | amino acids, hormone, HPLC, imaging, metabolite, modeling and simulation |
| C1070 | Glucose tolerance test GTT (intraperitoneal) (per animal) | carbohydrate, diabetes, glucose disposal, glucose metabolism, glucose tolerance, insulin resistance, insulin secretion, insulin sensitivity, intraperitoneal glucose tolerance |
| C1041 | Body Composition / Carcass Analysis (per animal) | body composition, carcass analysis, food intake, lean, obesity, QMR, total body fat |
| C1042 | Energy Expenditure Measurements | basal metabolic rate, calorimetry, CO2 production, energy expenditure, obesity, oxygen consumption, respiratory quotient |
| C1051 | Intestinal lipid absorption in the conscious mouse-lymph fistula (per animal) | absorption, energy balance, fistula, gastrointestinal tract, lipids, lymph |
| C1072 | Insulin Tolerance Test (per animal) | diabetes, insulin action, insulin effectiveness, insulin resistance, insulin sensitivity, metabolism |
| C1089 | Insulin Assay (per set of 38 samples) | carbohydrate, diabetes, hormone |
| C1090 | Leptin concentration (per set of 38 samples) | adipokine, diabetes, eating behaviour, feeding behavior, hormone, leptin, lipids, obesity |
| V3001 | Cannulation of cerebral ventricle | central control, CSF, surgery |
| V3002 | Jugular vein and carotid artery catheterization | artery, blood vessel, catheterization, chronic, insulin, insulin action, surgery, vein |

| Test No. | Test Name | Keywords |
|---|---|---|
| V3003 | Glucose Tolerance Test (Oral, i.p., Intravenous, or gastric catheter) | carbohydrate, diabetes, glucose intolerance, glucose tolerance, insulin, insulin action, insulin resistance, insulin sensitivity |
| V3004 | Glucose turnover | carbohydrate, clamp, diabetes, endogenous glucose production, flux, glucose flux, glucose kinetics, glucose turnover, insulin, insulin action, insulin resistance, isotopes, kinetics, liver, liver function, tracers |
| V3005 | Hyperinsulinemic clamp | clamp, diabetes, endogenous glucose production, glucose, glucose disposal, glucose uptake, hyperinsulinemic clamp, insulin, insulin action, insulin resistance |
| V3006 | Hyperglycemic clamp | clamp, diabetes, glucose, hyperglycemic clamp, insulin, insulin resistance, insulin secretion, insulin sensitivity |
| V3008 | Glycogen synthesis | carbohydrate, diabetes, flux, glycogen synthesis, isotope, liver, liver function, tracer |
| V3009 | Amino acid kinetics | amino acid flux, amino acid kinetics, isotopes, metabolite |
| V3010 | Tissue specific glucose uptake | 2-deoxyglucose, carbohydrate, diabetes, glucose metabolic index, insulin, insulin action, insulin sensitivity, tissue specific glucose uptake |
| V3011 | Tissue specific fatty acid uptake | 125I-BMIPP, flux, isotope, lipids, obesity, tissue specific fatty acid uptake, tracer |
| V3012 | Indirect calorimetry / energy expenditure in the Promethion | Activity, basal metabolic rate, body composition, carbon dioxide, CO2 production, energy expenditure, food intake, gas exchange, indirect calorimetry, obesity, oxygen, oxygen consumption, respiratory quotient, water intake, wheel running |
| V3013 | Exercise capacity/Exercise Stress Test (metabolic response to exercise) | Activity, endurance, exercise capacity, exercise stress test, exercise tolerance |
| V3014 | Spontaneous exercise activity | Activity, exercise, running wheel, spontaneous exercise activity, wheel running |
| V3015 | Food Consumption | energy balance, food intake, ingestion, spontaneous exercise activity, wheel running |
| V3016 | Exploratory locomotor activity | energy expenditure, exercise, exploratory locomotor activity |
| V3017 | Assess real time imaging of cellular metabolic events | imaging, metabolism, microcirculation, real time imaging |
| V3018 | In vivo optical imaging of gene expression | Function, gene expression, GFP, imaging, luciferase, transcription |
| V3072 | Fatty acid profiles of lipid esters by gas liquid chromatography | GCMS, lipids, metabolism |
| V3073 | Quantitation of individual phospholipid classes | cholesterol, lipids, metabolism, phospholipids |
| V3074 | Short chain fatty acid analysis by gas liquid chromatography | GCMS, lipids, metabolism, short chain fatty acid |
| V3091 | Amino Acid - gluconeogenic profile | amino acids, HPLC, metabolite |
| C1061 | Adiponectin concentration (per set of 38 samples) | adipokine, adiponectin, gut hormones, hormone, insulin, insulin action, insulin resistance, peptides, serum |

| Test No. | Test Name | Keywords |
|---|---|---|
| C1071 | Glucose tolerance test GTT (oral) (per animal) | carbohydrate, diabetes, insulin, insulin resistance, insulin sensitivity, metabolism, serum |
| V4006 | Personnel Training | advice, course, training |
| C1104 | Lipid extraction via folch (per set of 12 samples) | fatty acids, folch, lipid extraction, lipids, obesity |
| C1105 | Fatty Acid analysis via GC (each) | fatty acid composition, fatty acids, lipid, obesity |
| D3101 | Intravenous Glucose Tolerance Test | carbohydrate, diabetes, insulin, insulin action, insulin resistance, insulin secretion, insulin sensitivity |
| D3103 | IN VIVO Insulin Tolerance Tests | carbohydrate, diabetes, insulin, insulin action, insulin resistance, insulin sensitivity |
| D3104 | IN VIVO Glucose Tolerance Tests | carbohydrate, diabetes, glucose, glucose metabolism, glucose tolerance, insulin resistance, insulin sensitivity |
| D3105 | IN VIVO Glucose-stimulates Insulin Secretion Test | carbohydrate, diabetes, glucose, glucose metabolism, insulin, insulin action, insulin resistance, insulin sensitivity |
| D3301 | Lipid extraction from liver | atherosclerosis, cholesterol, obesity, total cholesterol, triglycerides |
| D3302 | Lipid extraction from muscle | atherosclerosis, cholesterol, obesity, total cholesterol, triglycerides |
| D3401 | Glucose (urine/plasma) | carbohydrate, diabetes, glucose, hyperglycemia, hypoglycemia, insulin, insulin action, insulin effectiveness, liver, liver function, liver function enzymes, metabolite, urine |
| D3404 | Triglyceride | liver, metabolism, triglycerides |
| D3412 | Metabolomics | amino acids, aromatics, carbohydrate, diabetes, exercise, free fatty acids, glycolysis, hormone, hydroxyl acids, lipids, liver, liver function, metabolism, metabolite, serum, sterol, sugar phosphates, TCA intermediates |
| D4002 | Adiposity (adipose depot weights) | body composition, obese, obesity, WAT |
| D4007 | Energy Expenditure (CLAMS, Indirect Calorimetry) | basal metabolic rate, CO2 production, energetics, energy balance, energy expenditure, food intake, heat, indirect calorimetry, obesity, oxygen consumption, RER, respiratory quotient, RQ, thermogenesis |
| M1001 | Hyperinsulinemic-euglycemic clamp | awake mice, clamp, diabetes, glucose, glucose metabolism, in vivo, insulin, insulin action, insulin resistance, insulin secretion, insulin sensitivity |
| M1002 | Basal glucose metabolism | carbohydrate, clamp, diabetes, flux, glucose turnover, glucose uptake, insulin resistance, kinetics |
| M1003 | Organ-specific glucose uptake | carbohydrate, diabetes, glucose uptake, insulin, insulin resistance, insulin sensitivity |
| M1004 | Hyperglycemic clamp | awake mice, clamp, diabetes, glucose, in vivo, insulin, insulin resistance, insulin secretion |
| M1005 | Insulin clearance | carbohydrate, diabetes, hormone, insulin |

| Test No. | Test Name | Keywords |
|---|---|---|
| M1006 | Glucose tolerance test | carbohydrate, diabetes, glucose clearance, glucose tolerance, insulin resistance, insulin sensitivity |
| M1007 | Glucose tolerance test with insulin secretion | carbohydrate, diabetes, glucose tolerance, insulin, insulin resistance, insulin sensitivity |
| M1008 | Insulin tolerance test | glucose, insulin effectiveness, insulin resistance, insulin sensitivity |
| M1009 | Hepatic gluconeogenesis | carbohydrate, diabetes, glucose, glucose production, insulin, insulin resistance, liver, liver function, liver function enzymes, pyruvate tolerance test |
| M1010 | Lipid metabolism | fatty acids, in vivo, lipids, obesity, palmitate, triglycerides |
| M1011 | Protein metabolism | amino acid, amino acids, in vivo protein turnover, phenylalanine, protein, protein synthesis |
| M1012 | Body composition (whole body) | 1H-MRS, body composition, fat mass, in vivo, lean muscle mass, obesity, whole animal |
| M1013 | Body composition (organs) | 1H-MRS, body composition, fat mass, in vivo, lean muscle mass, obesity |
| M1014 | Energy balance – food intake, energy expenditure, physical activity | basal metabolic rate, CO2 production, energy expenditure, food intake, in vivo, indirect calorimetry, metabolism, noninvasive, obesity, oxygen consumption, physical activity, respiratory exchange ratio, respiratory quotient, VCO2 production, VO2 consumption, water intake |
| M1015 | Chronic high-fat feeding | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, insulin resistance, mouse husbandry and transfer, obesity, type 2 diabetes |
| M1016 | Chronic drug delivery | Drug, drug treatment, infusion, mouse husbandry and transfer, osmotic pump, surgery |
| M1017 | STZ-induced type 1 diabetes model | Drug, hyperglycemia, insulin, insulinopenia, streptozotocin, type 1 diabetes |
| M1018 | Acute lipid infusion | animal model, fatty acids, FFA, insulin, insulin action, insulin resistance, lipids, obesity |
| M1019 | Chronic/acute phloridzin treatment | diabetes, Drug, glucose clearance, glycemia, insulin, insulin action, renal |
| M1020 | Exercise study using cage running wheels | Activity, Cage Activity, exercise |
| M1021 | Surgery – jugular vein cannulation | catheterization, clamp, intravenous, surgery, vein |
| M1022 | Surgery – tail vein injection | AAV delivery, intravenous, mouse husbandry and transfer, surgery, vein |
| M1023 | Surgery – carotid artery cannulation | artery, blood sampling, catheterization, surgery |
| M2015 | Ammonia | lipids, metabolite, nitrogen, serum chemicals |
| M2017 | Amylase | carbohydrate, enzyme activity, GI function |
| M2018 | Creatine kinase | cardiovascular, enzyme activity, lesion |
| M2032 | Cytokines Panel I - multiplex | chemokines, complications, cytokines, |

| Test No. | Test Name | Keywords |
|---|---|---|
| | | diabetes, immunology, inflammation, insulin, insulin action, insulin resistance, monokines, obesity, serum samples, tissue lysates |
| M2033 | Cytokines Panel II - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin action, insulin resistance, monokines, obesity, serum samples, tissue lysates |
| M2036 | Cytokines Panel III - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin resistance, monokines, obesity |
| D4008 | Energy Expenditure (CLAMS, Indirect Calorimetry) + Meal Pattern Analysis | basal metabolic rate, body composition, CO2 production, energetics, energy balance, energy expenditure, food intake, heat, indirect calorimetry, obesity, oxygen consumption, RER, respiratory exchange ratio, respiratory quotient, RQ, thermogenesis |
| D4006-C | Gut Microbiome Analysis (Illumina method-2X300bp- 20,000 avg seq read depth) | bacteria, cecum, energetics, feces, gastrointestinal tract, microbe, microbiome, sequence based species quantitation |
| V4024 | Bariatric Surgery (Roux-en-Y, VSG, biliopancreatic diversion, sham controls) | absorption, adipose, bacteria, body composition, body weight, food intake, gut, gut hormones, microbiome, surgery |
| D3415 | Aspartate Aminotransferase (AST) | |
| D4011 | Voluntary wheel running (activity and/or exercise) | Activity, exercise, running wheel, wheel running |
| C1043 | CLAMS- Activity Measurements (per run of 16 mice) | energy expenditure |
| C1045 | CLAMS- Simultaneous Energy Expenditure, Activity, and Food Intake Measurements (per run of 16 mice) | energy expenditure |
| D4012 | Core body temperature (temperature recorder) | body temperature, Temperature, thermogenesis, thermoneutrality |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| C1119 | C1119-TSE(per run of 8 mice per day in TSE apparatus) | Activity, feeding, feeding behavior, food intake, metabolic flux, metabolism, water intake |
| C1132 | C1132-Acute stress challenge (per run of 8 mice) | behavior, cognitive function, energy balance, metabolism, stress |
| C1133 | C1133-Chronic variable stress challenge (per run of 8 mice) | behavior, cognitive function, energy balance, metabolism, stress |
| MI2070 | APC Housing Per diem (Transfer of care from ULAM to APC) | mouse husbandry and transfer |
| MI2071 | Breeding Colony Care | mouse husbandry and transfer |
| MI2072 | Technician Time | mouse husbandry and transfer |

| Test No. | Test Name | Keywords |
|---|---|---|
| MI2073 | Data Analysis | data analysis |
| M1047 | Glucose Flux Measurement Using Stable Isotope | flux, glucose, glucose flux, isotope |
| M2059 | Tissue Glycogen | Glycogen |
| M2063 | Metabolic Signaling | phosphorylation, serine, threonine, tyrosine |
| M1056 | Hyperglucagonemic clamp | clamp |

## Metabolite Concentration and Enrichment

| Test No. | Test Name | Keywords |
|---|---|---|
| V3090 | Amino Acids - Full Profile (HPLC) | amino acids, hormone, HPLC, imaging, metabolite, modeling and simulation |
| C1057 | Free Fatty Acids (NEFA) Concentration (per set of 38 samples) | free fatty acids, lipids, non-esterified fatty acid, obesity, serum |
| C1087 | Glucose concentration (per set of 38 samples) | carbohydrate metabolism, diabetes, isotope, tracer |
| C1092 | Triglyceride concentration (per set of 38 samples) | lipids, metabolism, obesity |
| V3070 | Plasma lipids | cholesterol, fatty acids, lipids, metabolism, obesity |
| V3075 | Fast Protein Liquid Chromatographic (FPLC) Lipoproteins Separations | cholesterol, fatty acids, lipids, lipoproteins, metabolism |
| V3091 | Amino Acid - gluconeogenic profile | amino acids, HPLC, metabolite |
| C1058 | ß-hydroxybutyrate concentration (per set of 38 samples) | Atkins, beta-hydroxybutyrate, diabetes, ketones, low carbohydrate, serum |
| V4002 | Osmometer Plasma/Urine | osmolality, urine |
| V4003 | Urine Ca/Phosphorus Excretion | urine |
| M2015 | Ammonia | lipids, metabolite, nitrogen, serum chemicals |
| M2016 | Lipase | lipids, metabolite, obesity |
| M2021 | Albumin | liver, liver function, liver function enzymes, metabolite, protein, serum albumin, serum chemicals |
| M2022 | Alanine transferase | ALT, liver, liver function, liver function enzymes, metabolite, serum chemicals |
| M2024 | Bilirubin | liver, liver function, liver function enzymes, metabolite |
| M2025 | Gamma-glutamyl Transferase | liver, liver function, liver function enzymes, metabolite, serum chemicals |
| M2026 | Creatinine | cardiovascular, creatinine, kidney, kidney disease, lesion, metabolite |
| M2027 | C-reactive peptide | CRP, inflammation, liver, liver function, liver function enzymes, metabolite, obesity, serum chemicals |
| M2028 | Total protein | metabolite |
| M2029 | Urea/BUN | kidney, kidney disease, metabolite, renal |
| M2030 | Uric acid | kidney, kidney disease, metabolite, renal |
| M2031 | Electrolytes | electrolyte panel, electrolytes, metabolism, |

| Test No. | Test Name | Keywords |
|---|---|---|
| | | pH, potassium, renal function, serum chemicals, serum metabolic panel, sodium |
| V3071 | Lipid extraction, separation, quantification | fatty acids, lipids, metabolism, obesity |
| C1092-CHEM | Triglyceride Assay in Tissue- Chemical Method (per set of 12 samples) | |
| C1092-FPLC | Triglyceride Assay- FPLC Fractions (per sample) | |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| C1119 | C1119-TSE(per run of 8 mice per day in TSE apparatus) | Activity, feeding, feeding behavior, food intake, metabolic flux, metabolism, water intake |
| C1134 | C1134-Collecting post-stress plasma samples (per run of 8 mice) | hormone, metabolite, stress |
| M2063 | Metabolic Signaling | phosphorylation, serine, threonine, tyrosine |

## Microbiota/Microbiome

| Test No. | Test Name | Keywords |
|---|---|---|
| D4006-C | Gut Microbiome Analysis (Illumina method-2X300bp- 20,000 avg seq read depth) | bacteria, cecum, energetics, feces, gastrointestinal tract, microbe, microbiome, sequence based species quantitation |
| D6001 | Ex vivo assessment of barrier function/gut permeability (minimum of 8 samples) | barrier function, gastrointestinal tract, GI function, gut, intestinal permeability, intestine, microbiome |
| D6002 | Lipopolysaccharide Binding Protein (LBP)/Endotoxemia Assay | bacteria, endotoxemia, endotoxin, LBP, lipopolysaccharide, lipopolysaccharide binding protein, LPS, plasma |
| MI4001 | Study design consultation | consultation, study design |
| MI4002 | DNA extraction single plate with controls | DNA, extraction, isolation |
| MI4003 | Illumina 16S rRNA gene sequencing, V4 region 0.25 run | gene sequencing, RNA |
| MI4004 | Analysis of Sequencing Data - Mothur pipeline | gene sequencing, RNA |
| MI1063 | Germ Free Mice - C57BL/6 | free, germ, germ free, germ-free |
| MI1064 | Germ Free Mice - Swiss Webster | free, germ, germ free, germ-free |
| MI1065 | Germ Free Mice - BALB/c | free, germ, germ free, germ-free |
| MI1066 | Germ Free Mice - IL-10 Knockout | free, germ, germ free, germ-free |
| MI1067 | Germ Free Mice - Rag1 Knockout | free, germ, germ free, germ-free |
| MI1069 | Germ Free Mice - Shipping | free, germ, germ free, germ-free |
| MI1071 | Germ Free - Technician Time | free, germ, germ free, germ-free, mouse husbandry and transfer |
| MI1068 | Germ Free - Per Diem | free, germ, germ free, germ-free |

| Test No. | Test Name | Keywords |
|---|---|---|
| MI1070 | Germ Free - Rederivation | free, germ, germ free, germ-free |
| MI1072 | Germ Free - Microbial community establishment | free, germ, germ free, germ-free |
| MI1073 | Germ Free - Surgical manipulation | free, germ, germ free, germ-free |
| MI1074 | Germ Free - Experimental Design and consultation | free, germ, germ free, germ-free |
| M1034 | Fecal Sample Collection for Intestinal Flora Analysis | fecal matter, feces, microbiome |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| M7001 | Consultation - Study Design | consultation, study design |
| M7002 | Sample DNA Extraction & Quality Control Analyses | DNA, extraction |
| M7003 | 16S rRNA gene sequencing | gene sequencing, sequence based species quantitation |
| M7004 | Consultation - Sequence Data Analysis | gene sequencing, sequence based species quantitation |
| M7005 | Consultation - Post-analysis Data Preparation | |
| M7006 | Consultation - Data Upload | |
| M7007 | Fecal Microbiota Transplant (FMT) | gut, microbiome |
| M7008 | Antibiotic Treatment | antibiotic treatment, gut, microbiome |
| D6003 | Fecal Mouse Lipocalin-2 | gastrointestinal tract, gut, inflammation, intestinal permeability, intestine |
| D6004 | Fecal Mouse Calprotectin | gastrointestinal tract, gut, inflammation, intestinal permeability, intestine |
| D6007 | Special Services | consultation, data analysis, gut, intestinal permeability, intestine, microbiome, study design |

## Microvascular Complications

| Test No. | Test Name | Keywords |
|---|---|---|
| MI30001 | Optokinetic measurements of visual acuity and contrast sensitivity | contrast sensitivity, visual acuity |
| MI30002 | Retinal microstructure imaging by optical coherence tomography (OCT) | OCT, retinal layer |
| MI30003 | Retinal vascular permeability | permeability, retinal layer |
| MI30004 | Retinal cell death | apoptosis, retinal layer |
| MI30021 | Sciatic Motor NCV | conduction, Motor, NCV, nerve, SMNCV, velocity |
| MI30022 | Sural Sensory NCV | conduction, NCV, nerve, sensory activation, Sural, velocity |

| Test No. | Test Name | Keywords |
|---|---|---|
| MI30023 | Intra-epidermal Nerve Fiber Density | fiber density, IENFD, nerve |
| MI30024 | Thermal Hindpaw Withdrawal | hindpaw, hp, thermal |
| MI30025 | Cryoembedding | cryoembedding |
| MI30026 | TBARS | lipids peroxidation, TBARS |
| MI30050 | Qualitative light microscopic renal histopathology | histology, microscopy |
| MI30051 | Quantitative mesangial matrix evaluation | Mesangial matrix |
| MI30052 | Quantitative electron microscopic measurement of glomerular basement membrane | GBM thickness, Glomeruli, microscopy |
| MI30053 | Podocyte counts/glomerulus | Glomeruli, Podocyte |
| MI30054 | Glomerular harvest for protein or RNA | Glomeruli, protein, RNA |
| MI30055 | Immunoblot for glomerular lysates | Glomerular protein, Glomeruli, protein |
| MI30056 | 24 hour urine collection for albumin and creatinine | Albuminuria, creatinine, urinalysis, urinary albumin excretion (UAE), urine |
| MI30057 | Spot urine collection for albumin and creatinine | kidney, urinalysis, urinary albumin excretion (UAE), urine |
| MI30058 | Glomerular filtration rate (GFR) determination with minipump inulin clearance | glomerular filtration, kidney |
| MI30059 | Tail cuff Blood Pressure (BP) determination | blood pressure, tail-cuff |
| MI30006 | Fundus imaging | imaging, retinal layer |
| MI30007 | Intravitreal injection | injection |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |

## Miscellaneous

| Test No. | Test Name | Keywords |
|---|---|---|
| MI1026 | Verify Ampule (autoclave control) | autoclave control |
| MI1010 | Lab Sendout Processing Fee | |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| D6005 | Plasma/Serum Mouse Lipocalin-2 | inflammation, obesity |
| D6006 | Plasma/Serum Mouse Calprotectin | inflammation, obesity, secretion |

## Modeling and Simulation

| Test No. | Test Name | Keywords |
|---|---|---|
| V3090 | Amino Acids - Full Profile (HPLC) | amino acids, hormone, HPLC, imaging, metabolite, modeling and simulation |
| D2005 | Mouse Model Purchase | animal husbandry, modeling and simulation, mouse husbandry and transfer, mouse models |
| D2006 | Mouse Model Creation | animal husbandry, modeling and simulation, mouse husbandry and transfer, mouse models |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |

## Mouse Husbandry and Transfer

| Test No. | Test Name | Keywords |
|---|---|---|
| D2001 | Importation of Mice and Material | animal husbandry, mouse husbandry and transfer, mouse models |
| D2002 | Per Diem | animal husbandry, mouse husbandry and transfer, mouse models |
| D2003 | Colony Management (if needed) | animal husbandry, mouse husbandry and transfer, mouse models |
| D2004 | Genotyping (if needed) | animal husbandry, animal model, genetics, genotyping, mouse husbandry and transfer, mouse models |
| D2005 | Mouse Model Purchase | animal husbandry, modeling and simulation, mouse husbandry and transfer, mouse models |
| D2006 | Mouse Model Creation | animal husbandry, modeling and simulation, mouse husbandry and transfer, mouse models |
| D4001 | Gross Body Composition | body composition, fat free mass, fat-free mass, FFM, imaging, LBM, lean, mouse husbandry and transfer, obesity |
| D2013 | MMPC mouse gross necropsy with histology | histology, imaging, morphology, mouse husbandry and transfer, necropsy, organs, tissue |
| M1015 | Chronic high-fat feeding | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, insulin resistance, mouse husbandry and transfer, obesity, type 2 diabetes |
| M1016 | Chronic drug delivery | Drug, drug treatment, infusion, mouse husbandry and transfer, osmotic pump, surgery |
| M1022 | Surgery – tail vein injection | AAV delivery, intravenous, mouse husbandry and transfer, surgery, vein |
| D2007 | Chronic high-fat feeding | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, mouse husbandry and transfer, obesity, type 2 diabetes |

| Test No. | Test Name | Keywords |
|---|---|---|
| D2008 | Vertical Sleeve Gastrectomy (VSG) | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, mouse husbandry and transfer, obesity, type 2 diabetes |
| D2009 | Roux en Y Gastric Bypass (RYGB) | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, insulin resistance, mouse husbandry and transfer, obesity, type 2 diabetes |
| M5001 | Humanized Mouse (normoglycemic NSG mouse) | mouse husbandry and transfer, mouse models |
| M5002 | Humanized Mouse (STZ-induced diabetic NSG mouse) | mouse husbandry and transfer, mouse models |
| M5003 | Humanized Mouse (spontaneous-diabetic NSG-Ins2 Akita mouse) | diabetes, mouse husbandry and transfer, mouse models |
| M5004 | Humanized Mouse (induced-diabetic NSG-RIP-DTR mouse) | diabetes, mouse husbandry and transfer, mouse models |
| M6001 | Accelerated Quarantine Service | animal husbandry |
| MI1005 | Animal Health Surveillance - PCR Rodent Infectious Agent testing | animal husbandry, pathogen detection |
| MI1006 | Animal Health Surveillance - Pinworm PCR | mouse husbandry and transfer, pathogen detection |
| MI1008 | Mouse Microchipping | mouse husbandry and transfer |
| MI1063 | Germ Free Mice - C57BL/6 | free, germ, germ free, germ-free |
| MI1064 | Germ Free Mice - Swiss Webster | free, germ, germ free, germ-free |
| MI1065 | Germ Free Mice - BALB/c | free, germ, germ free, germ-free |
| MI1066 | Germ Free Mice - IL-10 Knockout | free, germ, germ free, germ-free |
| MI1067 | Germ Free Mice - Rag1 Knockout | free, germ, germ free, germ-free |
| MI1069 | Germ Free Mice - Shipping | free, germ, germ free, germ-free |
| MI1071 | Germ Free - Technician Time | free, germ, germ free, germ-free, mouse husbandry and transfer |
| MI1068 | Germ Free - Per Diem | free, germ, germ free, germ-free |
| MI1070 | Germ Free - Rederivation | free, germ, germ free, germ-free |
| MI1072 | Germ Free - Microbial community establishment | free, germ, germ free, germ-free |
| MI1073 | Germ Free - Surgical manipulation | free, germ, germ free, germ-free |
| MI1074 | Germ Free - Experimental Design and consultation | free, germ, germ free, germ-free |
| D2010 | Vertical Sleeve Gastrectomy (VSG) Package | animal model, diabetes, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, mouse husbandry and transfer, obesity |
| D2011 | Roux en Y Gastric Bypass (RYGB) Package | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, insulin resistance, mouse husbandry and transfer, obesity, type 2 diabetes |
| MI1003 | Quarantine per diem | |
| MI1004 | Intra-University trucking | |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |

| Test No. | Test Name | Keywords |
|---|---|---|
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| MI2070 | APC Housing Per diem (Transfer of care from ULAM to APC) | mouse husbandry and transfer |
| MI2071 | Breeding Colony Care | mouse husbandry and transfer |
| MI2072 | Technician Time | mouse husbandry and transfer |
| M1051 | Diet-induced mouse model of Non-Alcoholic Fatty Liver (NAFL) | mouse models |
| M1052 | Diet-induced mouse model of Non-Alcoholic Steatohepatitis (NASH) | mouse models |

## Neurobiology

| Test No. | Test Name | Keywords |
|---|---|---|
| MI30021 | Sciatic Motor NCV | conduction, Motor, NCV, nerve, SMNCV, velocity |
| MI30022 | Sural Sensory NCV | conduction, NCV, nerve, sensory activation, Sural, velocity |
| MI30023 | Intra-epidermal Nerve Fiber Density | fiber density, IENFD, nerve |
| MI30024 | Thermal Hindpaw Withdrawal | hindpaw, hp, thermal |
| MI30025 | Cryoembedding | cryoembedding |
| MI30026 | TBARS | lipids peroxidation, TBARS |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| M4016 | Denervation: Surgical and chemical Models | nerve, surgery |

## Neuronal Function

| Test No. | Test Name | Keywords |
|---|---|---|
| MI30021 | Sciatic Motor NCV | conduction, Motor, NCV, nerve, SMNCV, velocity |
| MI30022 | Sural Sensory NCV | conduction, NCV, nerve, sensory activation, Sural, velocity |
| MI30023 | Intra-epidermal Nerve Fiber Density | fiber density, IENFD, nerve |
| MI30024 | Thermal Hindpaw Withdrawal | hindpaw, hp, thermal |
| MI30025 | Cryoembedding | cryoembedding |
| MI30026 | TBARS | lipids peroxidation, TBARS |

| Test No. | Test Name | Keywords |
|---|---|---|
| MI30005 | Electroretinogram (ERG) | neural control |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| M4016 | Denervation: Surgical and chemical Models | nerve, surgery |

## Obesity

| Test No. | Test Name | Keywords |
|---|---|---|
| V3003 | Glucose Tolerance Test (Oral, i.p., Intravenous, or gastric catheter) | carbohydrate, diabetes, glucose intolerance, glucose tolerance, insulin, insulin action, insulin resistance, insulin sensitivity |
| V3005 | Hyperinsulinemic clamp | clamp, diabetes, endogenous glucose production, glucose, glucose disposal, glucose uptake, hyperinsulinemic clamp, insulin, insulin action, insulin resistance |
| V3006 | Hyperglycemic clamp | clamp, diabetes, glucose, hyperglycemic clamp, insulin, insulin resistance, insulin secretion, insulin sensitivity |
| V3012 | Indirect calorimetry / energy expenditure in the Promethion | Activity, basal metabolic rate, body composition, carbon dioxide, CO2 production, energy expenditure, food intake, gas exchange, indirect calorimetry, obesity, oxygen, oxygen consumption, respiratory quotient, water intake, wheel running |
| V4024 | Bariatric Surgery (Roux-en-Y, VSG, biliopancreatic diversion, sham controls) | absorption, adipose, bacteria, body composition, body weight, food intake, gut, gut hormones, microbiome, surgery |
| V4026 | Body Composition Analysis by NMR | body composition |
| M1026 | Drug trial study for therapeutic efficacy on obesity | Drug, drug infusion, drug treatment, drug trial, energy balance, energy expenditure, obese, obesity |
| D6001 | Ex vivo assessment of barrier function/gut permeability (minimum of 8 samples) | barrier function, gastrointestinal tract, GI function, gut, intestinal permeability, intestine, microbiome |
| D6002 | Lipopolysaccharide Binding Protein (LBP)/Endotoxemia Assay | bacteria, endotoxemia, endotoxin, LBP, lipopolysaccharide, lipopolysaccharide binding protein, LPS, plasma |
| D4010 | Special Services | body composition, cardiac function, exercise, indirect calorimetry, meal pattern, metabolism, telemetry |
| MI2010 | Glucose Tolerance Test (OGTT or IPGTT) including blood glucose and plasma insulin | blood, glucose, glucose tolerance, insulin |
| MI2011 | Glucose Tolerance Test (OGTT or IPGTT) w/o plasma insulin | glucose, glucose tolerance, insulin, plasma |
| MI2012 | Intravenous Glucose Tolerance Test (IVGTT with dual surgical catheterization) including | blood, catheterization, glucose, glucose tolerance, insulin |

| Test No. | Test Name | Keywords |
|---|---|---|
| | blood glucose and plasma insulin | |
| MI2013 | Intravenous Glucose Tolerance Test (IVGTT with dual surgical catheterization) w/o plasma insulin | catheterization, glucose, glucose tolerance |
| MI2015 | Intravenous Glucose Tolerance Test using portal vein delivery | glucose, glucose tolerance, portal, vein |
| MI2016 | Insulin or Pyruvate Tolerance Test | insulin, pyruvate tolerance test, tolerance |
| MI2017 | Hyperinsulinemic-euglycemic clamp (3H-glucose + 14C-2DG) | euglycemic clamp, hyperinsulinemic clamp |
| MI2018 | Hyperinsulinemic-euglycemic clamp (3H-glucose OR 14C-2DG) | hyperinsulinemic clamp |
| MI2019 | Hyperinsulinemic-euglycemic clamp w/o tracers | hyperinsulinemic clamp |
| MI2020 | Hyperinsulinemic-euglycemic clamp using portal vein infusion | hyperinsulinemic clamp, portal, vein |
| MI2021 | Hyperinsulinemic-euglycemic clamp + steady-state plasma NEFA | hyperinsulinemic clamp, NEFA, plasma |
| MI2022 | Hyperinsulinemic-euglycemic clamp + hepatic glycogen synthesis | glycogen synthesis, hepatic, hyperinsulinemic clamp |
| MI2023 | Hyperglycemic clamp | hyperglycemic clamp |
| MI2024 | Hyperinsulinemic-hypoglycemic clamp | hyperinsulinemic clamp |
| MI2046 | Body Weight Recording | body weight |
| M1032 | Body Weight | body weight, obesity |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| D6005 | Plasma/Serum Mouse Lipocalin-2 | inflammation, obesity |
| D6006 | Plasma/Serum Mouse Calprotectin | inflammation, obesity, secretion |

## Pancreas, Islets and Beta Cells

| Test No. | Test Name | Keywords |
|---|---|---|
| V3003 | Glucose Tolerance Test (Oral, i.p., Intravenous, or gastric catheter) | carbohydrate, diabetes, glucose intolerance, glucose tolerance, insulin, insulin action, insulin resistance, insulin sensitivity |
| V3006 | Hyperglycemic clamp | clamp, diabetes, glucose, hyperglycemic clamp, insulin, insulin resistance, insulin secretion, insulin sensitivity |
| V3082 | Tissue microdissection | diabetes, histology, immunology, insulin, insulin action, laser microdissection, organs, tissue, tissues |
| M1004 | Hyperglycemic clamp | awake mice, clamp, diabetes, glucose, in vivo, insulin, insulin resistance, insulin secretion |

| Test No. | Test Name | Keywords |
|---|---|---|
| V4024 | Bariatric Surgery (Roux-en-Y, VSG, biliopancreatic diversion, sham controls) | absorption, adipose, bacteria, body composition, body weight, food intake, gut, gut hormones, microbiome, surgery |
| M1029 | Drug trial study for therapeutic efficacy on diabetic complications | cardiovascular disease, complications, diabetes, Drug, drug infusion, drug treatment, drug trial, insulin secretion, islets, pancreas |
| M3001 | Pancreas isolation and embedding | islets, pancreas, surgery |
| M3002 | Islet histology – paraffin pancreas sections | histology, immunohistochemistry, islets, pancreas |
| M3003 | Islet histology – H&E stained pancreas sections | histology, islets, pancreas, staining |
| M3004 | Islet histology – insulin immunohistochemistry | histology, immunohistochemistry, insulin, islets |
| M3005 | Islet histology – insulin immunofluorescence | histology, immunohistochemistry, insulin, islet, islet function, islets |
| M3006 | Islet histology – insulin and glucagon immunofluorescence | glucagon, histology, immunohistochemistry, insulin, islet, islets, pancreas |
| M3007 | Islet histology – beta-cell proliferation and cell death | beta cell, imaging, immunohistochemistry, insulin, islet, islets, pancreas, staining |
| M3008 | Islet microscopy – islet images | histology, imaging, islet, islets, pancreas |
| M3009 | Islet microscopy – exocrine pancreas images | histology, imaging, islets, pancreas |
| M3010 | Islet microscopy – beta-cell mass | beta cell, imaging, islets, pancreas |
| M3011 | Pancreatic beta-cell mass (comprehensive) | beta cell, islet, islets, pancreas |
| M3012 | Pancreas islet architecture analysis | beta cell, glucagon, imaging, immunohistochemistry, insulin, islet, islets, pancreas |
| M3014 | Ex vivo islet analysis for insulin secretion | insulin, insulin secretion, islet, islets, pancreas |
| M3015 | Ex vivo islet molecular analyses | beta cell, islet, islets, pancreas, protein |
| M5005 | Phenotypic assessment of transplanted human islets | beta cell, diabetes, glucose tolerance, insulin, islet, islets, pancreas |
| M5006 | Phenotypic assessment of transplanted stem cell-derived beta-cells | beta cell, diabetes, glucose, glucose tolerance, imaging, immunohistochemistry, insulin, islet, islets, pancreas |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |

## Pathology & Immunohistochemistry

| Test No. | Test Name | Keywords |
|---|---|---|
| V3080 | Gross examinations and necropsy | gross examination, histology, necropsy, organs, tissue, tissues |
| V3081 | Tissue preparation, embedding, sectioning and routine staining | embedding, histology, organs, sectioning, staining, tissue, tissue preparation |

| Test No. | Test Name | Keywords |
|---|---|---|
| V3082 | Tissue microdissection | diabetes, histology, immunology, insulin, insulin action, laser microdissection, organs, tissue, tissues |
| V3083 | Screen/optimize immunohistochemical protocols for mouse-specific commercial and custom-designed antisera | histology, immunohistochemistry, organs, tissue, tissues |
| D2013 | MMPC mouse gross necropsy with histology | histology, imaging, morphology, mouse husbandry and transfer, necropsy, organs, tissue |
| M2032 | Cytokines Panel I - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin action, insulin resistance, monokines, obesity, serum samples, tissue lysates |
| M2033 | Cytokines Panel II - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin action, insulin resistance, monokines, obesity, serum samples, tissue lysates |
| M2036 | Cytokines Panel III - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin resistance, monokines, obesity |
| D5201 | IBA Immunohistochemistry | immunohistochemistry |
| D5202 | Factor VIII Immunohistochemistry | imaging, immunohistochemistry |
| M1030 | Drug trial study for toxicity | Drug, drug infusion, drug treatment, drug trial, liver function, liver function enzymes, toxicity |
| M3002 | Islet histology – paraffin pancreas sections | histology, immunohistochemistry, islets, pancreas |
| M3003 | Islet histology – H&E stained pancreas sections | histology, islets, pancreas, staining |
| M3004 | Islet histology – insulin immunohistochemistry | histology, immunohistochemistry, insulin, islets |
| M3005 | Islet histology – insulin immunofluorescence | histology, immunohistochemistry, insulin, islet, islet function, islets |
| M3006 | Islet histology – insulin and glucagon immunofluorescence | glucagon, histology, immunohistochemistry, insulin, islet, islets, pancreas |
| M3007 | Islet histology – beta-cell proliferation and cell death | beta cell, imaging, immunohistochemistry, insulin, islet, islets, pancreas, staining |
| M3008 | Islet microscopy – islet images | histology, imaging, islet, islets, pancreas |
| M3009 | Islet microscopy – exocrine pancreas images | histology, imaging, islets, pancreas |
| M3010 | Islet microscopy – beta-cell mass | beta cell, imaging, islets, pancreas |
| M3011 | Pancreatic beta-cell mass (comprehensive) | beta cell, islet, islets, pancreas |
| M3012 | Pancreas islet architecture analysis | beta cell, glucagon, imaging, immunohistochemistry, insulin, islet, islets, pancreas |
| M3015 | Ex vivo islet molecular analyses | beta cell, islet, islets, pancreas, protein |
| M5005 | Phenotypic assessment of transplanted human islets | beta cell, diabetes, glucose tolerance, insulin, islet, islets, pancreas |
| M5006 | Phenotypic assessment of transplanted stem cell-derived beta-cells | beta cell, diabetes, glucose, glucose tolerance, imaging, immunohistochemistry, insulin, islet, islets, pancreas |

| Test No. | Test Name | Keywords |
|---|---|---|
| MI1031 | Histology - Trim/Cassette (Paraffin or OCT) | histology |
| MI1033 | Histology - Paraffin Process & Embed | histology |
| MI1034 | Histology - Tissue Sections, Paraffin Unstained Slide | histology |
| MI1035 | Histology - Tissue Sections, Paraffin H&E Stain | histology |
| MI1036 | Histology - Tissue Sections, Frozen Unstained Slide | histology |
| MI1037 | Histology - Tissue Sections, Frozen H&E Stained | histology |
| MI1041 | Histology - Special Stain, Prussian Blue | histology |
| MI1042 | Histology - Special Stain, Picrosirius Red | histology |
| MI1043 | Histology - Speical Stian, Verhoeff Van Gieson | histology |
| MI1044 | Histology - Special Stain, Gram | bacteria, histology |
| MI1045 | Histology - Speical Stain, Luxol Fast Blue (LFB) | histology |
| MI1046 | Histology - Special Stain, Warthin Starry | bacteria, histology |
| MI1047 | Histology - Special Stain, Other | histology |
| MI1048 | Immunohistochemistry - Tier 1 (ALDH1, Amylase, aSMA, CD45R-B220, CD3, Caspase-3, F4/80, GFAP, GFP, Insulin, Ki67, Ly-6G, Lyve-1, Mac2, Neurofilament) | immunohistochemistry |
| MI1049 | Immunohistochemistry - Tier 2 Tier 2 (AE1/AE3 + 8/18, CD4, CD8a, CD31, Estrogen Receptor, Glucagon, c-erbB2/HER2, Progesterone, Von Willebrand Factor) | immunohistochemistry |
| MI1053 | Histology Technician Labor | histology, immunohistochemistry |
| MI1054 | Pathologist Hourly | histology, immunohistochemistry |
| MI1055 | Aperio 20X scan, Semi-automated, >50 slides | histology, immunohistochemistry |
| MI1056 | Aperio 20X scan, Semi-automated, batch of 20-50 | histology, immunohistochemistry |
| MI1057 | Aperio 20X scan, Semi-automated, each | histology, immunohistochemistry |
| MI1058 | Aperio Technician Labor | histology, immunohistochemistry |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| MI1080 | Histology - Special Stain, Oil Red O (ORO) | histology, immunohistochemistry |
| MI1081 | Immunohistochemistry - Stain, Negative Control | histology, immunohistochemistry |
| MI1082 | Immunohistochemistry - Stain, Non-IVAC Primary Antibody | histology, immunohistochemistry |
| MI1083 | Immunohistochemistry - Stain, Titration Slide | histology, immunohistochemistry |
| MI1084 | Immunohistochemistry - Stain, Frozen IHC or Immunofluorence Slide | histology, immunohistochemistry |

## Protein

| Test No. | Test Name | Keywords |
|---|---|---|
| C1041 | Body Composition / Carcass Analysis (per animal) | body composition, carcass analysis, food intake, lean, obesity, QMR, total body fat |
| V3009 | Amino acid kinetics | amino acid flux, amino acid kinetics, isotopes, metabolite |
| V3099 | Albuminuria | complications, diabetes, kidney, kidney disease, protein, urinary albumin excretion (UAE), urine |
| D3431 | Hormones - Generic ELISA Assay | hormone, liver, liver function |
| D3432 | Insulin | carbohydrate, diabetes, hormone, insulin, liver, liver function |
| D3433 | C-Peptide | hormone, insulin, insulin secretion, liver, liver function |
| D3434 | Proinsulin | carbohydrate, diabetes, hormone, insulin, liver function, liver function enzymes |
| D3435 | Leptin | adipokine, diabetes, feeding behavior, hormone, leptin, leptin measurement, liver, liver function, liver function enzymes, obesity |
| D3436 | Adiponectin (total) | adipokine, adiponectin, hormone, insulin, insulin resistance, lipids, liver, liver function, liver function enzymes |
| D3437 | Adiponectin (HMW) | adipokine, adiponectin, hormone, insulin, insulin resistance, lipids, liver, liver function, liver function enzymes |
| D3438 | Glucagon | counterregulatory, glucagon, hormone, lipids, liver, liver function, liver function enzymes |
| D3439 | Glucagon-like peptide 1 (active) | glucagon, hormone, incretin, lipids, liver, liver function, liver function enzymes |
| D3440 | Glucagon-like peptide 1 (total) | glucagon, hormone, incretin, lipids, liver, liver function, liver function enzymes |
| D3441 | Ghrelin | eating behavior, energy balance, hormone, liver, liver function, liver function enzymes |
| D3451 | Urinary Albumin Excretion | albumin, complications, kidney, kidney disease, renal, urinary albumin excretion (UAE), urine |
| D3452 | Creatinine | cardiovascular, creatinine, kidney, kidney disease, lesion, renal, urine |
| D3453 | Urea | kidney, kidney disease, renal, urea |
| M1011 | Protein metabolism | amino acid, amino acids, in vivo protein turnover, phenylalanine, protein, protein synthesis |
| M2021 | Albumin | liver, liver function, liver function enzymes, metabolite, protein, serum albumin, serum chemicals |
| M2026 | Creatinine | cardiovascular, creatinine, kidney, kidney disease, lesion, metabolite |
| M2027 | C-reactive peptide | CRP, inflammation, liver, liver function, liver function enzymes, metabolite, obesity, serum chemicals |
| M2028 | Total protein | metabolite |

| Test No. | Test Name | Keywords |
|---|---|---|
| M2029 | Urea/BUN | kidney, kidney disease, metabolite, renal |
| M2030 | Uric acid | kidney, kidney disease, metabolite, renal |
| M3015 | Ex vivo islet molecular analyses | beta cell, islet, islets, pancreas, protein |
| M2040 | Glucagon-like peptide 1 (GLP-1 ). | glucagon, liver, liver function, liver function enzymes, Luminex, peptides |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |

## Research Assistance and Training

| Test No. | Test Name | Keywords |
|---|---|---|
| V4006 | Personnel Training | advice, course, training |
| MI2064 | Laboratory Assistance and Training | training |
| MI2065 | Surgical Training and Supplies, Surgical cannulations of Jugular vein and/or carotid artery | artery, cannulation, carotid, jugular, surgery, training, vein |
| MI2066 | Surgical Training and Supplies, Carotid catheters (micro-renathane) | artery, carotid, catheterization, surgery |
| MI2067 | Surgical Training and Supplies, Jugular vein catheters (silicon tubing) | catheterization, jugular, surgery, vein |
| MI2068 | Surgical Training and Supplies, Dual-catheter Exteriorizing Connector | catheterization, surgery, training |
| MI4001 | Study design consultation | consultation, study design |
| MI4004 | Analysis of Sequencing Data - Mothur pipeline | gene sequencing, RNA |
| MI1005 | Animal Health Surveillance - PCR Rodent Infectious Agent testing | animal husbandry, pathogen detection |
| V4007 | Surgical Training | surgery, training |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| MI2072 | Technician Time | mouse husbandry and transfer |
| MI2073 | Data Analysis | data analysis |
| M7001 | Consultation - Study Design | consultation, study design |
| M7004 | Consultation - Sequence Data Analysis | gene sequencing, sequence based species quantitation |
| M7005 | Consultation - Post-analysis Data Preparation | |

| Test No. | Test Name | Keywords |
|---|---|---|
| M7006 | Consultation - Data Upload | |
| M1050 | Consultation - Study Design, Methodologies, Analysis, & Interpretation | consultation |

## Sample Preparation

| Test No. | Test Name | Keywords |
|---|---|---|
| MI4002 | DNA extraction single plate with controls | DNA, extraction, isolation |
| MI1030 | Decalcification | bone, decalcification |
| MI1031 | Histology - Trim/Cassette (Paraffin or OCT) | histology |
| MI1033 | Histology - Paraffin Process & Embed | histology |
| MI1034 | Histology - Tissue Sections, Paraffin Unstained Slide | histology |
| MI1035 | Histology - Tissue Sections, Paraffin H&E Stain | histology |
| MI1036 | Histology - Tissue Sections, Frozen Unstained Slide | histology |
| MI1037 | Histology - Tissue Sections, Frozen H&E Stained | histology |
| MI1038 | Histology - Special Stain, Masson Trichrome (MTC) | histology |
| MI1040 | Histology - Special Stain, Toluidine Blue | histology |
| MI1053 | Histology Technician Labor | histology, immunohistochemistry |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| M7002 | Sample DNA Extraction & Quality Control Analyses | DNA, extraction |
| M1046 | Tissue collection | isolation, tissue, tissue preparation, tissues |

## Surgery

| Test No. | Test Name | Keywords |
|---|---|---|
| C1051 | Intestinal lipid absorption in the conscious mouse-lymph fistula (per animal) | absorption, energy balance, fistula, gastrointestinal tract, lipids, lymph |
| V3001 | Cannulation of cerebral ventricle | central control, CSF, surgery |
| V3002 | Jugular vein and carotid artery catheterization | artery, blood vessel, catheterization, chronic, insulin, insulin action, surgery, vein |
| V3005 | Hyperinsulinemic clamp | clamp, diabetes, endogenous glucose production, glucose, glucose disposal, glucose uptake, hyperinsulinemic clamp, insulin, insulin action, insulin resistance |
| V3000 | Jugular Vein or Carotid Artery Catheterization | artery, catheterization, surgery, vein |

| Test No. | Test Name | Keywords |
|---|---|---|
| M1016 | Chronic drug delivery | Drug, drug treatment, infusion, mouse husbandry and transfer, osmotic pump, surgery |
| M1021 | Surgery – jugular vein cannulation | catheterization, clamp, intravenous, surgery, vein |
| M1022 | Surgery – tail vein injection | AAV delivery, intravenous, mouse husbandry and transfer, surgery, vein |
| M1023 | Surgery – carotid artery cannulation | artery, blood sampling, catheterization, surgery |
| D2008 | Vertical Sleeve Gastrectomy (VSG) | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, mouse husbandry and transfer, obesity, type 2 diabetes |
| D2009 | Roux en Y Gastric Bypass (RYGB) | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, insulin resistance, mouse husbandry and transfer, obesity, type 2 diabetes |
| V4024 | Bariatric Surgery (Roux-en-Y, VSG, biliopancreatic diversion, sham controls) | absorption, adipose, bacteria, body composition, body weight, food intake, gut, gut hormones, microbiome, surgery |
| M3001 | Pancreas isolation and embedding | islets, pancreas, surgery |
| M3013 | Pancreatic islet isolation | beta cell, islet, islets, pancreas, surgery |
| MI2001 | Catheterization of jugular vein | catheterization, surgery, vein |
| MI2002 | Catheterization of carotid artery | artery, catheterization, surgery |
| MI2003 | Catheterization of jugular vein AND carotid artery | artery, catheterization, surgery, vein |
| MI2004 | Catheterization of portal vein | catheterization, surgery, vein |
| MI2005 | Catheterization of portal vein AND carotid artery | artery, catheterization, surgery, vein |
| MI2006 | Catheterization of stomach or bladder | bladder, catheterization, stomach |
| MI2007 | Partial pancreatectomy | pancreas, surgery |
| MI2008 | Parabiosis (a surgical union of two mice) | parabiosis, surgery |
| MI2053 | Tissue Dissection/Collection | dissection, tissue |
| MI2065 | Surgical Training and Supplies, Surgical cannulations of Jugular vein and/or carotid artery | artery, cannulation, carotid, jugular, surgery, training, vein |
| MI2066 | Surgical Training and Supplies, Carotid catheters (micro-renathane) | artery, carotid, catheterization, surgery |
| MI2067 | Surgical Training and Supplies, Jugular vein catheters (silicon tubing) | catheterization, jugular, surgery, vein |
| MI2068 | Surgical Training and Supplies, Dual-catheter Exteriorizing Connector | catheterization, surgery, training |
| MI1027 | Necropsy Small Animal-standard | necropsy |
| MI1028 | Full tissue collection starting with fixed whole carcass | necropsy, surgery |
| MI1029 | Necropsy technician fee | necropsy |
| M1033 | Surgery – Ovariectomy | surgery |
| M3016 | Surgery- jugular vein cannulation for chronic | cannulation, jugular, surgery |

| Test No. | Test Name | Keywords |
|---|---|---|
| | infusion | |
| D2010 | Vertical Sleeve Gastrectomy (VSG) Package | animal model, diabetes, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, mouse husbandry and transfer, obesity |
| D2011 | Roux en Y Gastric Bypass (RYGB) Package | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, insulin resistance, mouse husbandry and transfer, obesity, type 2 diabetes |
| D2014 | Surgery - Data Recorder or Simple Telemetry (without cannulation) | surgery, telemetry |
| V4007 | Surgical Training | surgery, training |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| M1046 | Tissue collection | isolation, tissue, tissue preparation, tissues |
| M4017 | Parabiosis Models | parabiosis, surgery, Vascular Permeability |

## Urine Culture

| Test No. | Test Name | Keywords |
|---|---|---|
| MI1020 | Urinalysis - Aerobic General Culture | bacteria, urine |
| MI1021 | Urinalysis - Anaerobic Culture | bacteria, urine |
| MI1022 | Urinalysis - Fungal Culture | urine |
| MI1023 | Urinalysis - General Culture plus sensitivity | bacteria, urine |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| M2054 | Calcium | Ca, Ca2+, plasma, serum, urine |
| M2055 | Magnesium | plasma, serum, urine |
| M2056 | Phosphate | plasma, serum, urine |

## Vascular Function

| Test No. | Test Name | Keywords |
|---|---|---|
| V3013 | Exercise capacity/Exercise Stress Test (metabolic response to exercise) | Activity, endurance, exercise capacity, exercise stress test, exercise tolerance |
| V3031 | Echocardiography, in vivo morphology, systolic and diastolic function; Stress echocardiography | cardiac function, diastolic, ECG, echo, echocardiography, EKG, electrocardiography, morphology, pulsed Doppler, strain imaging, stress, systolic, vascular function |

| Test No. | Test Name | Keywords |
|---|---|---|
| V3032 | Telemetry (in vivo chronic arterial blood pressure measurement) | Activity, blood pressure<br>heart rate<br>activity<br>temperature<br>blood glucose<br>arrhythmia, cardiac, cardiovascular disease, diastolic, ECG, echo, EKG, glucose, systolic, telemetry, vascular function |
| V3033 | Blood pressure measurements | blood pressure, blood vessel, cardiac function, circulation, hypertension, hypotension, tail-cuff, telemetry, vascular, vascular function |
| V3034 | Vascular morphology | atherosclerosis, blood vessel, circulation, histology, vascular, vascular function |
| V3076 | Morphometric determinations (aorta) | atherosclerosis, blood vessel, histology, vascular, vascular function |
| D5005 | BP measurement by tail cuff | blood pressure, cardiac function, circulation, diabetes, hypertension, hypotension, obesity, vascular function |
| D5011 | CT, MRI, PET, & combinations | cardiac function, central nervous system, circulation, CT, diabetes, imaging, magnetic, metabolism, MRI, obesity, PET, resonance, spectroscopy, vascular function |
| M4005 | Endothelial Function | cardiovascular, endothelial denudation, vascular, vascular function, vascular tone |
| M4006 | Hind Limb Ischemia (HLI) Model | ischemia, vascular, vascular function |
| M4007 | Abdominal Aortic Aneurysm (AAA) Model | aortic reactivity, aortic ring, cardiovascular |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |
| M4010 | Moor Laser Speckle Contrast Imaging | blood flow, ischemia, peripheral vascular disease, vascular disease |
| M4013 | Carotid Artery Ligation Models | artery, carotid |
| M4014 | Carotid Artery Restriction Models | artery, carotid |
| M4015 | Wire Myography Studies | artery, vascular |
| M4018 | Jugular vein and carotid artery catheterization | arterial, artery, carotid, catheterization, jugular |

# Tests Listed by Center

## UNIVERSITY OF CALIFORNIA DAVIS

### Animal Care, Surgery, and Pathology Core

Director: Kristin Grimsrud, Co-Director: Stephen Griffey

The Core provides extensive scientific support services, including importation/exportation, colony management, customized mouse models, rederivation and creation of genetically-modified mutant mice (e.g. CRISPR), and re-animation of a variety of models cryopreserved within the KOMP or MMRRC repositories. These new and extant mouse models can then be bred to produce male and female cohorts for in vivo and in vitro phenotyping, including rederivation into our Gnotobiotic Mouse Research Center for gut microbiome studies.

The Core also operates a Microsurgery Suite, with two expert microsurgeons, for development of surgically-manipulated mouse models, such as bariatric surgical models, e.g. Vertical Sleeve Gastrectomy (VSG) and Roux en Y Gastric Bypass (RYGB), as well as cannulation telemetry and osmotic pump implants, in addition to providing microsurgery training services for investigators and clinicians. In addition to testing, manipulation, and sampling, investigator can have these surgically-manipulated models as well as any genetically-engineered mouse lines shipped from our approved vendor barrier vivarium directly into the recipient institution’s vivarium.

The Core also provides ancillary services and procedures, including blood sampling for in vivo testing for glucose tolerance tests and insulin tolerance tests. We provide pathology analysis to complement other testing including survey necropsy with histology, clinical chemistry and hematology analysis. This testing can be customized to include specific organ histologic examination, grading and photo documentation.

The Core is led by Kristin Grimsrud DVM, PhD, who oversees two trained rodent surgical technicians, one import/export coordinator, and two phenotyping technicians, and is co-led by Stephen Griffey DVM, PhD.

| Test No. | Test Name | Keywords |
|---|---|---|
| D2001 | Importation of Mice and Material | animal husbandry, mouse husbandry and transfer, mouse models |
| D2002 | Per Diem | animal husbandry, mouse husbandry and transfer, mouse models |
| D2003 | Colony Management (if needed) | animal husbandry, mouse husbandry and transfer, mouse models |
| D2004 | Genotyping (if needed) | animal husbandry, animal model, genetics, genotyping, mouse husbandry and transfer, mouse models |
| D2005 | Mouse Model Purchase | animal husbandry, modeling and simulation, mouse husbandry and transfer, mouse models |
| D2006 | Mouse Model Creation | animal husbandry, modeling and simulation, mouse husbandry and transfer, mouse models |
| D2007 | Chronic high-fat feeding | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, mouse husbandry and transfer, obesity, type 2 diabetes |
| D2008 | Vertical Sleeve Gastrectomy (VSG) | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, mouse husbandry and transfer, obesity, type 2 diabetes |
| D2009 | Roux en Y Gastric Bypass (RYGB) | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, insulin resistance, mouse husbandry and transfer, obesity, type 2 diabetes |
| D2010 | Vertical Sleeve Gastrectomy (VSG) Package | animal model, diabetes, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, mouse husbandry and transfer, obesity |

| Test No. | Test Name | Keywords |
|---|---|---|
| D2011 | Roux en Y Gastric Bypass (RYGB) Package | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, insulin resistance, mouse husbandry and transfer, obesity, type 2 diabetes |
| D2013 | MMPC mouse gross necropsy with histology | histology, imaging, morphology, mouse husbandry and transfer, necropsy, organs, tissue |
| D2014 | Surgery - Data Recorder or Simple Telemetry (without cannulation) | surgery, telemetry |
| D2016 | Additional Pathology Services | CT, histology, imaging, immunohistochemistry, Pathology, PET |
| D2017 | Clinical Chemistry, Hematology, Urine Analysis | ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC |

## Endocrinology and Metabolism Core

Director: Peter havel, Co-Director: Fawaz Haj, Coordinator: James Graham

The Endocrinology and Metabolism Core provides phenotyping services for the assessment of endocrine function and metabolic pathways in mouse models of obesity, diabetes, and related metabolic diseases including dyslipidemia and fatty liver disease (NAFLD).

The Core also provides expertise, technical resources, and instrumentation necessary to characterize perturbations in endocrine systems and metabolism in murine models useful for understanding obesity, diabetes, its complications, and related metabolic disorders, including NAFLD.

The Core performs assays and data interpretation for in vivo metabolic function tests, including IV, IP and oral glucose tolerance tests and insulin tolerance tests for parameters of insulin sensitivity, insulin secretion and glucose disposal.

In addition, the Core offers an extensive list of quality controlled assays of metabolic substrates, endocrine hormones, and indices of renal function, assessments of insulin signaling pathways, inflammation and endoplasmic reticulum stress in metabolically important tissues such as liver, muscle, adipose, pancreas, as well as state-of-the-art metabolomic analysis and interpretation, including complex lipids, phospholipids, bile acids, and biogenic amines using small sample volumes. The Core works closely with the Animal Care Core on projects evaluating the metabolic effects of bariatric surgery, and with the Microbiome Core to coordinate microbiome and metabolomic analyses and interpretation. Continuous glucose monitoring (CGM) in conscious unrestrained mice is in development and expected to be offered in the near future.

The Core is led by Dr. Peter Havel, DVM, PhD and Co-led by Dr.’s Fawaz Haj, PhD and Oliver Fiehn, PhD. Other Core members include Dr. Mark Huising and Staff Research Associate, James Graham.

| Test No. | Test Name | Keywords |
|---|---|---|
| D3101 | Intravenous Glucose Tolerance Test | carbohydrate, diabetes, insulin, insulin action, insulin resistance, insulin secretion, insulin sensitivity |
| D3103 | IN VIVO Insulin Tolerance Tests | carbohydrate, diabetes, insulin, insulin action, insulin resistance, insulin sensitivity |
| D3104 | IN VIVO Glucose Tolerance Tests | carbohydrate, diabetes, glucose, glucose metabolism, glucose tolerance, insulin resistance, insulin sensitivity |
| D3105 | IN VIVO Glucose-stimulates Insulin Secretion Test | carbohydrate, diabetes, glucose, glucose metabolism, insulin, insulin action, insulin resistance, insulin sensitivity |

| Test No. | Test Name | Keywords |
|---|---|---|
| D3301 | Lipid extraction from liver | atherosclerosis, cholesterol, obesity, total cholesterol, triglycerides |
| D3302 | Lipid extraction from muscle | atherosclerosis, cholesterol, obesity, total cholesterol, triglycerides |
| D3401 | Glucose (urine/plasma) | carbohydrate, diabetes, glucose, hyperglycemia, hypoglycemia, insulin, insulin action, insulin effectiveness, liver, liver function, liver function enzymes, metabolite, urine |
| D3402 | Hemoglobin A1C | diabetes, glucose, Hemoglobin A1C, hyperglycemia, liver, liver function, liver function enzymes, metabolism |
| D3403 | beta-OH butyrate | Atkins, diabetes, insulin, ketones, liver, liver function, liver function enzymes, low carbohydrate, metabolism |
| D3404 | Triglyceride | liver, metabolism, triglycerides |
| D3405 | Total Cholesterol | atherosclerosis, cholesterol, lipids, liver, liver function, metabolism, metabolite, obesity, total cholesterol |
| D3406 | HDL-C and LDL-C/VLDL-C | atherosclerosis, cholesterol, lipids, liver, liver function, metabolism, metabolite, obesity |
| D3407 | HDL-TG and LDL-TG/VLDL-TG | atherosclerosis, cholesterol, lipids, liver, liver function, metabolism, metabolite, obesity |
| D3408 | Non esterified fatty acids | lipids, liver, liver function, liver function enzymes, metabolism, non-esterified fatty acid |
| D3412 | Metabolomics | amino acids, aromatics, carbohydrate, diabetes, exercise, free fatty acids, glycolysis, hormone, hydroxyl acids, lipids, liver, liver function, metabolism, metabolite, serum, sterol, sugar phosphates, TCA intermediates |
| D3413 | Complex lipid ratios | ceramides, diabetes, exercise, lipids, liver, liver function, lysophosphatidylcholines, mass spectrometry, obesity, phospholipids, serum, sphingomyelins |
| D3414 | Alanine Transaminase (ALT) | Alanine transferase, plasma |
| D3415 | Aspartate Aminotransferase (AST) | |
| D3431 | Hormones - Generic ELISA Assay | hormone, liver, liver function |
| D3432 | Insulin | carbohydrate, diabetes, hormone, insulin, liver, liver function |
| D3433 | C-Peptide | hormone, insulin, insulin secretion, liver, liver function |
| D3434 | Proinsulin | carbohydrate, diabetes, hormone, insulin, liver function, liver function enzymes |
| D3435 | Leptin | adipokine, diabetes, feeding behavior, hormone, leptin, leptin measurement, liver, liver function, liver function enzymes, obesity |
| D3436 | Adiponectin (total) | adipokine, adiponectin, hormone, insulin, insulin resistance, lipids, liver, liver function, liver function enzymes |
| D3437 | Adiponectin (HMW) | adipokine, adiponectin, hormone, insulin, insulin resistance, lipids, liver, liver function, liver function enzymes |

| Test No. | Test Name | Keywords |
|---|---|---|
| D3438 | Glucagon | counterregulatory, glucagon, hormone, lipids, liver, liver function, liver function enzymes |
| D3439 | Glucagon-like peptide 1 (active) | glucagon, hormone, incretin, lipids, liver, liver function, liver function enzymes |
| D3440 | Glucagon-like peptide 1 (total) | glucagon, hormone, incretin, lipids, liver, liver function, liver function enzymes |
| D3441 | Ghrelin | eating behavior, energy balance, hormone, liver, liver function, liver function enzymes |
| D3451 | Urinary Albumin Excretion | albumin, complications, kidney, kidney disease, renal, urinary albumin excretion (UAE), urine |
| D3452 | Creatinine | cardiovascular, creatinine, kidney, kidney disease, lesion, renal, urine |
| D3453 | Urea | kidney, kidney disease, renal, urea |
| D3461 | Markers of Inflammation - custom panel | diabetes, growth factors, immunology, inflammation, interleukins, oxidative stress |
| D3463 | HS CRP | CRP, diabetes, immunology, inflammation |
| D3464 | Serum Amyloid A1 | diabetes, immunology, inflammation, serum, serum metabolic panel |
| D3465 | sICAM | diabetes, immunology, inflammation |
| D3466 | sVCAM | diabetes, immunology, inflammation |
| D3467 | sE-Selectin | diabetes, hormone, immunology, inflammation |
| D3468 | sP-Selectin | diabetes, hormone, immunology, inflammation |
| D3495 | MISC Assay | custom |
| D3496 | Corticosterone | carbohydrate, carbohydrate metabolism, hormone, serum |

## Energy Balance, Exercise & Behavior Core

Director: Jon Ramsey, Co-Director: Sue Bodine, Coordinator: Jennifer Rutkowsky

Obesity is the result of an inability to maintain energy balance, and changes in energy balance can also be important contributing factors in the etiology of diabetes and other metabolic diseases. A major goal of Core D is to provide investigators with the services necessary to accurately measure the major components of energy balance (energy intake, energy expenditure, body composition, nutrient digestibility) in their mouse models. Core D also provides tests that allow investigators to examine physiological factors that may influence food intake or energy expenditure. A second focus of Core D is to understand the contribution of physical activity to energy balance as well as the beneficial effects of voluntary exercise or treadmill training on metabolism. Behavior is the third component of Core D, with an array of tests for cognitive and behavioral assessment. Core D investigators have complementary expertise in energy metabolism and exercise/muscle biology to provide clients with assistance in all steps of the research process, from designing experiments to analyzing and interpreting data. In addition to offering standard services in our catalog, Core D also works with investigators to design custom tests or develop new tests to meet their research needs.

| Test No. | Test Name | Keywords |
|---|---|---|
| D4001 | Gross Body Composition | body composition, fat free mass, fat-free mass, FFM, imaging, LBM, lean, mouse husbandry and transfer, obesity |
| D4002 | Adiposity (adipose depot weights) | body composition, obese, obesity, WAT |
| D4003 | Meal Pattern Analysis | eating behavior, food intake, meal pattern |
| D4007 | Energy Expenditure (CLAMS, Indirect Calorimetry) | basal metabolic rate, CO2 production, energetics, energy balance, energy |

| Test No. | Test Name | Keywords |
|---|---|---|
| | | expenditure, food intake, heat, indirect calorimetry, obesity, oxygen consumption, RER, respiratory quotient, RQ, thermogenesis |
| D4008 | Energy Expenditure (CLAMS, Indirect Calorimetry) + Meal Pattern Analysis | basal metabolic rate, body composition, CO2 production, energetics, energy balance, energy expenditure, food intake, heat, indirect calorimetry, obesity, oxygen consumption, RER, respiratory exchange ratio, respiratory quotient, RQ, thermogenesis |
| D4010 | Special Services | body composition, cardiac function, exercise, indirect calorimetry, meal pattern, metabolism, telemetry |
| D4011 | Voluntary wheel running (activity and/or exercise) | Activity, exercise, running wheel, wheel running |
| D4012 | Core body temperature (temperature recorder) | body temperature, Temperature, thermogenesis, thermoneutrality |
| D5005 | BP measurement by tail cuff | blood pressure, cardiac function, circulation, diabetes, hypertension, hypotension, obesity, vascular function |
| D5011 | CT, MRI, PET, & combinations | cardiac function, central nervous system, circulation, CT, diabetes, imaging, magnetic, metabolism, MRI, obesity, PET, resonance, spectroscopy, vascular function |
| D5101 | Cognitive Function - Radial Arm Water Maze | cognitive function |
| D5102 | Cognitive Function - Morris Water Maze (Male Mice) | cognitive function |
| D5103 | Cognitive Function - Morris Water Maze (Female Mice) | cognitive function |
| D5104 | Cognitive Function - Y Maze | cognitive function |
| D5201 | IBA Immunohistochemistry | immunohistochemistry |
| D5202 | Factor VIII Immunohistochemistry | imaging, immunohistochemistry |

## Microbiome & Host Response Core

Director: Helen Raybould, Co-Director: Trina Knotts

Mission Statement:

To provide clients with a prompt and efficient service to determine how the gut microbiota is contributing to the observed metabolic or gut phenotype.

Core Description:

The gut is the first site of interaction between ingested nutrients and the host, and plays an important role in the regulation of metabolic homeostasis. The products of digestion provide the stimuli for release of hormones and activation of neural pathways crucial to integrate postprandial gut function, food intake and whole body metabolic function. In addition, there is a growing appreciation of the role of the gut microbial populations in health and disease, especially in metabolic disease and obesity. Thus, determination of gut microbiota and gut function is an important component of metabolic phenotyping.

The Microbiome & Host Response Core offers methods to survey the important bacterial taxa:

- Metagenomics, especially 16S variable region amplicon sequencing, data analysis and interpretation
- Multi-variate analysis

• Metabolomic approaches to assess microbial function by measuring levels of microbial metabolites.

Priorities of the core include reproducibility and reliability; sample preparation, storage, and handling of small sample volumes; gut region and/or time-dependent differences.

The Microbiome & Host Response Core offers methods to determine gut function in metabolic phenotypes:

• Measurement of gut permeability (Gut permeability: in vivo, ex vivo Ussing chambers and immunohistochemistry and/or expression of tight junction proteins)

• Plasma lipopolysaccharide binding protein (LBP) assay

• Inflammatory profiling

Other services are offered on a custom basis including measurement of gut transit time, gastric emptying and activity in the gut-brain axis. Future services include transcriptomics of the luminal microbiota and gut tissue of the host.

| Test No. | Test Name | Keywords |
|---|---|---|
| D4006-C | Gut Microbiome Analysis (Illumina method-2X300bp- 20,000 avg seq read depth) | bacteria, cecum, energetics, feces, gastrointestinal tract, microbe, microbiome, sequence based species quantitation |
| D6001 | Ex vivo assessment of barrier function/gut permeability (minimum of 8 samples) | barrier function, gastrointestinal tract, GI function, gut, intestinal permeability, intestine, microbiome |
| D6002 | Lipopolysaccharide Binding Protein (LBP)/Endotoxemia Assay | bacteria, endotoxemia, endotoxin, LBP, lipopolysaccharide, lipopolysaccharide binding protein, LPS, plasma |
| D6003 | Fecal Mouse Lipocalin-2 | gastrointestinal tract, gut, inflammation, intestinal permeability, intestine |
| D6004 | Fecal Mouse Calprotectin | gastrointestinal tract, gut, inflammation, intestinal permeability, intestine |
| D6005 | Plasma/Serum Mouse Lipocalin-2 | inflammation, obesity |
| D6006 | Plasma/Serum Mouse Calprotectin | inflammation, obesity, secretion |
| D6007 | Special Services | consultation, data analysis, gut, intestinal permeability, intestine, microbiome, study design |

## UNIVERSITY OF CINCINNATI MEDICAL CENTER

### Lipid, Lipoprotein and Glucose Metabolism Core

Director: Patrick Tso

Diabetes is defined by abnormalities in circulating metabolites; obviously glucose metabolism is impaired, but the presence of certain dyslipidemias can also lead to a predisposition for cardiovascular disease in diabetic patients.

This core is capable of measuring numerous metabolic parameters in mouse models pertaining to serum lipid profiles, glucose metabolism and plasma hormones.

| Test No. | Test Name | Keywords |
|---|---|---|
| C1051 | Intestinal lipid absorption in the conscious mouse-lymph fistula (per animal) | absorption, energy balance, fistula, gastrointestinal tract, lipids, lymph |
| C1052 | Lipid Profiles (TG, CHOL, PL, NEFA)(per set of 38 samples) | lipids, non-esterified fatty acid, obesity, phospholipids, total cholesterol, triglycerides |
| C1054 | Lipoprotein fractionation by FPLC (per sample) | apolipoproteins, cholesterol, fatty acids, FPLC, lipids, lipoproteins, obesity |
| C1055 | Metabolism of chylomicrons (per sample) | apolipoproteins, chylomicron, chylomicron |

| Test No. | Test Name | Keywords |
|---|---|---|
| | | remnants, lipids |
| C1057 | Free Fatty Acids (NEFA) Concentration (per set of 38 samples) | free fatty acids, lipids, non-esterified fatty acid, obesity, serum |
| C1058 | ß-hydroxybutyrate concentration (per set of 38 samples) | Atkins, beta-hydroxybutyrate, diabetes, ketones, low carbohydrate, serum |
| C1059 | Non-invasive measurement of intestinal fat absorption (each) | energy balance, fatty acids, fecal fat absorption, lipid, lipids, obesity |
| C1060 | Phospholipids concentration (per set of 38 samples) | fatty acids, lipids, phospholipids |
| C1061 | Adiponectin concentration (per set of 38 samples) | adipokine, adiponectin, gut hormones, hormone, insulin, insulin action, insulin resistance, peptides, serum |
| C1070 | Glucose tolerance test GTT (intraperitoneal) (per animal) | carbohydrate, diabetes, glucose disposal, glucose metabolism, glucose tolerance, insulin resistance, insulin secretion, insulin sensitivity, intraperitoneal glucose tolerance |
| C1071 | Glucose tolerance test GTT (oral) (per animal) | carbohydrate, diabetes, insulin, insulin resistance, insulin sensitivity, metabolism, serum |
| C1072 | Insulin Tolerance Test (per animal) | diabetes, insulin action, insulin effectiveness, insulin resistance, insulin sensitivity, metabolism |
| C1081 | C-peptide concentration (per set of 38 samples) | diabetes, hormone, insulin, insulin secretion |
| C1083 | Cholesterol (total) (per set of 38 samples) | atherosclerosis, cholesterol, lipids, metabolism, metabolite, obesity |
| C1083-CHEM | Cholesterol Assay in Tissue- Chemical Method (per set of 12) | cholesterol, tissue |
| C1083-FPLC | Cholesterol Assay- FPLC Fractions (per sample) | cholesterol, FPLC, HDL, LDL |
| C1085 | Glucagon concentration (per set of 38 samples) | counter-regulation, counterregulatory, hormone, lipids |
| C1086 | GLP-1 concentration (per set of 38 samples) | counterregulatory, glucagon, hormone, incretin, lipids |
| C1087 | Glucose concentration (per set of 38 samples) | carbohydrate metabolism, diabetes, isotope, tracer |
| C1088 | GIP concentration (per set of 38 samples) | hormone, incretin, lipids, metabolism |
| C1089 | Insulin Assay (per set of 38 samples) | carbohydrate, diabetes, hormone |
| C1090 | Leptin concentration (per set of 38 samples) | adipokine, diabetes, eating behaviour, feeding behavior, hormone, leptin, lipids, obesity |
| C1092 | Triglyceride concentration (per set of 38 samples) | lipids, metabolism, obesity |
| C1092-CHEM | Triglyceride Assay in Tissue- Chemical Method (per set of 12 samples) | |
| C1092-FPLC | Triglyceride Assay- FPLC Fractions (per sample) | |
| C1103 | Necropsy (tissue collection) (per animal/tissue) | necropsy, organs, tissue |
| C1104 | Lipid extraction via folch (per set of 12 samples) | fatty acids, folch, lipid extraction, lipids, obesity |

| Test No. | Test Name | Keywords |
|---|---|---|
| C1105 | Fatty Acid analysis via GC (each) | fatty acid composition, fatty acids, lipid, obesity |
| C1106 | Telemetry - Cardiac parameters (per 8 mice) | blood pressure, cardiovascular, diastolic, heart rate, systolic, telemetry |

## Energy Metabolism, Food Intake & Body Weight Regulation Core

Co-Director: Randy Seeley, Co-Director: Steve Woods

Obesity is the major predisposing risk factor for type II diabetes. This core provides comprehensive set of measurements of food intake, energy expenditure (including use of indirect calorimetry) and body fat composition.

| Test No. | Test Name | Keywords |
|---|---|---|
| C1041 | Body Composition / Carcass Analysis (per animal) | body composition, carcass analysis, food intake, lean, obesity, QMR, total body fat |
| C1042 | Energy Expenditure Measurements | basal metabolic rate, calorimetry, CO2 production, energy expenditure, obesity, oxygen consumption, respiratory quotient |
| C1043 | CLAMS- Activity Measurements (per run of 16 mice) | energy expenditure |
| C1044 | Meal Pattern Analysis - Food Intake Procedure | energy balance, food intake, ingestion, meal pattern |
| C1045 | CLAMS- Simultaneous Energy Expenditure, Activity, and Food Intake Measurements (per run of 16 mice) | energy expenditure |

## Behavioral and Cognitive Core

Director: Yvonne Ulrich-Lai

| Test No. | Test Name | Keywords |
|---|---|---|
| C1117 | C1117 Feeding & Weighing food intake (per run of 8 mice) | feeding, feeding behavior |
| C1118 | C1118-Food Preference Tests (per run of 8 mice) | feeding, feeding behavior |
| C1119 | C1119-TSE(per run of 8 mice per day in TSE apparatus) | Activity, feeding, feeding behavior, food intake, metabolic flux, metabolism, water intake |
| C1120 | C1120-Running Wheel Cages (per run of 8 mice per day) | Running Capacity, running wheel |
| C1121 | C1121-Operant fixed ratio (per set of 8 mice) | cognitive function, learning |
| C1122 | C1122-Operant progressive ratio (per set of 8 mice) | cognitive function, learning |
| C1123 | C1123-5-choice serial reaction time trial(per set of 8 mice) | cognitive function |
| C1124 | C1124-Delayed discounting (per set of 8 mice) | cognitive function |
| C1125 | C1125-Social learning of food stimuli (per set of 8 mice) | learning |
| C1126 | C1126-Conditioned taste aversion (per set of 8 mice) | cognitive function, learning |

| Test No. | Test Name | Keywords |
|---|---|---|
| C1127 | C1127-Conditioned place preference (per set of 8 mice) | cognitive function, learning, reward |
| C1128 | C1128-Radial arm maze (per set of 8 mice) | hippocampal function, learning, non spatial, spatial, specific activity |
| C1129 | C1129-Morris Water maze (per set of 8 mice) | learning, maze, non spatial, spatial, specific activity, water, water maze |
| C1130 | C1130-Hole-board maze (per set of 8 mice) | cognitive function, learning, memory |
| C1131 | C1131-Novel object recognition test (per set of 8 mice) | hippocampal function, memory |
| C1132 | C1132-Acute stress challenge (per run of 8 mice) | behavior, cognitive function, energy balance, metabolism, stress |
| C1133 | C1133-Chronic variable stress challenge (per run of 8 mice) | behavior, cognitive function, energy balance, metabolism, stress |
| C1134 | C1134-Collecting post-stress plasma samples (per run of 8 mice) | hormone, metabolite, stress |
| C1135 | C1135-Active and passive avoidance (per set of 8 mice) | fear, learning, long term memory, memory |
| C1136 | C1136-Elevated plus maze (per run of 8 mice) | anxiety, behavior, stress |
| C1137 | C1137-Open field test (per run of 8 mice) | Activity, anxiety, locomotor, stress |
| C1138 | C1138-Forced Swim test (per run of 8 mice) | behavior, depression, swim |
| C1139 | C1139- Tail suspension test (per run of 8 mice) | behavior, depression |
| C1140 | C1140- Sucrose preference test (per run of 8 mice) | anhedonia, reward, taste discrimination |
| C1141 | Cortisol RIA (per run of 200 tubes) | cortisol, radioimmunoassay, RIA |
| C1142 | ACTH RIA (per run of 200 tubes) | ACTH, adrenocorticotropic hormone, radioimmunoassay |
| C1143 | Blood Glucose (per run of 100 samples) | blood, glucose |
| C1144 | Blood Ketone (per run of 100 samples) | blood, ketones |

## UNIVERSITY OF MASSACHUSETTS MEDICAL SCHOOL

### Metabolism Core

Director: Jason Kim

performs elegant, physiological, and non-invasive metabolic experiments to assess insulin sensitivity hyperinsulinemic-euglycemic clamp & GTT/ITT), glucose/lipid/protein metabolism using labeled metabolites, body composition using 1H-MRS, energy balance (food/water intake, energy expenditure, physical activity) at varying temperature and light/dark cycle using TSE Metabolic Cage System with Environmental Chamber, and exercise capacity using treadmill in mice. The Core also conducts comprehensive drug trial studies for PK/PD, efficacy, and toxicity analysis with academic and pharmaceutical institutions.

| Test No. | Test Name | Keywords |
|---|---|---|
| M1001 | Hyperinsulinemic-euglycemic clamp | awake mice, clamp, diabetes, glucose, glucose metabolism, in vivo, insulin, insulin action, insulin resistance, insulin secretion, insulin sensitivity |
| M1002 | Basal glucose metabolism | carbohydrate, clamp, diabetes, flux, glucose turnover, glucose uptake, insulin resistance, kinetics |

| Test No. | Test Name | Keywords |
|---|---|---|
| M1003 | Organ-specific glucose uptake | carbohydrate, diabetes, glucose uptake, insulin, insulin resistance, insulin sensitivity |
| M1004 | Hyperglycemic clamp | awake mice, clamp, diabetes, glucose, in vivo, insulin, insulin resistance, insulin secretion |
| M1005 | Insulin clearance | carbohydrate, diabetes, hormone, insulin |
| M1006 | Glucose tolerance test | carbohydrate, diabetes, glucose clearance, glucose tolerance, insulin resistance, insulin sensitivity |
| M1007 | Glucose tolerance test with insulin secretion | carbohydrate, diabetes, glucose tolerance, insulin, insulin resistance, insulin sensitivity |
| M1008 | Insulin tolerance test | glucose, insulin effectiveness, insulin resistance, insulin sensitivity |
| M1009 | Hepatic gluconeogenesis | carbohydrate, diabetes, glucose, glucose production, insulin, insulin resistance, liver, liver function, liver function enzymes, pyruvate tolerance test |
| M1010 | Lipid metabolism | fatty acids, in vivo, lipids, obesity, palmitate, triglycerides |
| M1011 | Protein metabolism | amino acid, amino acids, in vivo protein turnover, phenylalanine, protein, protein synthesis |
| M1012 | Body composition (whole body) | 1H-MRS, body composition, fat mass, in vivo, lean muscle mass, obesity, whole animal |
| M1013 | Body composition (organs) | 1H-MRS, body composition, fat mass, in vivo, lean muscle mass, obesity |
| M1014 | Energy balance – food intake, energy expenditure, physical activity | basal metabolic rate, CO2 production, energy expenditure, food intake, in vivo, indirect calorimetry, metabolism, noninvasive, obesity, oxygen consumption, physical activity, respiratory exchange ratio, respiratory quotient, VCO2 production, VO2 consumption, water intake |
| M1015 | Chronic high-fat feeding | animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, insulin resistance, mouse husbandry and transfer, obesity, type 2 diabetes |
| M1016 | Chronic drug delivery | Drug, drug treatment, infusion, mouse husbandry and transfer, osmotic pump, surgery |
| M1017 | STZ-induced type 1 diabetes model | Drug, hyperglycemia, insulin, insulinopenia, streptozotocin, type 1 diabetes |
| M1018 | Acute lipid infusion | animal model, fatty acids, FFA, insulin, insulin action, insulin resistance, lipids, obesity |
| M1019 | Chronic/acute phloridzin treatment | diabetes, Drug, glucose clearance, glycemia, insulin, insulin action, renal |
| M1020 | Exercise study using cage running wheels | Activity, Cage Activity, exercise |
| M1021 | Surgery – jugular vein cannulation | catheterization, clamp, intravenous, surgery, vein |
| M1022 | Surgery – tail vein injection | AAV delivery, intravenous, mouse husbandry and transfer, surgery, vein |
| M1023 | Surgery – carotid artery cannulation | artery, blood sampling, catheterization, surgery |

| Test No. | Test Name | Keywords |
|---|---|---|
| M1024 | Exercise study using treadmill | endurance, energy expenditure, energy metabolism, exercise, exercise stress test, exertion |
| M1025 | Drug trial study for PK/PD analysis | chronic, Drug, drug treatment, drug trial, pharmacodynamics, pharmacokinetics |
| M1026 | Drug trial study for therapeutic efficacy on obesity | Drug, drug infusion, drug treatment, drug trial, energy balance, energy expenditure, obese, obesity |
| M1027 | Drug trial study for therapeutic efficacy on insulin resistance | Drug, drug infusion, drug treatment, drug trial, glucose homeostasis, glucose kinetics, glucose metabolism, glucose uptake, insulin action, insulin sensitivity |
| M1028 | Drug trial study for therapeutic efficacy on metabolic profile | Drug, drug infusion, drug treatment, drug trial, glucose, lipid, liver, serum, serum metabolic panel |
| M1029 | Drug trial study for therapeutic efficacy on diabetic complications | cardiovascular disease, complications, diabetes, Drug, drug infusion, drug treatment, drug trial, insulin secretion, islets, pancreas |
| M1030 | Drug trial study for toxicity | Drug, drug infusion, drug treatment, drug trial, liver function, liver function enzymes, toxicity |
| M1031 | Temperature (rectal measurement) | Temperature |
| M1032 | Body Weight | body weight, obesity |
| M1033 | Surgery – Ovariectomy | surgery |
| M1034 | Fecal Sample Collection for Intestinal Flora Analysis | fecal matter, feces, microbiome |
| M1035 | Energy Balance at Thermoneutrality | energy expenditure, food intake, physical activity, thermoneutrality |
| M1036 | Energy Balance at Cold Temperature | cold challenge, energy expenditure, food intake, physical activity |
| M1041 | Paired Feeding Regimen Analysis | feeding, feeding behavior |
| M1042 | Paired Feeding Study | feeding, feeding behavior |
| M1043 | Drug Treatment | Drug, drug treatment, drug trial |
| M1044 | Drug Preparation | Drug, drug treatment, drug trial |
| M1045 | Tail Vein Blood Sampling | blood, blood sampling, plasma, serum, serum samples |
| M1046 | Tissue collection | isolation, tissue, tissue preparation, tissues |
| M1047 | Glucose Flux Measurement Using Stable Isotope | flux, glucose, glucose flux, isotope |
| M1048 | Energy Balance at Altered Light/Dark Cycle | energy balance |
| M1049 | Glucose Uptake and Lipid Metabolism in additional organs | glucose, glucose uptake, lipid |
| M1050 | Consultation - Study Design, Methodologies, Analysis, & Interpretation | consultation |
| M1051 | Diet-induced mouse model of Non-Alcoholic Fatty Liver (NAFL) | mouse models |
| M1052 | Diet-induced mouse model of Non-Alcoholic Steatohepatitis (NASH) | mouse models |
| M1053 | 3D-Imaging for In Vivo Assessment of NAFL | fatty liver, fibrosis, liver, mouse models |

| Test No. | Test Name | Keywords |
|---|---|---|
| | and NASH | |
| M1054 | 3D-Imaging for In Vivo Assessment of Kidney Morphology & Volume | kidney, morphology |
| M1055 | 3D-Imaging for In Vivo Assessment of Tumor | tumor |
| M1056 | Hyperglucagonemic clamp | clamp |

## Analytical Core

Director: Randall Friedline

The Analytical Core utilizes Luminex, Cobas Clinical Chemistry Analyzer, and molecular experiments to perform a high-throughput, multiplexed analysis of serum/tissue/urine levels of hormones, cytokines, chemokines, electrolytes, and metabolites, liver/kidney/thyroid function panels, and metabolic/inflammatory signaling pathways. Samples can be directly sent to the Core or obtained from mice by the Core.

| Test No. | Test Name | Keywords |
|---|---|---|
| M2001 | Glucose | carbohydrate, diabetes, glucose, hyperglycemia, hypoglycemia, insulin resistance, metabolite |
| M2002 | Hemoglobin A1c | diabetes, glucose, hyperglycemia, insulin, insulin action, metabolite |
| M2003 | Lactate | acidosis, carbohydrate, diabetes, glucose, insulin, insulin action, metabolite |
| M2004 | Insulin | carbohydrate, diabetes, hormone, hyperinsulinemic clamp, insulin |
| M2005 | C-peptide | hormone, insulin, insulin secretion, islet function |
| M2006 | Glucagon | counter-regulation, gluconeogenesis, glucose, glucose production, hepatic, hormone, lipids |
| M2007 | Leptin | adipokine, diabetes, feeding behavior, food intake, hormone, leptin, obesity |
| M2008 | Adiponectin | adipokine, hormone, insulin resistance, lipids |
| M2009 | Resistin | adipokine, glucose metabolism, hormone, insulin resistance |
| M2010 | Triglyceride | cardiovascular disease, insulin, insulin resistance, lipids, metabolite, obesity, serum, serum chemicals, tissue |
| M2011 | Non-esterified fatty acids | insulin, insulin resistance, lipids, metabolite, obesity |
| M2012 | Cholesterol (total) | atherosclerosis, cardiovascular disease, lipids, metabolite, obesity |
| M2013 | Cholesterol (HDL) | atherosclerosis, cardiovascular disease, lipids, liver, liver function, liver function enzymes, metabolite, obesity |
| M2014 | Cholesterol (LDL) | atherosclerosis, cardiovascular disease, lipids, metabolite, obesity |
| M2015 | Ammonia | lipids, metabolite, nitrogen, serum chemicals |
| M2016 | Lipase | lipids, metabolite, obesity |
| M2017 | Amylase | carbohydrate, enzyme activity, GI function |
| M2018 | Creatine kinase | cardiovascular, enzyme activity, lesion |

| Test No. | Test Name | Keywords |
|---|---|---|
| M2019 | Alkaline phosphatase | enzyme activity, serum chemicals |
| M2020 | Lactate dehydrogenase | enzyme activity, tissue damage |
| M2021 | Albumin | liver, liver function, liver function enzymes, metabolite, protein, serum albumin, serum chemicals |
| M2022 | Alanine transferase | ALT, liver, liver function, liver function enzymes, metabolite, serum chemicals |
| M2023 | Aspartate transferase | liver, liver function, liver function enzymes, metabolite, serum chemicals |
| M2024 | Bilirubin | liver, liver function, liver function enzymes, metabolite |
| M2025 | Gamma-glutamyl Transferase | liver, liver function, liver function enzymes, metabolite, serum chemicals |
| M2026 | Creatinine | cardiovascular, creatinine, kidney, kidney disease, lesion, metabolite |
| M2027 | C-reactive peptide | CRP, inflammation, liver, liver function, liver function enzymes, metabolite, obesity, serum chemicals |
| M2028 | Total protein | metabolite |
| M2029 | Urea/BUN | kidney, kidney disease, metabolite, renal |
| M2030 | Uric acid | kidney, kidney disease, metabolite, renal |
| M2031 | Electrolytes | electrolyte panel, electrolytes, metabolism, pH, potassium, renal function, serum chemicals, serum metabolic panel, sodium |
| M2032 | Cytokines Panel I - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin action, insulin resistance, monokines, obesity, serum samples, tissue lysates |
| M2033 | Cytokines Panel II - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin action, insulin resistance, monokines, obesity, serum samples, tissue lysates |
| M2034 | Amylin (Active) | Amylin |
| M2035 | Ghrelin | ghrelin |
| M2036 | Cytokines Panel III - multiplex | chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin resistance, monokines, obesity |
| M2037 | Gastric inhibitory peptide (GIP; Total) | Gastric inhibitory peptide |
| M2038 | Pancreatic Polypeptide (PP) | Pancreatic Polypeptide |
| M2039 | Peptide YY (PYY; Total) | Peptide YY |
| M2040 | Glucagon-like peptide 1 (GLP-1 ). | glucagon, liver, liver function, liver function enzymes, Luminex, peptides |
| M2041 | Estradiol (E2) | ELISA, estradiol, plasma, serum |
| M2043 | Triiodothyronine (T3) | ELISA, T3, triiodothyronine |
| M2044 | Thyroxine (T4) | T4, thyroxine |
| M2045 | Thyrotropin-releasing hormone (TRH) | thyrotropin-releasing hormone, TRH |
| M2046 | Apolipoprotein C3 (ApoC3) | Apolipoprotein C3, apolipoproteins |
| M2047 | Adrenocorticotropic hormone (ACTH) | ACTH, adrenocorticotropic hormone |

| Test No. | Test Name | Keywords |
|---|---|---|
| M2048 | Growth Hormone (GH) | GH, Growth hormone |
| M2049 | Prolactin (PRL) | PRL, prolactin |
| M2050 | Thyroid-stimulating hormone (TSH) | Thyroid-stimulating hormone, TSH |
| M2051 | Progesterone | ELISA, Progesterone |
| M2052 | Testosterone | ELISA, Testosterone |
| M2053 | Bicarbonate | |
| M2054 | Calcium | Ca, Ca2+, plasma, serum, urine |
| M2055 | Magnesium | plasma, serum, urine |
| M2056 | Phosphate | plasma, serum, urine |
| M2057 | Aldosterone | Aldosterone, hormone |
| M2058 | Renin | Renin |
| M2059 | Tissue Glycogen | Glycogen |
| M2060 | Insulin-like growth factor 1 (IGF-1) | hormone |
| M2061 | Insulin Signaling | Forkhead Box O1, insulin, insulin receptor, insulin receptor substrate-1, insulin receptor substrate-2, phosphorylation, protein kinase B, serine, threonine, tyrosine |
| M2062 | Inflammatory Signaling | phosphorylation, serine, threonine, tyrosine |
| M2063 | Metabolic Signaling | phosphorylation, serine, threonine, tyrosine |
| M2070 | Histology - lipid content | histology, lipid |
| M2071 | Histology - lipid droplet | histology, lipid |
| M2072 | Liver Histology - fibrosis | histology |

## Animal Care Core

Director: George DeMarco

The Animal Core is the gateway to all Phenotyping Cores involving mice for phenotyping services, and the principal functions are: 1) Provision of high quality animal housing, husbandry, and health care by veterinarians and staff, 2) Processing of animal acquisition, quarantine, and health testing in preparation for phenotyping studies, 3) Coordination of standard quarantine screening (5 weeks) and accelerated quarantine screening (3 weeks) involving microbiological testing, 4) Transfer of mice between different Phenotyping Cores, and 5) Provision of special diet and animal procedures.

| Test No. | Test Name | Keywords |
|---|---|---|
| M6001 | Accelerated Quarantine Service | animal husbandry |

## Islet Core

Director: Laura Alonso, Co-Director: Dale Greiner

The Islet Core conducts sophisticated in vivo, ex vivo, and in vitro analysis of insulin secretion, islet function/structure, and pancreatic function using hyperglycemic clamp, perifusion, and molecular experiments in mice. The Core also performs histological and morphological analysis with islet isolation.

| Test No. | Test Name | Keywords |
|---|---|---|
| M3001 | Pancreas isolation and embedding | islets, pancreas, surgery |
| M3002 | Islet histology – paraffin pancreas sections | histology, immunohistochemistry, islets, |

| Test No. | Test Name | Keywords |
|---|---|---|
| | | pancreas |
| M3003 | Islet histology – H&E stained pancreas sections | histology, islets, pancreas, staining |
| M3004 | Islet histology – insulin immunohistochemistry | histology, immunohistochemistry, insulin, islets |
| M3005 | Islet histology – insulin immunofluorescence | histology, immunohistochemistry, insulin, islet, islet function, islets |
| M3006 | Islet histology – insulin and glucagon immunofluorescence | glucagon, histology, immunohistochemistry, insulin, islet, islets, pancreas |
| M3007 | Islet histology – beta-cell proliferation and cell death | beta cell, imaging, immunohistochemistry, insulin, islet, islets, pancreas, staining |
| M3008 | Islet microscopy – islet images | histology, imaging, islet, islets, pancreas |
| M3009 | Islet microscopy – exocrine pancreas images | histology, imaging, islets, pancreas |
| M3010 | Islet microscopy – beta-cell mass | beta cell, imaging, islets, pancreas |
| M3011 | Pancreatic beta-cell mass (comprehensive) | beta cell, islet, islets, pancreas |
| M3012 | Pancreas islet architecture analysis | beta cell, glucagon, imaging, immunohistochemistry, insulin, islet, islets, pancreas |
| M3013 | Pancreatic islet isolation | beta cell, islet, islets, pancreas, surgery |
| M3014 | Ex vivo islet analysis for insulin secretion | insulin, insulin secretion, islet, islets, pancreas |
| M3015 | Ex vivo islet molecular analyses | beta cell, islet, islets, pancreas, protein |
| M3016 | Surgery- jugular vein cannulation for chronic infusion | cannulation, jugular, surgery |
| M3017 | Chronic intravenous infusion | cannulation, chronic, infusion, intravenous |

## Cardiovascular Core

Director: Timothy Fitzgibbons, Co-Director: John Keaney

applies state-of-the-art high-frequency and high-resolution digital imaging platform with color Doppler mode (VisualSonics Vevo2100) to perform 2-D and M-mode echocardiography to non-invasively assess cardiac function and structure in mice. The Core also measures ECG/blood pressure and vascular/endothelial function, and conducts elegant micro-surgery procedures to generate mouse models of cardiovascular and peripheral vascular diseases.

| Test No. | Test Name | Keywords |
|---|---|---|
| M4001 | Abdominal Ultrasound | cardiac function, cardiovascular, cardiovascular disease, heart, heart rate, in vivo |
| M4002 | Echocardiography | cardiac function, cardiac output, echocardiography, heart |
| M4003 | Heart Rate Measurement | cardiac function, cardiac output, cardiovascular, heart, heart rate |
| M4004 | Blood Pressure Measurement | blood pressure, cardiac function, cardiac output, cardiovascular disease, heart |
| M4005 | Endothelial Function | cardiovascular, endothelial denudation, vascular, vascular function, vascular tone |
| M4006 | Hind Limb Ischemia (HLI) Model | ischemia, vascular, vascular function |
| M4007 | Abdominal Aortic Aneurysm (AAA) Model | aortic reactivity, aortic ring, cardiovascular |

| Test No. | Test Name | Keywords |
|---|---|---|
| M4008 | Coronary Artery Ligation (CAL) Model | artery, cardiac, cardiac function, cardiovascular, coronary ligation, heart |
| M4009 | Transverse Aortic Constriction (TAC) Model | aortic reactivity, cardiac function, cardiac hypertrophy, heart failure |
| M4010 | Moor Laser Speckle Contrast Imaging | blood flow, ischemia, peripheral vascular disease, vascular disease |
| M4011 | Aortic morphometry studies | aorta, morphometry |
| M4012 | Nash Models (nonalcoholic fatty liver disease) | |
| M4013 | Carotid Artery Ligation Models | artery, carotid |
| M4014 | Carotid Artery Restriction Models | artery, carotid |
| M4015 | Wire Myography Studies | artery, vascular |
| M4016 | Denervation: Surgical and chemical Models | nerve, surgery |
| M4017 | Parabiosis Models | parabiosis, surgery, Vascular Permeability |
| M4018 | Jugular vein and carotid artery catheterization | arterial, artery, carotid, catheterization, jugular |

## Humanized Mouse

Director: Dale Greiner

The Humanized Mouse Cell Transplantation and Assessment Core provides “humanized” mice that enable clinically relevant in vivo studies of human cells, tissues, and immune system without putting patients at risk. Humanized mice are immunodeficient mice engrafted with functional human cells and tissues and importantly address the scientific gap between human and mouse biology. The Core also provides expert in vivo functional analysis of transplanted human islets and stem cell-derived b-cells in immunodeficient mice that are highly valuable to the mouse research community.

| Test No. | Test Name | Keywords |
|---|---|---|
| M5001 | Humanized Mouse (normoglycemic NSG mouse) | mouse husbandry and transfer, mouse models |
| M5002 | Humanized Mouse (STZ-induced diabetic NSG mouse) | mouse husbandry and transfer, mouse models |
| M5003 | Humanized Mouse (spontaneous-diabetic NSG-Ins2 Akita mouse) | diabetes, mouse husbandry and transfer, mouse models |
| M5004 | Humanized Mouse (induced-diabetic NSG-RIP-DTR mouse) | diabetes, mouse husbandry and transfer, mouse models |
| M5005 | Phenotypic assessment of transplanted human islets | beta cell, diabetes, glucose tolerance, insulin, islet, islets, pancreas |
| M5006 | Phenotypic assessment of transplanted stem cell-derived beta-cells | beta cell, diabetes, glucose, glucose tolerance, imaging, immunohistochemistry, insulin, islet, islets, pancreas |

## Microbiome Core

Director: Beth McCormick

Microbiome Core provides expert knowledge and metagenomics 16S rRNA NextGen sequencing tools for state-of-the-art analysis of gut microbiota to investigate their role in altered energy balance and metabolism in mice. The Core also offers Fecal Microbiota Transplant (FMT) and antibiotic treatment procedures to facilitate alterations in gut microbiota population.

| Test No. | Test Name | Keywords |
|---|---|---|
| M7001 | Consultation - Study Design | consultation, study design |
| M7002 | Sample DNA Extraction & Quality Control Analyses | DNA, extraction |
| M7003 | 16S rRNA gene sequencing | gene sequencing, sequence based species quantitation |
| M7004 | Consultation - Sequence Data Analysis | gene sequencing, sequence based species quantitation |
| M7005 | Consultation - Post-analysis Data Preparation | |
| M7006 | Consultation - Data Upload | |
| M7007 | Fecal Microbiota Transplant (FMT) | gut, microbiome |
| M7008 | Antibiotic Treatment | antibiotic treatment, gut, microbiome |

## UNIVERSITY OF MICHIGAN MEDICAL SCHOOL

### Animal Care and Germ-Free Mouse Core

Co-Director: Robert Sigler

The Animal Care and Germ-Free Mouse Core plays a central role in the management of animal flow through the Center's phenotyping cores from initial acquisition to final disposition of imported mice. The gateway for all phenotyping involving live mice, the Animal Care and Germ-Free Mouse Core provides mouse importation, quarantine, housing, veterinary care, clinical chemistry and histopathology services; as well as, host a germ-free mouse facility that will interact with the Microbiome core to produce and distribute germ-free and gnotobiotic mouse models.

| Test No. | Test Name | Keywords |
|---|---|---|
| MI1003 | Quarantine per diem | |
| MI1004 | Intra-University trucking | |
| MI1005 | Animal Health Surveillance - PCR Rodent Infectious Agent testing | animal husbandry, pathogen detection |
| MI1006 | Animal Health Surveillance - Pinworm PCR | mouse husbandry and transfer, pathogen detection |
| MI1007 | Technician Service Fee / Special Procedures | animal husbandry, animal procedures, dosing, gavage, mouse husbandry and transfer, TST, venipuncture |
| MI1008 | Mouse Microchipping | mouse husbandry and transfer |
| MI1010 | Lab Sendout Processing Fee | |
| MI1011 | Complete blood count (CBC) | CBC, Hb HT, MCH, MCHC, NCV, PLT, RBC, WBC |
| MI1012 | Blood smear (prep only) | blood |
| MI1013 | Reticulocyte count | RBC, reticulocytes |
| MI1014 | Blood Chemistry | ALB, ALP, ALT, AST, blood chemistry, BUN, Ca, cholesterol, CK, creatinine, electrolytes, glucose, T. Bili, T. Prot, triglycerides |
| MI1015 | Blood Chemistry - Mini Liver Panel | ALT, AST, serum |
| MI1016 | Blood Chemistry - Renal Panel | BUN, creatinine, serum |
| MI1017 | Blood Chemistry - Additional Chemistries per animal | blood chemistry, clinical chemistry |
| MI1018 | Urinalysis - Complete Panel | urinalysis, urine |

| Test No. | Test Name | Keywords |
|---|---|---|
| MI1019 | Urinalysis - Routine Panel | urinalysis, urine |
| MI1020 | Urinalysis - Aerobic General Culture | bacteria, urine |
| MI1021 | Urinalysis - Anaerobic Culture | bacteria, urine |
| MI1022 | Urinalysis - Fungal Culture | urine |
| MI1023 | Urinalysis - General Culture plus sensitivity | bacteria, urine |
| MI1025 | White Blood Cell (WBC) Differential Count | WBC |
| MI1026 | Verify Ampule (autoclave control) | autoclave control |
| MI1027 | Necropsy Small Animal-standard | necropsy |
| MI1028 | Full tissue collection starting with fixed whole carcass | necropsy, surgery |
| MI1029 | Necropsy technician fee | necropsy |
| MI1030 | Decalcification | bone, decalcification |
| MI1031 | Histology - Trim/Cassette (Paraffin or OCT) | histology |
| MI1033 | Histology - Paraffin Process & Embed | histology |
| MI1034 | Histology - Tissue Sections, Paraffin Unstained Slide | histology |
| MI1035 | Histology - Tissue Sections, Paraffin H&E Stain | histology |
| MI1036 | Histology - Tissue Sections, Frozen Unstained Slide | histology |
| MI1037 | Histology - Tissue Sections, Frozen H&E Stained | histology |
| MI1038 | Histology - Special Stain, Masson Trichrome (MTC) | histology |
| MI1040 | Histology - Special Stain, Toluidine Blue | histology |
| MI1041 | Histology - Special Stain, Prussian Blue | histology |
| MI1042 | Histology - Special Stain, Picrosirius Red | histology |
| MI1043 | Histology - Speical Stian, Verhoeff Van Gieson | histology |
| MI1044 | Histology - Special Stain, Gram | bacteria, histology |
| MI1045 | Histology - Speical Stain, Luxol Fast Blue (LFB) | histology |
| MI1046 | Histology - Special Stain, Warthin Starry | bacteria, histology |
| MI1047 | Histology - Special Stain, Other | histology |
| MI1048 | Immunohistochemistry - Tier 1 (ALDH1, Amylase, aSMA, CD45R-B220, CD3, Caspase-3, F4/80, GFAP, GFP, Insulin, Ki67, Ly-6G, Lyve-1, Mac2, Neurofilament) | immunohistochemistry |
| MI1049 | Immunohistochemistry - Tier 2 Tier 2 (AE1/AE3 + 8/18, CD4, CD8a, CD31, Estrogen Receptor, Glucagon, c-erbB2/HER2, Progesterone, Von Willebrand Factor) | immunohistochemistry |
| MI1053 | Histology Technician Labor | histology, immunohistochemistry |
| MI1054 | Pathologist Hourly | histology, immunohistochemistry |
| MI1055 | Aperio 20X scan, Semi-automated, >50 slides | histology, immunohistochemistry |
| MI1056 | Aperio 20X scan, Semi-automated, batch of 20-50 | histology, immunohistochemistry |

| Test No. | Test Name | Keywords |
|---|---|---|
| MI1057 | Aperio 20X scan, Semi-automated, each | histology, immunohistochemistry |
| MI1058 | Aperio Technician Labor | histology, immunohistochemistry |
| MI1059 | Histology - Negative Control (mouse tissue) | |
| MI1060 | Histology - Stain (mouse tissue) | |
| MI1063 | Germ Free Mice - C57BL/6 | free, germ, germ free, germ-free |
| MI1064 | Germ Free Mice - Swiss Webster | free, germ, germ free, germ-free |
| MI1065 | Germ Free Mice - BALB/c | free, germ, germ free, germ-free |
| MI1066 | Germ Free Mice - IL-10 Knockout | free, germ, germ free, germ-free |
| MI1067 | Germ Free Mice - Rag1 Knockout | free, germ, germ free, germ-free |
| MI1068 | Germ Free - Per Diem | free, germ, germ free, germ-free |
| MI1069 | Germ Free Mice - Shipping | free, germ, germ free, germ-free |
| MI1070 | Germ Free - Rederivation | free, germ, germ free, germ-free |
| MI1071 | Germ Free - Technician Time | free, germ, germ free, germ-free, mouse husbandry and transfer |
| MI1072 | Germ Free - Microbial community establishment | free, germ, germ free, germ-free |
| MI1073 | Germ Free - Surgical manipulation | free, germ, germ free, germ-free |
| MI1074 | Germ Free - Experimental Design and consultation | free, germ, germ free, germ-free |
| MI1080 | Histology - Special Stain, Oil Red O (ORO) | histology, immunohistochemistry |
| MI1081 | Immunohistochemistry - Stain, Negative Control | histology, immunohistochemistry |
| MI1082 | Immunohistochemistry - Stain, Non-IVAC Primary Antibody | histology, immunohistochemistry |
| MI1083 | Immunohistochemistry - Stain, Titration Slide | histology, immunohistochemistry |
| MI1084 | Immunohistochemistry - Stain, Frozen IHC or Immunofluorence Slide | histology, immunohistochemistry |

## Metabolism, Bariatric Surgery and Behavior Core

The primary goals and function of the Metabolism, Bariatric Surgery and Behavior Core are to provide expert consultation, state-of-the art equipment and technical services that are critical for the detailed metabolic and behavioral phenotyping of mouse models of diabetes, obesity and associated disorders. The Metabolism, Bariatric Surgery and Behavior Core will perform a variety of in vivo physiological assessments encompassing glucose homeostasis (glucose tolerance, insulin tolerance, hyperinsulinemic/euglycemic clamps), energy homeostasis (indirect calorimetry by CLAMS, dietary challenge), ultradian hormone secretion (Culex platform for serial biological fluid sampling from unrestrained mice), behavioral measurements (locomotor activity, meal pattern analysis, operant conditioning) and generation of bariatric surgery models.

| Test No. | Test Name | Keywords |
|---|---|---|
| MI2001 | Catheterization of jugular vein | catheterization, surgery, vein |
| MI2002 | Catheterization of carotid artery | artery, catheterization, surgery |
| MI2003 | Catheterization of jugular vein AND carotid artery | artery, catheterization, surgery, vein |
| MI2004 | Catheterization of portal vein | catheterization, surgery, vein |
| MI2005 | Catheterization of portal vein AND carotid artery | artery, catheterization, surgery, vein |

| Test No. | Test Name | Keywords |
|---|---|---|
| MI2006 | Catheterization of stomach or bladder | bladder, catheterization, stomach |
| MI2007 | Partial pancreatectomy | pancreas, surgery |
| MI2008 | Parabiosis (a surgical union of two mice) | parabiosis, surgery |
| MI2010 | Glucose Tolerance Test (OGTT or IPGTT) including blood glucose and plasma insulin | blood, glucose, glucose tolerance, insulin |
| MI2011 | Glucose Tolerance Test (OGTT or IPGTT) w/o plasma insulin | glucose, glucose tolerance, insulin, plasma |
| MI2012 | Intravenous Glucose Tolerance Test (IVGTT with dual surgical catheterization) including blood glucose and plasma insulin | blood, catheterization, glucose, glucose tolerance, insulin |
| MI2013 | Intravenous Glucose Tolerance Test (IVGTT with dual surgical catheterization) w/o plasma insulin | catheterization, glucose, glucose tolerance |
| MI2015 | Intravenous Glucose Tolerance Test using portal vein delivery | glucose, glucose tolerance, portal, vein |
| MI2016 | Insulin or Pyruvate Tolerance Test | insulin, pyruvate tolerance test, tolerance |
| MI2017 | Hyperinsulinemic-euglycemic clamp (3H-glucose + 14C-2DG) | euglycemic clamp, hyperinsulinemic clamp |
| MI2018 | Hyperinsulinemic-euglycemic clamp (3H-glucose OR 14C-2DG) | hyperinsulinemic clamp |
| MI2019 | Hyperinsulinemic-euglycemic clamp w/o tracers | hyperinsulinemic clamp |
| MI2020 | Hyperinsulinemic-euglycemic clamp using portal vein infusion | hyperinsulinemic clamp, portal, vein |
| MI2021 | Hyperinsulinemic-euglycemic clamp + steady-state plasma NEFA | hyperinsulinemic clamp, NEFA, plasma |
| MI2022 | Hyperinsulinemic-euglycemic clamp + hepatic glycogen synthesis | glycogen synthesis, hepatic, hyperinsulinemic clamp |
| MI2023 | Hyperglycemic clamp | hyperglycemic clamp |
| MI2024 | Hyperinsulinemic-hypoglycemic clamp | hyperinsulinemic clamp |
| MI2025 | VO2 &VCO2 with spontaneous activity and food intake @Room temperature (22 °C) | VCO2 production, VO2 consumption |
| MI2026 | VO2 &VCO2 with spontaneous activity and food intake, Thermoneutrality (30 °C) and/or cold (as low as 4 °C) | VCO2 production, VO2 consumption |
| MI2027 | VO2 &VCO2 with spontaneous activity and food intake, plus body temperature (implantable BMDS electronic transponder) | VCO2 production, VO2 consumption |
| MI2028 | Non-shivering thermogenesis using injection of norepinephrine (including 24hours acclimation at 30°C) | thermogenesis |
| MI2029 | Body Composition (Bruker Minispec LF 90II) | body composition |
| MI2030 | Body Temperature (microchips implanted) | body temperature |
| MI2031 | Digestible Energy Content | fecal matter, food intake |
| MI2032 | Fat Tolerance Test, Oral gavage (olive or corn oil) | corn oil, fat tolerance, gavage, olive oil |
| MI2033 | Fat Tolerance Test, Intravenous injection (20% Intralipid) | carotid, catheterization, fat tolerance, jugular |

| Test No. | Test Name | Keywords |
|---|---|---|
| MI2034 | Hepatic TG Secretion (Poloxamer 407 or Triton WR-1339) | hepatic, secretion, triacylglycerides |
| MI2038 | Automated Arterial Blood Sampling and/or Intravenous Infusion in undisturbed and unrestrained mice, Blood sampling only | arterial, artery, blood sampling, intravenous |
| MI2039 | Automated Arterial Blood Sampling and/or Intravenous Infusion in undisturbed and unrestrained mice, Intravenous Infusion only | arterial, artery, blood sampling, infusion, intravenous |
| MI2040 | Automated Arterial Blood Sampling and/or Intravenous Infusion in undisturbed and unrestrained mice, Blood sampling AND intravenous infusion | arterial, artery, blood sampling, intravenous |
| MI2041 | Exercise Training | exercise, training |
| MI2042 | Test of Running Capacity (run to exhaustion), Without measuring VO2 and VCO2 | exercise, exercise stress test, Running Capacity |
| MI2043 | Test of Running Capacity (run to exhaustion), With measuring VO2 and VCO2 (VO2max) | exercise, exercise capacity, exercise stress test, Running Capacity, VCO2 production, VO2 consumption |
| MI2044 | Running Wheel Activity (Med Associates) | Activity, exercise, running wheel, wheel running |
| MI2046 | Body Weight Recording | body weight |
| MI2047 | Manual Food or Water Recording | food intake, water intake |
| MI2048 | Orogastric Gavage | gavage, orogastric |
| MI2049 | Pair-Feeding | feeding, pair-feeding |
| MI2050 | Rectal Temperature Recording (YSI 4600 precision thermometer) | Temperature |
| MI2052 | 24-hour Urine and/or Fecal Collection | fecal matter, feces, urine |
| MI2053 | Tissue Dissection/Collection | dissection, tissue |
| MI2054 | Tail Vein Blood Sampling (plasma or serum) | blood sampling, plasma, serum |
| MI2055 | Retro-orbital bleeding (under isoflurane anesthesia) | blood sampling |
| MI2056 | Tail Vein Injection | injection, tail vein |
| MI2057 | IP Injection | injection |
| MI2058 | Plasma glucose (using a colorimetric kit) | glucose, plasma |
| MI2059 | Plasma insulin (using a ELISA kit) | insulin, plasma |
| MI2060 | Plasma NEFA (using a colorimetric kit) | NEFA, plasma |
| MI2061 | Plasma TG (using a colorimetric kit) | plasma, triacylglycerides |
| MI2062 | Tissue glycogen content | glycogen synthesis, tissue |
| MI2063 | Tissue TG content | tissue, triacylglycerides |
| MI2064 | Laboratory Assistance and Training | training |
| MI2065 | Surgical Training and Supplies, Surgical cannulations of Jugular vein and/or carotid artery | artery, cannulation, carotid, jugular, surgery, training, vein |
| MI2066 | Surgical Training and Supplies, Carotid catheters (micro-renathane) | artery, carotid, catheterization, surgery |
| MI2067 | Surgical Training and Supplies, Jugular vein catheters (silicon tubing) | catheterization, jugular, surgery, vein |

| Test No. | Test Name | Keywords |
|---|---|---|
| MI2068 | Surgical Training and Supplies, Dual-catheter Exteriorizing Connector | catheterization, surgery, training |
| MI2070 | APC Housing Per diem (Transfer of care from ULAM to APC) | mouse husbandry and transfer |
| MI2071 | Breeding Colony Care | mouse husbandry and transfer |
| MI2072 | Technician Time | mouse husbandry and transfer |
| MI2073 | Data Analysis | data analysis |
| MI2500 | Spatial Object Recognition | behavior, cognitive function, learning, memory |
| MI2501 | Novel Objective Recognition | cognitive function |
| MI2502 | Morris Water Maze | water maze |
| MI2503 | Home Cage (Ethovision or Photobeam) | Activity, behavior, Motor |
| MI2504 | Open Field Test (Ethovision or Photobeam) Moto Activity | Activity, behavior, Motor, physical activity |
| MI2505 | Open Field Test (Ethovision or Photobeam) Anxiety | anxiety, behavior |
| MI2506 | Elevated Plus Maze (Ethovision) | anxiety, behavior |
| MI2507 | Novelty Suppressed Feeding Test | anxiety, behavior, depression |
| MI2508 | Forced Swim Test | anxiety, behavior, depression |
| MI2509 | Tail Suspension Test | anxiety, behavior, depression |
| MI2510 | Conditioned Place Preference | behavior, reward |
| MI2511 | Wheel Running (home cage, low profile RF running wheels) | behavior, reward |
| MI2512 | Operant Conditioning | behavior, reward |
| MI2513 | Locomotor sensitization/tolerance | behavior, reward |
| MI2514 | General Activity | behavior |
| MI2515 | Training | behavior |

## Microvascular Complications Core

Provide a complete range of microvascular phenotyping of murine models of diabetes, obesity and metabolic disease; including validated, reproducible and standardized phenotyping of the 3 major microvascular complications: diabetic polyneuropathy (DPN), nephropathy (DN) and retinopathy (DR).

DPN advanced testing will include phenotyping of models exhibiting neuropathy such as measures of cell death and oxidative stress in dorsal root ganglion (DRG) and peripheral nerve.

DN advanced phenotyping will include measures of podocyte number, precise morphometric analysis of glomerular expansion, glomerular volume and tubulointerstitial fibrosis, EM morphometry of podocyte foot processes, immunohistochemical analysis of podocyte specific proteins, and glomerular isolation.

DR advanced testing will include measures of retinal vascular permeability, retinal cell death and non-lethal measures of retinal morphology using optical coherence tomography and visual function using optokinetic response.

| Test No. | Test Name | Keywords |
|---|---|---|
| MI30001 | Optokinetic measurements of visual acuity and contrast sensitivity | contrast sensitivity, visual acuity |
| MI30002 | Retinal microstructure imaging by optical coherence tomography (OCT) | OCT, retinal layer |
| MI30003 | Retinal vascular permeability | permeability, retinal layer |

| Test No. | Test Name | Keywords |
|---|---|---|
| MI30004 | Retinal cell death | apoptosis, retinal layer |
| MI30005 | Electroretinogram (ERG) | neural control |
| MI30006 | Fundus imaging | imaging, retinal layer |
| MI30007 | Intravitreal injection | injection |
| MI30021 | Sciatic Motor NCV | conduction, Motor, NCV, nerve, SMNCV, velocity |
| MI30022 | Sural Sensory NCV | conduction, NCV, nerve, sensory activation, Sural, velocity |
| MI30023 | Intra-epidermal Nerve Fiber Density | fiber density, IENFD, nerve |
| MI30024 | Thermal Hindpaw Withdrawal | hindpaw, hp, thermal |
| MI30025 | Cryoembedding | cryoembedding |
| MI30026 | TBARS | lipids peroxidation, TBARS |
| MI30050 | Qualitative light microscopic renal histopathology | histology, microscopy |
| MI30051 | Quantitative mesangial matrix evaluation | Mesangial matrix |
| MI30052 | Quantitative electron microscopic measurement of glomerular basement membrane | GBM thickness, Glomeruli, microscopy |
| MI30053 | Podocyte counts/glomerulus | Glomeruli, Podocyte |
| MI30054 | Glomerular harvest for protein or RNA | Glomeruli, protein, RNA |
| MI30055 | Immunoblot for glomerular lysates | Glomerular protein, Glomeruli, protein |
| MI30056 | 24 hour urine collection for albumin and creatinine | Albuminuria, creatinine, urinalysis, urinary albumin excretion (UAE), urine |
| MI30057 | Spot urine collection for albumin and creatinine | kidney, urinalysis, urinary albumin excretion (UAE), urine |
| MI30058 | Glomerular filtration rate (GFR) determination with minipump inulin clearance | glomerular filtration, kidney |
| MI30059 | Tail cuff Blood Pressure (BP) determination | blood pressure, tail-cuff |

## Microbiome Core

Co-Director: Vincent Young, Co-Director: Tom Schmidt, Co-Director: Patrick Schloss

The goal of the Microbiome Core is to serve the specific needs of investigators who are studying the role that complex microbial communities can play in shaping the overall metabolic state of their host. Provide analytical tools to investigators to permit determination of the structure of the microbiome in mouse models of disease and assistance in the cultivation of microbes that will permit hypothesis testing in murine models including the germfree animals that are available in the Animal Care Core.

| Test No. | Test Name | Keywords |
|---|---|---|
| MI4001 | Study design consultation | consultation, study design |
| MI4002 | DNA extraction single plate with controls | DNA, extraction, isolation |
| MI4003 | Illumina 16S rRNA gene sequencing, V4 region 0.25 run | gene sequencing, RNA |
| MI4004 | Analysis of Sequencing Data - Mothur pipeline | gene sequencing, RNA |

## VANDERBILT UNIVERSITY SCHOOL OF MEDICINE

## Metabolic Regulation Core

Director: Owen McGuinness, Co-Director: Louise Lantier, Personnel: Carlo Malabanan

The Metabolic Regulation Core conducts these major tests: vein/artery cannulations, glucose and insulin clamps in conscious unstressed mice, glucose tolerance test, tissue specific glucose/fatty acid uptake, gluconeogenesis/glycogenolysis, metabolic flux analysis, optical imaging of gene expression/cellular events, isolation of pancreatic islets /insulin secretion.

| Test No. | Test Name | Keywords |
|---|---|---|
| V3000 | Jugular Vein or Carotid Artery Catheterization | artery, catheterization, surgery, vein |
| V3001 | Cannulation of cerebral ventricle | central control, CSF, surgery |
| V3002 | Jugular vein and carotid artery catheterization | artery, blood vessel, catheterization, chronic, insulin, insulin action, surgery, vein |
| V3003 | Glucose Tolerance Test (Oral, i.p., Intravenous, or gastric catheter) | carbohydrate, diabetes, glucose intolerance, glucose tolerance, insulin, insulin action, insulin resistance, insulin sensitivity |
| V3004 | Glucose turnover | carbohydrate, clamp, diabetes, endogenous glucose production, flux, glucose flux, glucose kinetics, glucose turnover, insulin, insulin action, insulin resistance, isotopes, kinetics, liver, liver function, tracers |
| V3005 | Hyperinsulinemic clamp | clamp, diabetes, endogenous glucose production, glucose, glucose disposal, glucose uptake, hyperinsulinemic clamp, insulin, insulin action, insulin resistance |
| V3006 | Hyperglycemic clamp | clamp, diabetes, glucose, hyperglycemic clamp, insulin, insulin resistance, insulin secretion, insulin sensitivity |
| V3008 | Glycogen synthesis | carbohydrate, diabetes, flux, glycogen synthesis, isotope, liver, liver function, tracer |
| V3009 | Amino acid kinetics | amino acid flux, amino acid kinetics, isotopes, metabolite |
| V3010 | Tissue specific glucose uptake | 2-deoxyglucose, carbohydrate, diabetes, glucose metabolic index, insulin, insulin action, insulin sensitivity, tissue specific glucose uptake |
| V3011 | Tissue specific fatty acid uptake | 125I-BMIPP, flux, isotope, lipids, obesity, tissue specific fatty acid uptake, tracer |
| V3013 | Exercise capacity/Exercise Stress Test (metabolic response to exercise) | Activity, endurance, exercise capacity, exercise stress test, exercise tolerance |
| V3017 | Assess real time imaging of cellular metabolic events | imaging, metabolism, microcirculation, real time imaging |
| V3018 | In vivo optical imaging of gene expression | Function, gene expression, GFP, imaging, luciferase, transcription |
| V3094 | Direct jugular vein injection and blood sampling | blood sampling, blood vessel, conscious animal, drug infusion, vein |
| V3099 | Albuminuria | complications, diabetes, kidney, kidney disease, protein, urinary albumin excretion (UAE), urine |
| V4005 | Glycemic Control using Minimed | glucose |
| V4006 | Personnel Training | advice, course, training |
| V4007 | Surgical Training | surgery, training |

## Cardiovascular Pathophysiology

Director: Douglas Vaughan, Associate Director: Jeff Rottman

The Cardiovascular Pathophysiology and Complications Core conducts these major tests: morphology and histology, echocardiography, electrocardiography, blood pressure, vascular morphology, renal function, metabolic panel in state-of-the-art facilities.

| Test No. | Test Name | Keywords |
|---|---|---|
| V3030 | In vitro Morphology, Morphometrics and Histology (isolated heart) | cardiac function, isolated organ and cell perfusion, morphology |
| V3031 | Echocardiography, in vivo morphology, systolic and diastolic function; Stress echocardiography | cardiac function, diastolic, ECG, echo, echocardiography, EKG, electrocardiography, morphology, pulsed Doppler, strain imaging, stress, systolic, vascular function |
| V3034 | Vascular morphology | atherosclerosis, blood vessel, circulation, histology, vascular, vascular function |
| V3036 | Tail vein injections | cardiac, drug infusion, vein |
| V3095 | Myocardial infarction | artery, cardiac injury, cardiac remodeling, coronary ligation, heart failure, infarct |
| V3096 | Myocardial ischemia reperfusion | artery, cardiac injury, ischemia, reperfusion injury |
| V3097 | Transverse aortic constriction | artery, cardiac injury, heart failure, hypertension, hypertrophy, pressure overload, TAC |
| V3098 | GFR-FITC-Inulin; HPLC Cr | glomerular filtration, HPLC |
| V4000 | Renal Blood Flow (Doppler) | blood flow, blood pressure |
| V4002 | Osmometer Plasma/Urine | osmolality, urine |
| V4003 | Urine Ca/Phosphorus Excretion | urine |
| V4004 | Urine pH | pH, urine |

## Analytical Resources Core

Director: Owen McGuinness, Co-Director: Dale Edgerton

The Analytical Resources Core performs these major tests: plasma hormones, amino acids, lipids and lipoproteins, pathology and immunohistochemistry.

| Test No. | Test Name | Keywords |
|---|---|---|
| V3050 | Insulin | carbohydrate, diabetes, hormone |
| V3051 | Glucagon - ELISA | counter-regulation, hormone, lipids |
| V3052 | Corticosterone | glucocorticoid, hormone, stress |
| V3053 | Catecholamines (epinephrine & norepinephrine only) | hormone, stress |
| V3054 | Leptin (Luminex assay) | adipokine, diabetes, feeding behavior, hormone, leptin, obesity |
| V3055 | C-peptide (Luminex assay) | hormone, insulin, insulin action, insulin secretion |
| V3059 | PRL (prolactin) | fertility, hormone, prolactin |
| V3060 | ACTH | adrenocorticotropic hormone, corticotropin, glucocorticoid, hormone, stress |

| Test No. | Test Name | Keywords |
|---|---|---|
| V3067 | Testosterone | hormone, sex, steroid |
| V3070 | Plasma lipids | cholesterol, fatty acids, lipids, metabolism, obesity |
| V3071 | Lipid extraction, separation, quantification | fatty acids, lipids, metabolism, obesity |
| V3072 | Fatty acid profiles of lipid esters by gas liquid chromatography | GCMS, lipids, metabolism |
| V3073 | Quantitation of individual phospholipid classes | cholesterol, lipids, metabolism, phospholipids |
| V3074 | Short chain fatty acid analysis by gas liquid chromatography | GCMS, lipids, metabolism, short chain fatty acid |
| V3075 | Fast Protein Liquid Chromatographic (FPLC) Lipoproteins Separations | cholesterol, fatty acids, lipids, lipoproteins, metabolism |
| V3076 | Morphometric determinations (aorta) | atherosclerosis, blood vessel, histology, vascular, vascular function |
| V3080 | Gross examinations and necropsy | gross examination, histology, necropsy, organs, tissue, tissues |
| V3081 | Tissue preparation, embedding, sectioning and routine staining | embedding, histology, organs, sectioning, staining, tissue, tissue preparation |
| V3082 | Tissue microdissection | diabetes, histology, immunology, insulin, insulin action, laser microdissection, organs, tissue, tissues |
| V3083 | Screen/optimize immunohistochemical protocols for mouse-specific commercial and custom-designed antisera | histology, immunohistochemistry, organs, tissue, tissues |
| V3090 | Amino Acids - Full Profile (HPLC) | amino acids, hormone, HPLC, imaging, metabolite, modeling and simulation |
| V3091 | Amino Acid - gluconeogenic profile | amino acids, HPLC, metabolite |
| V4010 | Ghrelin - Active (RIA) | hormone |
| V4011 | Ghrelin - Total (RIA) | hormone |
| V4012 | Glucose (Enzymatic) | hormone |
| V4014 | Purine Nucleotides (HPLC) | hormone |
| V4015 | T3 (RIA) | hormone |
| V4016 | T4 (RIA) | hormone |
| V4017 | Luminex Assays | hormone, Luminex |
| V4018 | Acetaminophen | assay, hormone |
| V4020 | Cortisol - Salivary | |
| V4021 | Creatinine | creatinine |

## Body Weight Regulation Core

Director: Kevin Niswender, Co-Director: Louise Lantier, Personnel: Merrygay James, Personnel: Carlo Malabanan

The Body Weight Regulation Core conducts these major tests: mouse models of bariatric surgery, indirect calorimetry, exercise, mitochondrial function, body composition, food consumption, telemetry, body temperature.

| Test No. | Test Name | Keywords |
|---|---|---|
| V3012 | Indirect calorimetry / energy expenditure in the Promethion | Activity, basal metabolic rate, body composition, carbon dioxide, CO2 production, energy expenditure, food intake, gas |

| Test No. | Test Name | Keywords |
|---|---|---|
| | | exchange, indirect calorimetry, obesity, oxygen, oxygen consumption, respiratory quotient, water intake, wheel running |
| V3014 | Spontaneous exercise activity | Activity, exercise, running wheel, spontaneous exercise activity, wheel running |
| V3015 | Food Consumption | energy balance, food intake, ingestion, spontaneous exercise activity, wheel running |
| V3016 | Exploratory locomotor activity | energy expenditure, exercise, exploratory locomotor activity |
| V3032 | Telemetry (in vivo chronic arterial blood pressure measurement) | Activity, blood pressure<br>heart rate<br>activity<br>temperature<br>blood glucose<br>arrhythmia, cardiac, cardiovascular disease, diastolic, ECG, echo, EKG, glucose, systolic, telemetry, vascular function |
| V3033 | Blood pressure measurements | blood pressure, blood vessel, cardiac function, circulation, hypertension, hypotension, tail-cuff, telemetry, vascular, vascular function |
| V4024 | Bariatric Surgery (Roux-en-Y, VSG, biliopancreatic diversion, sham controls) | absorption, adipose, bacteria, body composition, body weight, food intake, gut, gut hormones, microbiome, surgery |
| V4026 | Body Composition Analysis by NMR | body composition |

# Test Descriptions by Center

## UNIVERSITY OF CALIFORNIA DAVIS

## Animal Care, Surgery, and Pathology Core

### D2001 Importation of Mice and Material
Keywords: animal husbandry, mouse husbandry and transfer, mouse models

Assume 10 experimental mice {5M, 5F} and 10 wt controls {5M, 5F}

Importation of 1 crate of mice

### D2002 Per Diem
Keywords: animal husbandry, mouse husbandry and transfer, mouse models

Cage/Day

### D2003 Colony Management (if needed)
Keywords: animal husbandry, mouse husbandry and transfer, mouse models

: A colony management fee is applied to projects requiring more than routine housing and care. This fee is applied on a per cage per day basis. Colony management includes (but is not limited to) projects requiring timed matings with or without plug collection; breeding with pup identification; collection of samples for genotyping; special diets.

### D2004 Genotyping (if needed)
Keywords: animal husbandry, animal model, genetics, genotyping, mouse husbandry and transfer, mouse models

Some projects may require genotyping during the course of housing mice at UCD. Genotyping sampling may be done by ear punch or tail snips, depending on age. Altricial pups will be sampled by “toeing”. This fee is applied on a per sample basis, to samples submitted to the MBP Murine Genotyping Analysis laboratory for testing.

### D2005 Mouse Model Purchase
Keywords: animal husbandry, modeling and simulation, mouse husbandry and transfer, mouse models

Access mutant mouse models from the MMRRC or the KOMP Repositories and submit to MMPC for phenotyping

### D2006 Mouse Model Creation
Keywords: animal husbandry, modeling and simulation, mouse husbandry and transfer, mouse models

Create mutant mouse models de novo and submit to MMPC for phenotyping

### D2007 Chronic high-fat feeding
Keywords: animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, mouse husbandry and transfer, obesity, type 2 diabetes

An experimental mouse model of obesity can be generated by feeding either a high fat diet (HFD) or very high fat diet (VHFD) for specified period of time; diet based on investigator preference for study needs. Differences in body weight can be seen as soon as 2 weeks after the initiation of feeding HFD. After 4 weeks on HFD, many mice begin exhibiting hyperglycemia with the full obese phenotype measureable after 16 weeks. Within 16-20 weeks mice may experience a 20-30% increase in body weight, adipocyte hyperplasia, fat deposition in the mesentery, increased fat mass, diabetes, and hypertension. The effect of the diet on obesity development is directly related to the fat content of the diet and the length of time the animal spends on the diet with variability in severity of metabolic changes observed between individual animals. The Animal Care Core works with the users in designing a study with appropriate feeding duration and selection of diet with respect to percent and composition of fat in the diet.

### D2008 Vertical Sleeve Gastrectomy (VSG)
Keywords: animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, mouse husbandry and transfer, obesity, type 2 diabetes

Vertical sleeve Gastrectomy (VSG) is a common surgical treatment of obesity, type-2 diabetes, and other comorbidities of obesity. The VSG mouse surgical model provides researchers with a mechanism to evaluate mechanistic studies to explore the methods by which VSG bariatric surgery produces beneficial effects on obesity. Pricing includes the VSG or SHAM surgery performed on one mouse and surgical supplies. Rate does not include the, cost of the mouse, per diems, special diets, colony management fees. The Animal Care, Surgery and Pathology Core works with users to design and optimize each study, including recommendations for animal numbers, feeding strategies, and data collection.

### D2009 Roux en Y Gastric Bypass (RYGB)

Keywords: animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, insulin resistance, mouse husbandry and transfer, obesity, type 2 diabetes

Roux en Y Gastric Bypass (RYGB) is the most effective common surgical treatment of obesity, type-2 diabetes, and other comorbidities of obesity. The RYGB mouse surgical model provides researchers with a mechanism to evaluate mechanistic studies to explore the methods by which RYGB bariatric surgery produces beneficial effects on obesity. Pricing includes the RYGB or SHAM surgery for one mouse and surgical supplies. Rate does not include the cost of the mouse, per diems, special diets, and colony management fees. The Animal Care, Surgery and Pathology Core works with users to design and optimize each study, including recommendations for animal numbers, feeding strategies, and data collection.

### D2010 Vertical Sleeve Gastrectomy (VSG) Package

Keywords: animal model, diabetes, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, mouse husbandry and transfer, obesity

Vertical sleeve Gastrectomy (VSG) is a common surgical treatment of obesity, type-2 diabetes, and other comorbidities of obesity. The VSG mouse surgical model provides researchers with a mechanism to evaluate mechanistic studies to explore the methods by which VSG bariatric surgery produces beneficial effects on obesity. Pricing includes surgery and surgical supplies only for one VSG, one pair fed Sham, and one ad lib Sham for a total of 3 surgeries. Rate does not include the cost of the mice, per diems, special diets, and colony management fees. The Animal Care, Surgery and Pathology Core works with users to design and optimize each study, including recommendations for animal numbers, feeding strategies, and data collection.

### D2011 Roux en Y Gastric Bypass (RYGB) Package

Keywords: animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, insulin resistance, mouse husbandry and transfer, obesity, type 2 diabetes

Roux en Y Gastric Bypass (RYGB) is the most effective common surgical treatment of obesity, type-2 diabetes, and other comorbidities of obesity. The RYGB mouse surgical model provides researchers with a mechanism to evaluate mechanistic studies to explore the methods by which RYGB bariatric surgery produces beneficial effects on obesity.. Pricing includes surgery and surgical supplies only for one RYGB, one pair fed Sham, and one ad lib Sham for a total of 3 surgeries. Rate does not include the cost of the mice, per diems, special diets, and colony management fees. The Animal Care, Surgery and Pathology Core works with users to design and optimize each study, including recommendations for animal numbers, feeding strategies, and data collection.

### D2013 MMPC mouse gross necropsy with histology

Keywords: histology, imaging, morphology, mouse husbandry and transfer, necropsy, organs, tissue

Assessment of gross and histologic changes to complement other MMPC assays; Gross necropsy with documentation of changes present. Collection and histologic processing (paraffin blocks/H&E slides) and interpretation of kidneys, liver, spleen, pancreas, heart, lungs, esophagus, trachea, thymus, mesenteric lymph nodes, GI Tract, cerebrum, cerebellum, urinary bladder, and reproductive tract and additional tissues with gross changes. This includes photodocumentation of significant findings. This assay can be customized to include other target organs based on findings from other MMPC assays.

### D2014 Surgery - Data Recorder or Simple Telemetry (without cannulation)

Keywords: surgery, telemetry

Implantation of a simple telemetry or data recorder, per mouse. Pricing includes surgery for one animal and surgical supplies. , Rate does not include the cost of the mouse, per diems, colony management fees and telemetry device. The Animal Care, Surgery and Pathology Core works with users to design and optimize each study, including recommendations for animal numbers, device selection and data collection.

### D2016 Additional Pathology Services

Keywords: CT, histology, imaging, immunohistochemistry, Pathology, PET

The scope of Additional Pathology Services can encompass a wide variety of activities that can enhance routine histopathology analysis and processing.

Special tissue collections requiring special expertise, time and labor-intensive processing and analyses could be included in "Additional Pathology Services". Creation and processing of gut-rolls or special organ preparations, precise brain sectioning and processing, and a myriad of advanced photo-microscopy or "Count & Measure" analyses are possible. We have imaging analysis software that allows Pixel-Dependent reviews and analysis of stained tissues.

### D2017 Clinical Chemistry, Hematology, Urine Analysis

Keywords: ALT, AST, blood chemistry, carbohydrate metabolism, cardiac function, CBC, chemistry, cholesterol, CK, fatty acids, HDL, hematology, Hemoglobin A1C, kidney, LDL, lipids, liver function, NEFA, plasma, PLT, RBC, reticulocytes, serum, toxicity, triglycerides, urinalysis, urine, WBC

A wide variety of clinical chemistry and hematology assays are available for characterization of rodent blood and rodent strain types. The Comparative Pathology Laboratory has special instrumentation that can analyze extremely small sample volumes. We are able to provide analytical services to many types of clients, but we are optimized for rodent researchers. Please inquire for a consultation: Main Laboratory Phone: 530-752-2832

## Endocrinology and Metabolism Core

### D3101 Intravenous Glucose Tolerance Test

Keywords: carbohydrate, diabetes, insulin, insulin action, insulin resistance, insulin secretion, insulin sensitivity

Assessment of insulin sensitivity, glucose tolerance, and insulin secretion in vivo.

Price include insulin/glucose assay costs.

Mice from an inbred strain with low inter-animal variability in insulin sensitivity will be run with each group of animals undergoing the IVGTTs/clamps as an internal standard.

### D3103 IN VIVO Insulin Tolerance Tests

Keywords: carbohydrate, diabetes, insulin, insulin action, insulin resistance, insulin sensitivity

Mice will be injected IP with 1mU/g of insulin. Samples will be collected at 0,15,30,45,60,90,120 min for the measurement of glucose.Plumpton,1969

Includes housing, surgery, biochemical assays to measure glucose/insulin level.

Mice from an inbred strain with low inter-animal variability will be run with each group of animals undergoing the same procedure

### D3104 IN VIVO Glucose Tolerance Tests

Keywords: carbohydrate, diabetes, glucose, glucose metabolism, glucose tolerance, insulin resistance, insulin sensitivity

Mice will be injected IP with 2mg/g of glucose. Samples will be collected at 0,15,30,60,120 min for the measurement of glucose.

Includes housing, surgery, biochemical assays to measure glucose/insulin level.

Mice from an inbred strain with low inter-animal variabilitywill be run with each group of animals undergoing the same procedure.

### D3105 IN VIVO Glucose-stimulates Insulin Secretion Test

Keywords: carbohydrate, diabetes, glucose, glucose metabolism, insulin, insulin action, insulin resistance, insulin sensitivity

Mice will be injected IP with 2mg/g of glucose. Samples will be collected at 0,2,5,15,30 min for the measurement of glucose and insulin.

Includes housing, surgery, biochemical assays to measure glucose/insulin level.

Mice from an inbred strain with low inter-animal variabilitywill be run with each group of animals undergoing the same procedure

### D3301 Lipid extraction from liver

Keywords: atherosclerosis, cholesterol, obesity, total cholesterol, triglycerides

Triglyceride and cholesterol content in liver tissue will be determined by the Folch method (Folch, 1957). Weighed tissue samples are homogenized in methanol:chloroform. After overnight extraction, 0.7% sodium chloride is added. The aqueous layer is aspirated and duplicate aliquots of the chloroform/lipid layer are dried under nitrogen gas. The lipid is reconstituted in isopropyl alcohol and assayed for TG spectrophotometrically with enzymatic reagents from Fisher Diagnostics (Middletown, VA)

### D3302 Lipid extraction from muscle

Keywords: atherosclerosis, cholesterol, obesity, total cholesterol, triglycerides

Triglyceride and cholesterol content in muscle tissue will be determined by the Folch method (Folch, 1957). Weighed tissue samples are homogenized in methanol:chloroform. After overnight extraction, 0.7% sodium chloride is added. The aqueous layer is aspirated and duplicate aliquots of the chloroform/lipid layer are dried under nitrogen gas. The lipid is reconstituted in isopropyl alcohol and assayed for TG spectrophotometrically with enzymatic reagents from Fisher Diagnostics (Middletown, VA)

### D3401 Glucose (urine/plasma)

Keywords: carbohydrate, diabetes, glucose, hyperglycemia, hypoglycemia, insulin, insulin action, insulin effectiveness, liver, liver function, liver function enzymes, metabolite, urine

Hyperglycemia/ glycosuria

Thermo microplate (5ul) enzymatic assay

### D3402 Hemoglobin A1C

Keywords: diabetes, glucose, Hemoglobin A1C, hyperglycemia, liver, liver function, liver function enzymes, metabolism

Index of long-term glycemic control.

Diazyme (20ul whole blood) enzymatic assay.

### D3403 beta-OH butyrate

Keywords: Atkins, diabetes, insulin, ketones, liver, liver function, liver function enzymes, low carbohydrate, metabolism

Markers of ketosis.

Millipore-Sigma enzymatic assay (20ul for duplicates).

### D3404 Triglyceride

Keywords: liver, metabolism, triglycerides

This assay uses reagents from Millipore-Sigma and 10ul of sample is required for duplicates, an additional 5ul of sample is recommended for a sample blank if the sample is hemolyzed.

### D3405 Total Cholesterol

Keywords: atherosclerosis, cholesterol, lipids, liver, liver function, metabolism, metabolite, obesity, total cholesterol

This assay uses reagents from Fisher Diagnostics and 10ul of sample is required for duplicates, an additional 5ul of sample is recommended for a sample blank if the sample is hemolyzed.

### D3406 HDL-C and LDL-C/VLDL-C

Keywords: atherosclerosis, cholesterol, lipids, liver, liver function, metabolism, metabolite, obesity

This assay uses a precipitation buffer from AbCam to precipitate LDL and VLDL particles and 25ul of sample is required. The cholesterol content will be determined in the HDL fraction, and this value will be subtracted from the total cholesterol of the original sample to provide the cholesterol value for the LDL/VLDL fraction.

### D3407 HDL-TG and LDL-TG/VLDL-TG

Keywords: atherosclerosis, cholesterol, lipids, liver, liver function, metabolism, metabolite, obesity

This assay uses a precipitation buffer from AbCam to precipitate LDL and VLDL particles and 25ul of sample is required. The triglyceride content will be determined in the HDL fraction, and this value will be subtracted from the total triglyceride of the original sample to provide the triglyceridel value for the LDL/VLDL fraction.

### D3408 Non esterified fatty acids

Keywords: lipids, liver, liver function, liver function enzymes, metabolism, non-esterified fatty acid

WAKO microplate (10ul for duplicates) with standard reagents from PolyMedCo

### D3412 Metabolomics

Keywords: amino acids, aromatics, carbohydrate, diabetes, exercise, free fatty acids, glycolysis, hormone, hydroxyl acids, lipids, liver, liver function, metabolism, metabolite, serum, sterol, sugar phosphates, TCA intermediates

Multiple metabolite levels measured. Intensity values normalized to total metabolome content. Gass Chromatograph (GC)-Time of Flight (TOF) mass spectrometry. MS deconvolution, BinBase DB processing. compounds.

### D3413 Complex lipid ratios

Keywords: ceramides, diabetes, exercise, lipids, liver, liver function, lysophosphatidylcholines, mass spectrometry, obesity, phospholipids, serum, sphingomyelins

Multiple metabolite levels measured. Intensity values normalized to total metabolome content. UPLC/QTOF mass spectrometry. MZmine data processing. Identification on accurate mass and MS/MS databases.

### D3414 Alanine Transaminase (ALT)

Keywords: Alanine transferase, plasma

Bio-Enzymatic Assay to determine the level of Alanine Transaminase (ALT) in plasma samples (serum/EDTA). 20ul of plasma per duplicate.

ALT is measured to see if the liver is damaged or diseased. Low levels of ALT are normally found in the blood. But when the liver is damaged or diseased, it releases ALT into the bloodstream, which makes ALT levels go up. Most increases in ALT levels are caused by liver damage.

The ALT test is often done along with other tests that check for liver damage, including aspartate aminotransferase (AST), alkaline phosphatase, lactate dehydrogenase (LDH), and bilirubin. Both ALT and AST levels are reliable tests for liver damage.

### D3415 Aspartate Aminotransferase (AST)

Keywords:

Bio-Enzymatic Assay to determine the level of Aspartate Aminotransferase (AST)in

plasma samples (serum/EDTA). 20ul of plasma per duplicate.

AST is measured to see if the liver is damaged or diseased. Low levels of AST

are normally found in the blood. But when the liver is damaged or diseased, it

releases AST into the bloodstream, which makes AST levels go up. Most increases

in AST levels are caused by liver damage.

The AST test is often done along with other tests that check for liver damage,

including Alanine Transaminase (ALT) , alkaline phosphatase, lactate

dehydrogenase (LDH), and bilirubin. Both ALT and AST levels are reliable tests

for liver damage.

**D3431 Hormones - Generic ELISA Assay**
Keywords: hormone, liver, liver function

Any hormone can be measured if it is offered in an assay format without extraction (for example IGF1, Corticosterone, Resistin, etc).

**D3432 Insulin**
Keywords: carbohydrate, diabetes, hormone, insulin, liver, liver function

Fasting insulin is an index of IR. Also measured for functional tests. Meso Scale Discovery (10ul for duplicates)

**D3433 C-Peptide**
Keywords: hormone, insulin, insulin secretion, liver, liver function

Proinsulin cleavage product. ALPCO ELISA (10ul)

**D3434 Proinsulin**
Keywords: carbohydrate, diabetes, hormone, insulin, liver function, liver function enzymes

Precursor to insulin. ALPCO ELISA (10ul)

**D3435 Leptin**
Keywords: adipokine, diabetes, feeding behavior, hormone, leptin, leptin measurement, liver, liver function, liver function enzymes, obesity

Adipocyte hormone involved in energy balance/anti-steatotic Meso Scale Discovery (10ul for duplicates)

**D3436 Adiponectin (total)**
Keywords: adipokine, adiponectin, hormone, insulin, insulin resistance, lipids, liver, liver function, liver function enzymes

Insulin-sensitizing/anti-steatotic/anti-atherogenic adipocyte hormone

Meso Scale Discovery (5ul)

**D3437 Adiponectin (HMW)**
Keywords: adipokine, adiponectin, hormone, insulin, insulin resistance, lipids, liver, liver function, liver function enzymes

Insulin-sensitizing/anti-steatotic/anti-atherogenic adipocyte hormone. ALPCO ELISA (5ul)

**D3438 Glucagon**
Keywords: counterregulatory, glucagon, hormone, lipids, liver, liver function, liver function enzymes

Counterregulatory hormone. Millipore RIA (100ul)

**D3439 Glucagon-like peptide 1 (active)**
Keywords: glucagon, hormone, incretin, lipids, liver, liver function, liver function enzymes

Incretin hormone. Meso Scale Discovery (20ul for duplicates)

**D3440 Glucagon-like peptide 1 (total)**

Keywords: glucagon, hormone, incretin, lipids, liver, liver function, liver function enzymes

Incretin hormone. Meso Scale Discovery (20ul for duplicates)

**D3441 Ghrelin**
Keywords: eating behavior, energy balance, hormone, liver, liver function, liver function enzymes

Orexigenic GI hormone. Millipore ELISA (50ul)

**D3451 Urinary Albumin Excretion**
Keywords: albumin, complications, kidney, kidney disease, renal, urinary albumin excretion (UAE), urine

Index of renal damage/Impaired glomerular function. 24 hour urine samples are collected from animals in a metabolic cage and albmunin is measured with a standard assay kit, using Albumin Blue 580 Fluorescence

**D3452 Creatinine**
Keywords: cardiovascular, creatinine, kidney, kidney disease, lesion, renal, urine

Uremia products. Uses Cayman ELISA (20ul)

**D3453 Urea**
Keywords: kidney, kidney disease, renal, urea

Uremia products. Uses Cayman ELISA (20ul)

**D3461 Markers of Inflammation - custom panel**
Keywords: diabetes, growth factors, immunology, inflammation, interleukins, oxidative stress

Inflammation plays a crucial role in atherosclerosis and contributes to insulin resistance. Up to 10 proinflammatory cytokines (IFN-?, IL-1ß, IL-2, IL-4, IL-5, IL-6, IL-10, IL-12 p70, KC/GRO, TNF-a) can be measured with 25µl of serum (50µl for duplicates) using a Meso Scale Discovery Sector Imager.

**D3463 HS CRP**
Keywords: CRP, diabetes, immunology, inflammation

Associated with insulin resistance and dyslipidemia. R&D Systems ELISA (10ul)

**D3464 Serum Amyloid A1**
Keywords: diabetes, immunology, inflammation, serum, serum metabolic panel

Displaces apo A1 from HDL. R&D ELISA (10ul)

**D3465 sICAM**
Keywords: diabetes, immunology, inflammation

Soluble intercellular adhesion molecule-1. Increased levels associated with increased risk of vascular disease. R&D ELISA (10ul)

**D3466 sVCAM**
Keywords: diabetes, immunology, inflammation

Vascular cell adhesion molecule-1. Increased levels associated with increased risk of vascular disease. R&D ELISA (10ul)

**D3467 sE-Selectin**
Keywords: diabetes, hormone, immunology, inflammation

Soluble E-selectin. Increased levels associated with increased risk of vascular disease. R&D ELISA (10ul)

**D3468 sP-Selectin**
Keywords: diabetes, hormone, immunology, inflammation

Soluble P-selectin. Increased levels associated with increased risk of vascular disease. R&D ELISA (10ul)

**D3495 MISC Assay**
Keywords: custom

Miscellaneous Assay

**D3496 Corticosterone**
Keywords: carbohydrate, carbohydrate metabolism, hormone, serum

10ul of serum or EDTA Plasma measured by RIA (RadioImmuno Assay)

## Energy Balance, Exercise & Behavior Core

**D4001 Gross Body Composition**
Keywords: body composition, fat free mass, fat-free mass, FFM, imaging, LBM, lean, mouse husbandry and transfer, obesity

Measures adiposity and lean mass using DEXA (PixiMus)

**D4002 Adiposity (adipose depot weights)**
Keywords: body composition, obese, obesity, WAT

Measures adipose tissue weights, by manual tissue dissection.

**D4003 Meal Pattern Analysis**
Keywords: eating behavior, food intake, meal pattern

Detailed analysis of food intake behavior including Avg Meal Duration-Active Eating Time (sec), Avg Meal Size (g), # of Meals, Avg Inter-Meal Interval (IMI) (sec), Total Meal Duration, Satiety Ratio, Avg Eating Rate, Avg Light-Meal Duration, Avg Dark-Meal Duration, Avg Light-Meal Size, Avg Dark-Meal Size, Avg Light-IMI, Avg Dark-IMI, Light- # Meals, Dark- # Meals, Light-Satiety Ratio, Dark-Satiety Ratio, Light-Eating Rate (g/min), Dark-Eating Rate (g/min), Food Intake/BW). "Meal" defined by minimum food intake of 0.02g and at least 10 min between food bout events.

**D4007 Energy Expenditure (CLAMS, Indirect Calorimetry)**
Keywords: basal metabolic rate, CO2 production, energetics, energy balance, energy expenditure, food intake, heat, indirect calorimetry, obesity, oxygen consumption, RER, respiratory quotient, RQ, thermogenesis

Measures energy utilization and fuel preference by indirect calorimetry; gross 24 hour food and water intake; body composition by DEXA

**D4008 Energy Expenditure (CLAMS, Indirect Calorimetry) + Meal Pattern Analysis**
Keywords: basal metabolic rate, body composition, CO2 production, energetics, energy balance, energy expenditure, food intake, heat, indirect calorimetry, obesity, oxygen consumption, RER, respiratory exchange ratio, respiratory quotient, RQ, thermogenesis

Measures energy utilization and fuel preference by indirect calorimetry; gross

24 hour food and water intake; body composition by DEXA

-and-

Detailed analysis of food intake behavior including Avg Meal Duration-Active

Eating Time (sec), Avg Meal Size (g), # of Meals, Avg Inter-Meal Interval (IMI)

(sec), Total Meal Duration, Satiety Ratio, Avg Eating Rate, Avg Light-Meal

Duration, Avg Dark-Meal Duration, Avg Light-Meal Size, Avg Dark-Meal Size, Avg

Light-IMI, Avg Dark-IMI, Light- # Meals, Dark- # Meals, Light-Satiety Ratio,

Dark-Satiety Ratio, Light-Eating Rate (g/min), Dark-Eating Rate (g/min), Food

Intake/BW). "Meal" defined by minimum food intake of 0.02g and at least 10 min

between food bout events.

### D4010 Special Services

Keywords: body composition, cardiac function, exercise, indirect calorimetry, meal pattern, metabolism, telemetry

Consultation; Study design or data analysis. (Advanced data analysis or data analyses from data obtained outside core.)

### D4011 Voluntary wheel running (activity and/or exercise)

Keywords: Activity, exercise, running wheel, wheel running

Voluntary wheel running provides detailed information on the running capacity and activity patterns (i.e., total distance, median velocity, time of breaks, etc.). This system may also be used as a means of providing voluntary exercise in metabolic or exercise based studies.

### D4012 Core body temperature (temperature recorder)

Keywords: body temperature, Temperature, thermogenesis, thermoneutrality

Measures core body temperature with IP temperature recorder (DST-nano-T). This service is paired with Data Recorder Implant Surgery through the animal core.

### D5005 BP measurement by tail cuff

Keywords: blood pressure, cardiac function, circulation, diabetes, hypertension, hypotension, obesity, vascular function

BP measurement by tail cuff. The technique provides a good estimate of actual systolic pressure.

### D5011 CT, MRI, PET, & combinations

Keywords: cardiac function, central nervous system, circulation, CT, diabetes, imaging, magnetic, metabolism, MRI, obesity, PET, resonance, spectroscopy, vascular function

CT, MRI, PET, & combinations. Cardiac or brain are assessed.

http://imaging.bme.ucdavis.edu/faqs/recharge-rates/

### D5101 Cognitive Function - Radial Arm Water Maze

Keywords: cognitive function

This is a spatial learning and memory task. Animals are tested for 9 daily sessions of five trials. Each session consists of four learning trails and a fifth retention trial 30 minutes after trial four over a ten consecutive day period. Parameters such as error rate and latency aid in detecting cognitive deficits. Fees are quoted for a cohort of 8 mice.

### D5102 Cognitive Function - Morris Water Maze (Male Mice)

Keywords: cognitive function

The Morris water maze (MWM) is a widely used tool to study spatial learning and memory. It can assess learning, memory, and spatial working memory and can also indicative of damage to cortical regions of the brain. It can measure the effect of neurocognitive disorders on spatial learning and possible neural treatments, to test the effect of lesions to the brain in areas focused on memory, and to study how age influences cognitive function and spatial learning. The fee listed applies to a cohort of 8 mice.

### D5103 Cognitive Function - Morris Water Maze (Female Mice)

Keywords: cognitive function

The Morris water maze (MWM) is a widely used tool to study spatial learning and memory. It can assess learning, memory, and spatial working memory and can also indicative of damage to cortical regions of the brain. It can measure the effect of neurocognitive disorders on spatial learning and possible neural treatments, to test the effect of lesions to the brain in areas focused on memory, and to study how age influences cognitive function and spatial learning. Fees apply to a cohort of 8 Female mice.

### D5104 Cognitive Function - Y Maze

Keywords: cognitive function

The y-maze is a modification of the T- maze which evaluates memory and special learning in rodents though quantification of spontaneous alternation (a measure of spatial cognition). This measure has previously been shown to be affected in mouse models of Alzheimer's. Fee is per mouse, 8 mouse minimum.

### D5201 IBA Immunohistochemistry

Keywords: immunohistochemistry

Ionized calcium-binding adapter molecule 1 (IBA1) is specifically expressed in macrophages / microglia and is upregulated during the activation of these cells. Iba1 expression is up-regulated in microglia following nerve injury, central nervous system ischemia, and several other brain diseases. Furthermore it has been found in athlesclerotic plaques and at sigts of vascular injury.

### D5202 Factor VIII Immunohistochemistry

Keywords: imaging, immunohistochemistry

Factor VIII is a glycoprotein present in human plasma, human endothelial cells, megakaryocytes and platelets. Immunohistochemical staining for factor VIII related antigen could be used to determine if the benign and malignant neoplastic lesions are of endothelial origin. Furthermore, it can be utilized to determine vessel density in a tissue of interest.

## Microbiome & Host Response Core

### D4006-C Gut Microbiome Analysis (Illumina method-2X300bp- 20,000 avg seq read depth)

Keywords: bacteria, cecum, energetics, feces, gastrointestinal tract, microbe, microbiome, sequence based species quantitation

Determines differences in gut microbial community and diversity; 16S rDNA sequencing by Illumina (2X 300bp; 20K avg seq read depth) of feces, cecal, or other GI contents; correlation of results with metabolic phenotype variables. Performed with primers directed against V3-V4 (515F-806R)

### D6001 Ex vivo assessment of barrier function/gut permeability (minimum of 8 samples)

Keywords: barrier function, gastrointestinal tract, GI function, gut, intestinal permeability, intestine, microbiome

Gut tissue (by region- e.g ileum & colon) will be opened along the mesenteric border and mounted in Ussing chambers (Physiologic Instruments, San Diego, CA, USA), exposing 0.3 cm2 of tissue surface area to 2.5ml of oxygenated Krebs-glucose (10mM) and Krebs-mannitol (10mM) at 37°C on the serosal and luminal sides, respectively. The paracellular pathway and transcellular pathway will be measured as the flux of FITC-Dextran 4000 (FD-4, Sigma –Aldrich) and horseradish peroxidase (HRP Type VI, Sigma Aldrich), respectively. FD-4 (400µg/ml) and HRP (200µg/ml) will be added to the mucosal chamber and samples will be collected from the serosal chamber every 30 min for 2 hours. Concentration of FD-4 is measured via fluorescence at excitation 485 nm, emission 538 nm. O-dianisidine substrate is used to detect HRP at absorbance 450 nm.

### D6002 Lipopolysaccharide Binding Protein (LBP)/Endotoxemia Assay

Keywords: bacteria, endotoxemia, endotoxin, LBP, lipopolysaccharide, lipopolysaccharide binding protein, LPS, plasma

Plasma samples will be assayed for lipopolysaccharide binding protein (LBP) as surrogate for bacterial LPS/measure of endotoxemia via ELISA.

### D6003 Fecal Mouse Lipocalin-2

Keywords: gastrointestinal tract, gut, inflammation, intestinal permeability, intestine

Lipocalin-2, also known as neutrophil gelatinase-associated lipocalin (NGAL), 2 is a secreted glycoprotein that can be used as a biomarker of inflammation. Lipocalin-2 is expressed in intestinal epithelium and is upregulated in models of intestinal inflammation and injury. Fecal lipocalin-2 levels correlate well to other markers of intestinal inflammation. Lipocalin-2 will be measured by ELISA.

### D6004 Fecal Mouse Calprotectin

Keywords: gastrointestinal tract, gut, inflammation, intestinal permeability, intestine

Calprotectin is a heterodimer of calcium binding proteins S100A8 and S100A9. Calprotectin is almost exclusively expressed in neutrophils and precursors cells in the bone marrow. Fecal calprotectin levels can be used as a marker for intestinal inflammation, reflecting the recruitment and activation of neutrophils to the mucosa. Fecal calprotectin is often used clinically to diagnose inflammatory bowel diseases and correlate well to other well-established clinical markers of intestinal inflammation. Fecal homogenates will be assayed for S100A8/S100A9 heterodimer by ELISA.

### D6005 Plasma/Serum Mouse Lipocalin-2

Keywords: inflammation, obesity

Lipocalin-2, also known as neutrophil gelatinase-associated lipocalin (NGAL), 2 is a secreted glycoprotein that can be used as a biomarker of inflammation. Lipocalin-2 is increased in metabolic diseases associated with an inflammatory phenotype, including type 2 diabetes, obesity and liver steatosis. Lipocalin-2 is highly expressed in white adipose tissue and tracks obesity. Strong correlations between blood concentrations of lipocalin-2 and insulin resistance and type 2 diabetes have been noted. Lipocalin-2 can be measured in urine, blood, and feces. Lipocalin-2 will be measured by ELISA.

### D6006 Plasma/Serum Mouse Calprotectin

Keywords: inflammation, obesity, secretion

Calprotectin is a heterodimer of calcium binding proteins S100A8 and S100A9. Calprotectin is almost exclusively expressed in neutrophils and precursors cells in the bone marrow. Plasma/serum calprotectin levels can be used to monitor diseases involving chronic inflammation such as rheumatoid arthritis, inflammatory bowel diseases, and systemic lupus erythematosus. Calprotectin levels often correlate with obesity and severity of metabolic disease. Plasma/Serum will be assayed for S100A8/S100A9 heterodimer by ELISA.

### D6007 Special Services

Keywords: consultation, data analysis, gut, intestinal permeability, intestine, microbiome, study design

Consultation; Study design or specialized data analysis. (Advanced data analysis or data analyses from data obtained outside core.)

## UNIVERSITY OF CINCINNATI MEDICAL CENTER

## Lipid, Lipoprotein and Glucose Metabolism Core

### C1051 Intestinal lipid absorption in the conscious mouse-lymph fistula (per animal)

Keywords: absorption, energy balance, fistula, gastrointestinal tract, lipids, lymph

This procedure enables the study of the intestinal digestion, absorption and lymphatic transport of dietary lipid in the conscious mouse. By infusing the lipid test meal intraduadenally at a constant rate, the lymphatic lipid output usually reaches a steady rate by the 3rd or 4th hour. Thus, lymphatic lipid output during the 5th or 6th hour represents the amount of lipid transported by the small intestine under steady-state conditions. At the end of the study, both luminal as well as mucosal radioactive lipids can be collected. Thus one can obtain a considerable amount of information regarding the digestion, uptake and mucosal esterification and the lymphatic transport of lipids.

### C1052 Lipid Profiles (TG, CHOL, PL, NEFA)(per set of 38 samples)

Keywords: lipids, non-esterified fatty acid, obesity, phospholipids, total cholesterol, triglycerides

Plasma lipid profiles

**C1054 Lipoprotein fractionation by FPLC (per sample)**
Keywords: apolipoproteins, cholesterol, fatty acids, FPLC, lipids, lipoproteins, obesity

To obtain a more precise determination of lipids and apolipoproteins in the different lipoprotein fractions, the lipoproteins of plasma or lymph can be separated using Fast Protein Liquid Chromatography. This method is sometimes preferred over ultracentrifugation as the amount of blood required is much lower. The lipoproteins in each column fraction will be separated by agarose electrophoresis and stained to identify VLDL remnants, LDL, apo E-containing large HDL particles, small alpha migrating HDL and pre-beta HDL.

**C1055 Metabolism of chylomicrons (per sample)**
Keywords: apolipoproteins, chylomicron, chylomicron remnants, lipids

The intestinal lymph duct and duodenum will be surgically cannulated. Chylomicrons are harvested and sized by negative staining. A small sample will be delipidated, and the apoprotein composition will be analyzed by polyacrylamide gel electrophoresis. Labeled CM is injected into mice and the plasma clearance rate is calculated as well as a determination of the uptake by the liver.

**C1057 Free Fatty Acids (NEFA) Concentration (per set of 38 samples)**
Keywords: free fatty acids, lipids, non-esterified fatty acid, obesity, serum

Determinations of substrates (free fatty acids) in blood will be made using specific biochemical reactions that generate a specific color in proportion to their concentration. Reactions will be run in microtiter plates and analyzed on a plate reader. Using this method assays can be performed on small (5-25ul) samples of plasma or serum.

**C1058 ß-hydroxybutyrate concentration (per set of 38 samples)**
Keywords: Atkins, beta-hydroxybutyrate, diabetes, ketones, low carbohydrate, serum

Determinations of substrates (B-hydroxybutyrate) in blood will be made using specific biochemical reactions that generate a specific color in proportion to their concentration. Reactions will be run in microtiter plates and analyzed on a plate reader. Using this method assays can be performed on small (5-25ul) samples of plasma or serum.

**C1059 Non-invasive measurement of intestinal fat absorption (each)**
Keywords: energy balance, fatty acids, fecal fat absorption, lipid, lipids, obesity

Non-invasive measurement of fat absorption

**C1060 Phospholipids concentration (per set of 38 samples)**
Keywords: fatty acids, lipids, phospholipids

Chemical determination of phospholipid

**C1061 Adiponectin concentration (per set of 38 samples)**
Keywords: adipokine, adiponectin, gut hormones, hormone, insulin, insulin action, insulin resistance, peptides, serum

Serum/Plasma Adiponectin

**C1070 Glucose tolerance test GTT (intraperitoneal) (per animal)**
Keywords: carbohydrate, diabetes, glucose disposal, glucose metabolism, glucose tolerance, insulin resistance, insulin secretion, insulin sensitivity, intraperitoneal glucose tolerance

Mice will be fasted for 4 hours and anesthetized. A fasting blood sample will be removed from the tail vein and a concentrated solution of glucose injected into the abdominal cavity of the mice through a needle passed through the abdominal skin. Blood samples will be removed from the tail vein 5, 10, 15, 20, 25 and 30 minutes later. Samples of plasma obtained during the test will be measured for concentrations of glucose and insulin.

**C1071 Glucose tolerance test GTT (oral) (per animal)**
Keywords: carbohydrate, diabetes, insulin, insulin resistance, insulin sensitivity, metabolism, serum

Determinations of substrates (glucose) in blood will be made using specific biochemical reactions that generate a specific color in proportion to their concentration. Reactions will be run in microtiter plates and analyzed on a plate

reader. Using this method assays can be performed on small (5-25ul) samples of plasma or serum.

**C1072 Insulin Tolerance Test (per animal)**
Keywords: diabetes, insulin action, insulin effectiveness, insulin resistance, insulin sensitivity, metabolism

Mice will be fasted for 4 hours and anesthetized. A fasting blood sample will be removed from the tail vein and insulin (0.5mU/g) will be injected into the abdominal cavity. Blood samples will be removed from the tail vein 5, 10, 15, 20, 25 and 30 minutes later. samples of plasma obtained during the test will be measured for concentrations of glucose and insulin.

**C1081 C-peptide concentration (per set of 38 samples)**
Keywords: diabetes, hormone, insulin, insulin secretion

Plasma concentrations of C-peptide are determined using radioimmunoassay kits available from Linco Inc. (St. Louis, MO)

**C1083 Cholesterol (total) (per set of 38 samples)**
Keywords: atherosclerosis, cholesterol, lipids, metabolism, metabolite, obesity

Total cholesterol will be measured using a colorimetric assay. Reactions will be run in microtiter plates and analyzed on a plate reader. Using this method assays can be performed on small (5-25ul) samples of plasma or serum.

**C1083-CHEM Cholesterol Assay in Tissue- Chemical Method (per set of 12)**
Keywords: cholesterol, tissue

Cholesterol is measured in lipid extracted via Folch extraction from tissue. This service is completed in conjunction with C1104.

**C1083-FPLC Cholesterol Assay- FPLC Fractions (per sample)**
Keywords: cholesterol, FPLC, HDL, LDL

Cholesterol is measured in FPLC fractions to determine the concentrations of VLDL-Cholesterol, LDL-Cholesterol, and HDL-Cholesterol. This service is completed in conjunction with C1054.

**C1085 Glucagon concentration (per set of 38 samples)**
Keywords: counter-regulation, counterregulatory, hormone, lipids

Plasma concentrations of glucagon are determined using radioimmunoassay kits available from Linco Inc. (St. Louis, MO)

**C1086 GLP-1 concentration (per set of 38 samples)**
Keywords: counterregulatory, glucagon, hormone, incretin, lipids

Glucagon-like peptide 1 (GLP-1) concentrations are measured using a specific radioimmunoassay.

**C1087 Glucose concentration (per set of 38 samples)**
Keywords: carbohydrate metabolism, diabetes, isotope, tracer

Glucose enrichment and concentration

**C1088 GIP concentration (per set of 38 samples)**
Keywords: hormone, incretin, lipids, metabolism

Glucose-dependent insulinotropic polypeptide (GIP) is measured by radioimmunoassay.

**C1089 Insulin Assay (per set of 38 samples)**
Keywords: carbohydrate, diabetes, hormone

Concentrations of insulin in plasma or serum are determined using a sensitive radioimmunoassay that is specific for insulin but also reacts with proinsulin. The assay has been sensitized such that concentrations of insulin can be determined in small (10-25 ul) aliquots of serum/plasma. The assay has been used to detect insulin concentrations in other body fluids such as lymph and cerebrospinal fluid.

### C1090 Leptin concentration (per set of 38 samples)

Keywords: adipokine, diabetes, eating behaviour, feeding behavior, hormone, leptin, lipids, obesity

Plasma concentrations of leptin are determined using radioimmunoassay kits available fro Linco Inc. (St. Louis, MO)

### C1092 Triglyceride concentration (per set of 38 samples)

Keywords: lipids, metabolism, obesity

Determinations of triglycerides in plasma/serum/lymph will be made using a specific colorimetric assay. Reactions will be run in microtiter plates and analyzed on a plate reader. Using this method assays can be performed on small (5-25ul) samples of plasma or serum.

### C1092-CHEM Triglyceride Assay in Tissue- Chemical Method (per set of 12 samples)

Keywords:

Triglycerides are measured in lipid extracted via Folch extraction from tissue. This service is completed in conjunction with C1104.

### C1092-FPLC Triglyceride Assay- FPLC Fractions (per sample)

Keywords:

Triglycerides are measured in FPLC fractions to determine the concentrations of VLDL-Triglycerides, LDL-Triglycerides, and HDL-Triglycerides. This service is completed in conjunction with C1054

### C1103 Necropsy (tissue collection) (per animal/tissue)

Keywords: necropsy, organs, tissue

Animals will be anesthetized and tissues harvested as requested. These tissue will be frozen in liquid nitrogen or fixed.

### C1104 Lipid extraction via folch (per set of 12 samples)

Keywords: fatty acids, folch, lipid extraction, lipids, obesity

Lipids will be extracted from tissues using the Folch extraction method.

Folch et al., J Biol Chem 1957, 226, 497

### C1105 Fatty Acid analysis via GC (each)

Keywords: fatty acid composition, fatty acids, lipid, obesity

Samples are saponified and methylated for GC analysis. The extracted solution is injected into the GC and retention times are compared to known standards.

### C1106 Telemetry - Cardiac parameters (per 8 mice)

Keywords: blood pressure, cardiovascular, diastolic, heart rate, systolic, telemetry

Adult mice will be anesthetized and the PA-C10 telemetry device (available from Data Sciences International) will be placed SQ and anchored with suture to the abdominal muscle wall in a location that will not hinder the animal's mobility. The catheter tip will be inserted into the animal's left carotid artery and advanced so that it enters the aorta. Animals will be allowed to recover for at least seven days before the onset of testing. The PA-C10 device will measure physiological variables such as blood pressure, heart rate, pulse pressure and activity.

## Energy Metabolism, Food Intake & Body Weight Regulation Core

### C1041 Body Composition / Carcass Analysis (per animal)

Keywords: body composition, carcass analysis, food intake, lean, obesity, QMR, total body fat

Total body composition in live, un-anaesthetized small animals and carcasses will reveal absolute amounts of body fat, lean tissue and body water via quantitative magnetic resonance (QMR).

References:

Tinsley FC, Taicher GZ, Heiman ML. Evaluation of a quantitative magnetic resonance method for mouse whole body composition analysis. Obes Res. 2004 Jan;12(1):150-60.

**C1042 Energy Expenditure Measurements**
Keywords: basal metabolic rate, calorimetry, CO2 production, energy expenditure, obesity, oxygen consumption, respiratory quotient

Oxygen consumption and carbon dioxide production is measured using indirect calorimetry. The Columbus Instruments Oxymax Equal Flow System is an indirect open circuit calorimeter designed to simultaneously measure metabolic performance of multiple subjects that have similar ventilation needs. uses an open circuit calorimetry technique. This system allows sixteen animal cages to be simultaneously monitored. Variables provided by this measurement include VO2, VCO2, RQ, and HEAT.

**C1043 CLAMS- Activity Measurements (per run of 16 mice)**
Keywords: energy expenditure

This multi-channel activity monitor supports a variety of sensor lengths and configurations. Up to 32 channels are supported providing both ambulatory and total counts for each channel.

**C1044 Meal Pattern Analysis - Food Intake Procedure**
Keywords: energy balance, food intake, ingestion, meal pattern

DietMax Meal Pattern Analysis

**C1045 CLAMS- Simultaneous Energy Expenditure, Activity, and Food Intake Measurements (per run of 16 mice)**
Keywords: energy expenditure

This service incorporates multiple measurement parameters such as feeding mass/bouts, drinking volume, VO2 and VCO2, etc.

## Behavioral and Cognitive Core

**C1117 C1117 Feeding & Weighing food intake (per run of 8 mice)**
Keywords: feeding, feeding behavior

Used for obesity and diabetes studies, as well as testing various feeding paradigms (e.g., macronutrient selection, binge eating).

**C1118 C1118-Food Preference Tests (per run of 8 mice)**
Keywords: feeding, feeding behavior

Used to measure reward value, sensitivity and taste preferences

**C1119 C1119-TSE(per run of 8 mice per day in TSE apparatus)**
Keywords: Activity, feeding, feeding behavior, food intake, metabolic flux, metabolism, water intake

Automated metabolic caging system to assess food and water intake, locomotor activity, and metabolic rate (oxygen consumption and CO2 production).

**C1120 C1120-Running Wheel Cages (per run of 8 mice per day)**
Keywords: Running Capacity, running wheel

Used for obesity, metabolism, exercise and motor ability studies.

**C1121 C1121-Operant fixed ratio (per set of 8 mice)**
Keywords: cognitive function, learning

Used to measure of basic cognition/learning

**C1122 C1122-Operant progressive ratio (per set of 8 mice)**
Keywords: cognitive function, learning

Used to measure motivation to obtain food reward

**C1123 C1123-5-choice serial reaction time trial(per set of 8 mice)**
Keywords: cognitive function

Used to assess executive function (attention and impulsivity).

**C1124 C1124-Delayed discounting (per set of 8 mice)**
Keywords: cognitive function

Used to assess impulsive choice

**C1125 C1125-Social learning of food stimuli (per set of 8 mice)**
Keywords: learning

Used in social interaction tests of rewards and nutrient leaving

**C1126 C1126-Conditioned taste aversion (per set of 8 mice)**
Keywords: cognitive function, learning

Used to assess the negative effects of pharmacological agents. Often a choice test for initial preclinical testing, and a test of amygdala function.

**C1127 C1127-Conditioned place preference (per set of 8 mice)**
Keywords: cognitive function, learning, reward

Used to assess the rewarding properties of a stimulus and reward learning.

**C1128 C1128-Radial arm maze (per set of 8 mice)**
Keywords: hippocampal function, learning, non spatial, spatial, specific activity

Used to assess spatial and non spatial learning. Sensitive measure of hippocampal function. Can be used to distinguish between working (short term) and reference (long term memory).

**C1129 C1129-Morris Water maze (per set of 8 mice)**
Keywords: learning, maze, non spatial, spatial, specific activity, water, water maze

Classic test to assess spatial and non spatial learning. Sensitive Measure of hippocampal function.

**C1130 C1130-Hole-board maze (per set of 8 mice)**
Keywords: cognitive function, learning, memory

Used to assess learning, memory and stimulus discrimination.

**C1131 C1131-Novel object recognition test (per set of 8 mice)**
Keywords: hippocampal function, memory

Used to assess working memory (prefrontal cortext and hippocampal function).

**C1132 C1132-Acute stress challenge (per run of 8 mice)**
Keywords: behavior, cognitive function, energy balance, metabolism, stress

Used to assess the effects of acute stress exposure on energy balance, metabolism and behavior

**C1133 C1133-Chronic variable stress challenge (per run of 8 mice)**
Keywords: behavior, cognitive function, energy balance, metabolism, stress

Used to assess the effects of long-term exposure to stress on energy balance, metabolism, and behavior.

**C1134 C1134-Collecting post-stress plasma samples (per run of 8 mice)**
Keywords: hormone, metabolite, stress

Used to measure hormonal (e.g., ACTH, corticosterone, insulin) and metabolite (e.g., glucose, fatty acid) responses to stress.

**C1135 C1135-Active and passive avoidance (per set of 8 mice)**
Keywords: fear, learning, long term memory, memory

Measures fear learning and long-term memory

**C1136 C1136-Elevated plus maze (per run of 8 mice)**
Keywords: anxiety, behavior, stress

Used to assess anxiety-related behaviors.

**C1137 C1137-Open field test (per run of 8 mice)**
Keywords: Activity, anxiety, locomotor, stress

Used to assess anxiety-related behavior and/or general locomotor ability.

**C1138 C1138-Forced Swim test (per run of 8 mice)**
Keywords: behavior, depression, swim

Used to assess depressive-like behavior.

**C1139 C1139- Tail suspension test (per run of 8 mice)**
Keywords: behavior, depression

Used to assess depressive-like behavior

**C1140 C1140- Sucrose preference test (per run of 8 mice)**
Keywords: anhedonia, reward, taste discrimination

Used to assess taste discrimination, anhedonia (a depressive-like behavior), and reward-related phenotypes.

**C1141 Cortisol RIA (per run of 200 tubes)**
Keywords: cortisol, radioimmunoassay, RIA

CORT RIA is a radioimmunoassay that measures seric and salivary cortisol levels.

**C1142 ACTH RIA (per run of 200 tubes)**
Keywords: ACTH, adrenocorticotropic hormone, radioimmunoassay

Determine adrenocorticotropic hormone (ACTH) levels using radioimmunoassay (RIA)

**C1143 Blood Glucose (per run of 100 samples)**
Keywords: blood, glucose

Determine blood glucose levels

### C1144 Blood Ketone (per run of 100 samples)

Keywords: blood, ketones

Ketones or ketone bodies are byproducts of fat metabolism. This test measures the amount of ketones in the blood.

## UNIVERSITY OF MASSACHUSETTS MEDICAL SCHOOL

## Metabolism Core

### M1001 Hyperinsulinemic-euglycemic clamp

Keywords: awake mice, clamp, diabetes, glucose, glucose metabolism, in vivo, insulin, insulin action, insulin resistance, insulin secretion, insulin sensitivity

A survival surgery with anesthesia is performed at 4~5 days prior to the clamp to establish a chronic indwelling catheter in the right jugular vein for intravenous infusion during the clamp. On the day of experiment, a mouse fasted for overnight (14-hr; 18:00-08:00) or 5 hrs (07:00-12:00) is placed in an over-sized restrainer (i.e., rat-sized) for the experiment to be conducted in fully conscious and minimally-stressed state. The tail is tape-tethered at one end to obtain blood samples from the tail vessel during the clamp. This procedure is applied for 2 hours before the clamp (basal period) for acclimatization in this partially-restrained state and recovery from the initial handling. Intravenous catheter is connected to a microdialysis infusion pump via a 3-way connector. During the basal period, D-[3-3H]glucose is infused at 0.05 ?Ci/min to assess basal glucose turnover. A blood sample (40 ?l) is collected at the end for the basal measurement of plasma glucose, insulin, and [3H]glucose concentrations.

Following the basal period, a 2-hr hyperinsulinemic-euglycemic clamp begins with a primed (150 mU per kg body weight) and continuous infusion of human insulin at a rate of 15 pmol/kg/min to raise plasma insulin within a physiological range (~300 pM). Blood samples (10 ?l) are collected at 10~20 min intervals for the immediate measurement of plasma glucose using glucose analyzer, and 20% dextrose is infused at variable rates to maintain basal glucose levels (~7 mM). Insulin-stimulated whole body glucose turnover rate is measured with a continuous infusion of [3H]glucose throughout the clamp (0.1 ?Ci/min).

To estimate glucose uptake in individual organs, 2-[1-14C]deoxy-D-glucose (2-[14C]DG) is administered as a bolus (10 ?Ci) at 75 min after the start of clamp. Blood samples (20 ?l) are taken at 80, 85, 90, 100, 110, and 120 min of clamp for the measurement of plasma [3H]glucose, 3H2O, and 2-[14C]DG concentrations. Additional blood sample (20 ?l) is taken at 120 min to measure clamp plasma insulin levels. At the end of clamp, the mouse is anesthetized using sodium pentobarbital, and tissue samples (gastrocnemius and quadriceps from both hindlimbs, epididymal white adipose tissue, interscapular brown adipose tissue, liver, and heart) are taken for biochemical analyses. Serum and tissue samples may be transferred to the Analytical Core for analytical measurements (e.g., insulin, adipokines).

The hyperinsulinemic-euglycemic clamp is a “gold-standard” method of measuring insulin sensitivity and generates the following metabolic data:

- Insulin-stimulated whole body glucose turnover, glycolysis, and glycogen synthesis

- Basal and insulin-stimulated rates of hepatic glucose production

- Insulin-stimulated glucose uptake, glycogen synthesis, and glycolysis in individual organs

Further details of the clamp experiment and calculation of clamp-derived parameters can be found in the following references: Diabetes 53:1060-1067 (2004), Stocker (ed.), Type 2 Diabetes, Methods in Molecular Biology, Vol. 560:221-238 (2009)

### M1002 Basal glucose metabolism

Keywords: carbohydrate, clamp, diabetes, flux, glucose turnover, glucose uptake, insulin resistance, kinetics

Following overnight fast or in fed state (5 hours after food removal), basal glucose metabolism is assessed using an intravenous infusion of [3-3H]glucose (0.05 ?Ci/min) for 2 hours in conscious mice. Blood samples are taken at 110 and 120 min for the measurement of plasma glucose and [3H]glucose concentrations. During basal state, whole body glucose turnover is estimated to be the basal rate of hepatic glucose production.

### M1003 Organ-specific glucose uptake

Keywords: carbohydrate, diabetes, glucose uptake, insulin, insulin resistance, insulin sensitivity

Following overnight fast or in fed state (5 hours after food removal), basal glucose uptake in individual organs is determined using a bolus intravenous injection of 2-[1-14C]deoxy-D-glucose (2-[14C]DG; 20 uCi) in conscious mice and collecting tissues after 30 min to measure intracellular 2-[14C]DG-6-P concentrations using ion-exchange columns.

### M1004 Hyperglycemic clamp

Keywords: awake mice, clamp, diabetes, glucose, in vivo, insulin, insulin resistance, insulin secretion

A survival surgery with anesthesia is performed at 4~5 days prior to the clamp to establish a chronic indwelling catheter in the right jugular vein for intravenous infusion during the clamp. On the day of experiment, a mouse fasted for overnight (14-hr; 18:00-08:00) or 5 hrs (07:00-12:00) is placed in an over-sized restrainer (i.e., rat-sized) for the experiment to be conducted in fully conscious and minimally-stressed state. The tail is tape-tethered at one end to obtain blood samples from the tail vessel during the clamp. Intravenous catheter is connected to a microdialysis infusion pump, and a blood sample (20 ?l) is collected to measure basal glucose and insulin concentrations.

A 2-hr hyperglycemic clamp begins with a variable infusion of 20% dextrose to raise and maintain plasma glucose concentration at ~300 mg/dl. Blood samples (20 ?l) are collected at 0, 10, 20, 30, 45, 60, 80, 100, and 120 min to measure plasma glucose and insulin concentrations using glucose analyzer and Luminex, respectively. At the end of clamp, the mouse may be anesthetized, and pancreas may be collected for islet isolation and histology/molecular analyses by the Analytical Core.

The area-under-curve of plasma insulin levels indicates glucose-induced insulin secretion or in vivo pancreatic ?-cell function. In addition to insulin, c-peptide levels may be measured using additional blood samples for direct assessment of glucose-induced insulin secretion in mouse models potentially affected by altered hepatic insulin clearance.

### M1005 Insulin clearance

Keywords: carbohydrate, diabetes, hormone, insulin

Hepatic insulin clearance is assessed in conscious mice by administering an intraperitoneal bolus injection of human insulin (1 U/kg of body weight) and collecting blood samples at 5, 10, 15, 20, 30, 45, and 60 min for the measurement of plasma insulin levels.

### M1006 Glucose tolerance test

Keywords: carbohydrate, diabetes, glucose clearance, glucose tolerance, insulin resistance, insulin sensitivity

Intraperitoneal (IP) or intravenous (IV) glucose tolerance tests (GTTs) are performed in conscious mice following overnight fast (~14 hours). Glucose is administered as a bolus at 1 or 2 g/kg body weight, and blood samples (20 ?l) are taken from tail vessels at 0, 10, 20, 30, 60, 90, and 120 min following a glucose bolus. Plasma glucose concentrations are determined using a glucose analyzer, and glucose clearance or area-under-curve of GTT reflects insulin sensitivity, assuming normal pancreatic ?-cell function.

### M1007 Glucose tolerance test with insulin secretion

Keywords: carbohydrate, diabetes, glucose tolerance, insulin, insulin resistance, insulin sensitivity

During IP or IV GTTs, additional blood samples (20~40 ul) are taken to measure plasma insulin and/or C-peptide levels using Luminex. Insulin or C-peptide levels in response to a bolus glucose load reflect pancreatic beta-cell function.

### M1008 Insulin tolerance test

Keywords: glucose, insulin effectiveness, insulin resistance, insulin sensitivity

Intraperitoneal (IP) or intravenous (IV) insulin tolerance tests (ITTs) are performed in conscious mice at fed state (at least 5 hours after food removal). Insulin is administered as a bolus at 0.25 or 0.5 U/kg body weight, and blood samples (20 ul) are taken from tail vessels at 0, 10, 20, 30, 60, 90, and 120 min following a glucose bolus. Plasma glucose concentrations are determined using a glucose analyzer, and glucose

### M1009 Hepatic gluconeogenesis

Keywords: carbohydrate, diabetes, glucose, glucose production, insulin, insulin resistance, liver, liver function, liver function enzymes, pyruvate tolerance test

Pyruvate tolerance test indirectly measures hepatic gluconeogenesis in conscious mice following overnight fast (~14 hours). Pyruvate is intraperitoneally administered as a bolus at 1 g/kg body weight, and blood samples (20 ul) are

taken from tail vessels at 0, 15, 30, 45, 60, 90, and 120 min following a pyruvate bolus. Plasma glucose concentrations are determined using a glucose analyzer, and glucose derived from pyruvate reflects hepatic gluconeogenesis.

### M1010 Lipid metabolism

Keywords: fatty acids, in vivo, lipids, obesity, palmitate, triglycerides

Lipid metabolism is measured in conscious mice using labeled palmitate or glucose incorporation into tissue-specific triglyceride. The experiment begins with an intravenous bolus injection of [14C]palmitate (20 uCi), and blood samples (20 ul) are collected at 0, 0.5, 1, 2, 3, 4, and 5 min following a bolus injection. At the end of experiment, mice are euthanized, and tissue samples are rapidly taken for biochemical assays to measure [14C]palmitate incorporation into [14C]-labeled triglyceride in individual organs. Plasma [14C]palmitate concentrations are measured using liquid scintillation counter to assess systemic clearance of [14C]palmitate.

Alternatively, [3-3H]glucose (20 uCi) is intraperitoneally administered as a bolus, and mice are euthanized after 1 hour for tissue collection. Biochemical assays are performed to measure [3-3H]glucose incorporation into [3H]-labeled triglyceride in individual organs.

### M1011 Protein metabolism

Keywords: amino acid, amino acids, in vivo protein turnover, phenylalanine, protein, protein synthesis

Protein metabolism is assessed using the flooding-dose method previously described by Dr. Thomas C. Vary (Am. J. Physiol. 262:C445-452, 1992; Am. J. Physiol. 262:C1513-1519, 1992). The experiment begins with an intraperitoneal bolus injection of [3H]-L-phenylalanine (0.2 uCi/ml/umol, 30uCi/100 g/body weight; 1 ml/100 g/body weight) in conscious mice. After 15 min, mice are euthanized, and blood and tissue samples are rapidly taken for biochemical analyses. Blood samples are used to measure plasma phenylalanine and [3H]-L-phenylalanine concentrations. The phenylalanine levels are measured by HPLC analysis of supernatants from trichloroacetic acid extracts of plasma samples. The assumption in using this technique to estimate the rate of protein synthesis in vivo is that the tissue phenylalanine concentration is elevated to a high level thereby limiting any dilution effect of non-radioactive phenylalanine derived from proteolysis on the intracellular specific radioactivity. Under the condition of elevated plasma phenylalanine level (~1.2 mM), the specific radioactivity of the plasma phenylalanine is assumed to be equal to the specific radioactivity of the tRNA-bound phenylalanine.

### M1012 Body composition (whole body)

Keywords: 1H-MRS, body composition, fat mass, in vivo, lean muscle mass, obesity, whole animal

Whole body composition of fat/lean/water mass is non-invasively measured in conscious mice using 1H-MRS developed by Echo Medical Systems (EchoMRI 3-in-1). This instrument has an important advantage over commonly used mouse densitometer (PIXImus), which applies dual energy x-ray technology for analysis of body composition in anesthetized mice. In contrast, 1H-MRS can be applied in studies requiring multiple measurement in individual mice, such as chronic changes in adiposity in response to a high-fat diet, without the risk of anesthesia-associated complications.

### M1013 Body composition (organs)

Keywords: 1H-MRS, body composition, fat mass, in vivo, lean muscle mass, obesity

Organ-specific composition of fat/lean/water mass is non-invasively measured in conscious mice using 1H-MRS developed by Echo Medical Systems (EchoMRI 3-in-1).

### M1014 Energy balance – food intake, energy expenditure, physical activity

Keywords: basal metabolic rate, CO2 production, energy expenditure, food intake, in vivo, indirect calorimetry, metabolism, noninvasive, obesity, oxygen consumption, physical activity, respiratory exchange ratio, respiratory quotient, VCO2 production, VO2 consumption, water intake

Metabolic cages (TSE Systems) are used to perform indirect calorimetry and simultaneously measure food/water intake, energy expenditure, and physical activity in conscious mice. The experiment non-invasively measures VO2 consumption and VCO2 production in individual mice using metabolic chambers and calculates the respiratory exchange ratio (RER) to reflect energy expenditure. RER values close to 1.0 reflects carbohydrate utilization, and RER values close to 0.7 reflects lipid utilization. The metabolic cages are also used for the quantitative measurement of horizontal and vertical movement (XYZ-axis) as an index of physical activity and food/water intake over a given period of time (typically 3 days). TSE metabolic cages provide natural food intake setting with cage-lid location of food, and mice tend to quickly acclimate to the TSE metabolic cages with natural cage setting during the 3-day measurements.

### M1015 Chronic high-fat feeding

Keywords: animal model, diet-induced obesity, food intake, high-fat diet, insulin, insulin action, insulin resistance, mouse husbandry and transfer, obesity, type 2 diabetes

An experimental mouse model of obesity can be generated by feeding a high-fat diet (HFD) ad libitum for select duration. Quality control studies indicate that a short-term (3-4 weeks) of HFD feeding increases whole body fat mass by more than 2-fold and causes insulin resistance in male C57BL/6 mice. Most of the mice fed short-term HFD develop compensatory hyperinsulinemia but do not develop hyperglycemia. Chronic HFD feeding of longer term (2-6 months) further increases obesity and exacerbates insulin resistance in skeletal muscle, liver, adipose tissue, and heart. Most of the mice fed chronic HFD develop hyperglycemia, a hallmark of type 2 diabetes. The Metabolism Core works with the users in designing a study with appropriate feeding duration and selection of HFD with respect to percent and composition of fat in the diet.

### M1016 Chronic drug delivery

Keywords: Drug, drug treatment, infusion, mouse husbandry and transfer, osmotic pump, surgery

Alzet mini-osmotic pump (Alza) is subcutaneously implanted for chronic delivery of drugs. For this procedure, mice are anesthetized with ketamine/xylazine, and osmotic pumps containing drug or placebo are subcutaneously inserted to the mice prior to the metabolic experiments. Alternatively, drug or placebo may be administered using subcutaneous injection or oral gavage.

### M1017 STZ-induced type 1 diabetes model

Keywords: Drug, hyperglycemia, insulin, insulinopenia, streptozotocin, type 1 diabetes

An experimental mouse model of hyperglycemia and type 1 diabetes can be generated by intraperitoneal injection of streptozotocin (STZ; 50 mg/kg daily for 5 days), which selectively destroys the pancreatic beta-cells with rapid and irreversible necrosis. STZ-injected mice develop hypoinsulinemia within several days and thereby, hyperglycemia. Following STZ injection, blood glucose levels are monitored for the onset and maintenance of hyperglycemia. For selected mouse models, other STZ doses may be required to maintain chronic hyperglycemia. With onset of hyperglycemia and significant urinary loss of glucose, mice are closely monitored for proper hydration with adequate water supply and frequent change of cage bedding.

### M1018 Acute lipid infusion

Keywords: animal model, fatty acids, FFA, insulin, insulin action, insulin resistance, lipids, obesity

An experimental model of acute hyperlipidemia can be generated by an intravenous infusion of lipid emulsion at a rate of 2.5 ml/kg body weight/hour and heparin (6 U/hour). A 2-hour hyperinsulinemic-euglycemic clamp experiment may follow acute lipid infusion to measure insulin sensitivity in conscious mice exposed to acute hyperlipidemia. Quality control studies indicate that an acute lipid infusion for 5 hours increases serum fatty acids levels to 3~4 mM and causes insulin resistance in skeletal muscle. Lipid emulsion may be infused at different rates to raise serum fatty acids to different levels. This study allows users to investigate acute and direct effects of fatty acids without altering obesity or adipokines that may affect glucose metabolism.

### M1019 Chronic/acute phloridzin treatment

Keywords: diabetes, Drug, glucose clearance, glycemia, insulin, insulin action, renal

Acute hypoglycemia in normal mice or acute/chronic glucose reduction in hyperglycemic mice may be achieved by acute or chronic treatment of phloridzin (PHZ; 100 ug/kg body weight/min for acute treatment, 0.4 mg/kg body weight twice daily for chronic treatment). This procedure can be used prior to in vivo experiments.

### M1020 Exercise study using cage running wheels

Keywords: Activity, Cage Activity, exercise

Cage wheels, designed to fit into the home cages, are used to induce exercise in mice. This procedure can be used prior to in vivo experiments to examine exercise-mediated metabolic effects and metabolic phenotypes secondary to exercise-induced weight loss.

### M1021 Surgery – jugular vein cannulation

Keywords: catheterization, clamp, intravenous, surgery, vein

At 4-5 days prior to metabolic experiments requiring intravenous infusion, a survival surgery is performed to place an

indwelling intravenous catheter in anesthetized mice. Experiments are performed 4-5 days after the surgery in order for the mice to fully recuperate from surgery/anesthesia stress, which is measured by a regain of body weight to pre-operative level.

Mice are anesthetized with an intraperitoneal injection of ketamine (100 mg/kg body weight) and xylazine (10 mg/kg body weight). A transverse incision (~0.5 cm) is made over the trachea, and the right jugular vein is isolated. A silastic catheter (PE 10) is inserted into the vessel. The catheter is filled with a saline solution containing heparin (10 U/ml) and plugged. The catheter is then tunneled to the back of the neck, and placed under the back skin to prevent its accessibility from the mouse. A silk is tied to the catheter, and a small opening is made at the back of neck. This silk, which is partially exposed, is used on the day of metabolic experiment to expose and connect the catheter. The catheter requires no other care until the experiment day when it is flushed with a heparinised saline solution to reopen. This surgery requires ~15 minutes to complete. All surgical procedures are performed using standardized aseptic techniques, and all surgical tools are autoclaved following the surgery.

In order to prevent hypothermia, a heating pad is used during the surgery, while a heating lamp and/or heating pad is used during the post-operative recovery period. After surgery, the mice are monitored closely in a post-operative cage with gauze bedding. Mice are monitored until they are awake and about which is usually within 1-2 hours. Mice are then housed in individual cages and monitored for post-operative recovery and weight gain on a daily basis for 48 hours for evidence of catheter infection.

### M1022 Surgery – tail vein injection

Keywords: AAV delivery, intravenous, mouse husbandry and transfer, surgery, vein

Intravenous injection via tail vein is used for acute delivery of drugs, hormones, and adeno-associated virus.

### M1023 Surgery – carotid artery cannulation

Keywords: artery, blood sampling, catheterization, surgery

Carotid artery is cannulated and indwelling cathether is placed in order to obtain rapid blood samples from mice during select experiments.

### M1024 Exercise study using treadmill

Keywords: endurance, energy expenditure, energy metabolism, exercise, exercise stress test, exertion

Exercise phenotyping in awake mice is conducted using multi-lane treadmills with variable speeds for characterizing endurance exercise (varied intensity), chronic endurance exercise, exhaustive exercise, and acute exercise.

### M1025 Drug trial study for PK/PD analysis

Keywords: chronic, Drug, drug treatment, drug trial, pharmacodynamics, pharmacokinetics

Drug trial study can be customized with chronic or acute administration of compounds (blinded) and blood/tissue sampling at specified intervals for Pharmocokinetic (PK)/Pharmocodynamic (PD) analysis.

### M1026 Drug trial study for therapeutic efficacy on obesity

Keywords: Drug, drug infusion, drug treatment, drug trial, energy balance, energy expenditure, obese, obesity

Drug trial study can be customized with chronic or acute administration of compounds (blinded) and outcome parameters on obesity and energy balance

### M1027 Drug trial study for therapeutic efficacy on insulin resistance

Keywords: Drug, drug infusion, drug treatment, drug trial, glucose homeostasis, glucose kinetics, glucose metabolism, glucose uptake, insulin action, insulin sensitivity

Drug trial study can be customized with chronic or acute administration of compounds (blinded) and outcome parameters on insulin sensitivity and glucose metabolism

### M1028 Drug trial study for therapeutic efficacy on metabolic profile

Keywords: Drug, drug infusion, drug treatment, drug trial, glucose, lipid, liver, serum, serum metabolic panel

Drug trial study can be customized with chronic or acute administration of compounds (blinded) and outcome parameters on serum glucose/lipid profile and markers of NAFLD/NASH

**M1029 Drug trial study for therapeutic efficacy on diabetic complications**
Keywords: cardiovascular disease, complications, diabetes, Drug, drug infusion, drug treatment, drug trial, insulin secretion, islets, pancreas

Drug trial study can be customized with chronic or acute administration of compounds (blinded) and outcome parameters on pancreatic islets, insulin secretion, and diabetic cardiovascular complications

**M1030 Drug trial study for toxicity**
Keywords: Drug, drug infusion, drug treatment, drug trial, liver function, liver function enzymes, toxicity

Drug trial study can be customized with chronic or acute administration of compounds (blinded) and outcome parameters on toxicity (e.g., liver function panels)

**M1031 Temperature (rectal measurement)**
Keywords: Temperature

Measurement of rectal temperature in mice.

**M1032 Body Weight**
Keywords: body weight, obesity

Measurement of body weights using a balance weight.

**M1033 Surgery – Ovariectomy**
Keywords: surgery

Ovariectomy is a surgical procedure to remove ovaries in female mice, and this procedure is often used to study the effects of estrogen deficiency in rodents.

Ovary, estrogen, female hormones

**M1034 Fecal Sample Collection for Intestinal Flora Analysis**
Keywords: fecal matter, feces, microbiome

For microbiome analysis, mouse fecal sample will be collected the first fecal pellet per animal into sterile eppendorf tube. Eppendorf tube containing fecal pellets in -80°C freezer.

**M1035 Energy Balance at Thermoneutrality**
Keywords: energy expenditure, food intake, physical activity, thermoneutrality

In themoneutrality condition (at 27-30degree), metabolic cage (TSE systems) are used to perform indirect calorimetry and simultaneously measure food/water intake, energy expenditure, and physical activity in conscious mice.

**M1036 Energy Balance at Cold Temperature**
Keywords: cold challenge, energy expenditure, food intake, physical activity

In Cold temperature condition (at 4 degree), metabolic cage (TSE systems) are used to perform indirect calorimetry and simultaneously measure food/water intake, energy expenditure, and physical activity in conscious mice.

**M1041 Paired Feeding Regimen Analysis**
Keywords: feeding, feeding behavior

Study to measure amount of diet required for 'Paired Feeding Study' (See Catalog # M1042)

**M1042 Paired Feeding Study**
Keywords: feeding, feeding behavior

Study to match diet intake between different groups of mice (May require 'Paired Feeding Regimen Analysis' - See Catalog # M1041)

**M1043 Drug Treatment**
Keywords: Drug, drug treatment, drug trial

Administration of drug or compound via oral gavage (per os), intraperitoneal (i.p.), or intravenous (i.v.) for acute or chronic delivery at targeted dosage

**M1044 Drug Preparation**
Keywords: Drug, drug treatment, drug trial

Preparation of drug or compound based on specified instructions

**M1045 Tail Vein Blood Sampling**
Keywords: blood, blood sampling, plasma, serum, serum samples

Sampling via tail for blood, serum, or plasma collection

**M1046 Tissue collection**
Keywords: isolation, tissue, tissue preparation, tissues

Removal of tissues for subsequent analysis (chosen by investigator)

**M1047 Glucose Flux Measurement Using Stable Isotope**
Keywords: flux, glucose, glucose flux, isotope

Intravenous Infusion of U-13C Glucose for 2 hours with blood sampling at 0,15,30,60,120 minutes followed by tissue harvest.

**M1048 Energy Balance at Altered Light/Dark Cycle**
Keywords: energy balance

Under altered light/dark cycle conditions, metabolic cages (TSE systems) are used to perform indirect calorimetry and simultaneously measure food/water intake, energy expenditure, and physical activity in conscious mice.

**M1049 Glucose Uptake and Lipid Metabolism in additional organs**
Keywords: glucose, glucose uptake, lipid

Assess glucose and/or lipid uptake in individual organs

**M1050 Consultation - Study Design, Methodologies, Analysis, & Interpretation**
Keywords: consultation

Consultation on Study Design, Experimental Methods, and Data Analysis & Interpretation

**M1051 Diet-induced mouse model of Non-Alcoholic Fatty Liver (NAFL)**
Keywords: mouse models

Mouse models of non-alcoholic fatty liver (NAFL) by chronic feeding of custom diets that are high in fat and/or carbohydrates

**M1052 Diet-induced mouse model of Non-Alcoholic Steatohepatitis (NASH)**
Keywords: mouse models

Mouse models of non-alcoholic steatohepatitis (NASH) by chronic feeding of custom NASH diets that are high in fat and/or carbohydrates with selective amino acid deficiency.

**M1053 3D-Imaging for In Vivo Assessment of NAFL and NASH**
Keywords: fatty liver, fibrosis, liver, mouse models

Noninvasive measurement of fatty liver and fibrosis in mouse models of non-alcoholic fatty liver disease (NAFLD) using Sonovol Vega automated wide-field ultrasound system.

### M1054 3D-Imaging for In Vivo Assessment of Kidney Morphology & Volume

Keywords: kidney, morphology

Noninvasive measurement of kidney morphology and total kidney volume (TKV) in mouse models of polycystic kidney disease (PKD) using Sonovol Vega automated wide-field ultrasound system.

### M1055 3D-Imaging for In Vivo Assessment of Tumor

Keywords: tumor

Noninvasive analysis of tumor and volumetric tumor measurements in orthotopic and subcutaneous tumor models and cancer mouse models using Sonovol Vega automated wide-field ultrasound system.

### M1056 Hyperglucagonemic clamp

Keywords: clamp

A survival surgery with anesthesia is performed at 4~5 days prior to the clamp to establish a chronic indwelling catheter in the right jugular vein for intravenous infusion during the clamp. On the day of experiment, a mouse fasted overnight (14-hr; 18:00-08:00) is placed in an over-sized restrainer (i.e., rat-sized) for the experiment to be conducted in fully conscious and minimally-stressed state. The tail is tape-tethered at one end to obtain blood samples from the tail vessel during the clamp. This procedure is applied for 1 hour before the clamp (basal period) for acclimatization in this partially-restrained state and recovery from the initial handling. An intravenous catheter is connected to a microdialysis infusion pump and during the basal period, phloridzin (80ug/kg/min), is infused to promote glucose excretion. A blood sample (40 ul) is collected at the end for the basal measurement of plasma glucose. A 2-hour glucagon clamp follows the basal period with IV infusion of glucagon (10ng/kg/min) combined with phloridzin (80ug/kg/min) and [3-H]glucose used to calculate hepatic glucose production. Blood samples (10 ul) are collected at 10~20 min intervals for the immediate measurement of plasma glucose using glucose analyzer, and 20% dextrose is infused at variable rates to maintain basal glucose levels (~7 mM). To estimate glucose uptake in individual organs, 2-[1-14C]deoxy-D-glucose (2-[14C]DG) is administered as a bolus (10 uCi) at 75 min after the start of clamp. Blood samples (20 ul) are taken at 80, 85, 90, 100, 110, and 120 min of clamp for the measurement of plasma [3H]glucose, 3 and 2-[14C]DG concentrations. Additional blood sample (20 ml) is taken at 120 min to measure clamp plasma glucagon and other analytes (e.g. insulin, FFA). At the end of clamp, the mouse is anesthetized using sodium pentobarbital, and tissue samples (gastrocnemius and quadriceps from both hindlimbs, epididymal white adipose tissue, interscapular brown adipose tissue, liver, and heart) are taken for biochemical analyses. Serum and tissue samples may be transferred to the Analytical Core for analytical measurements. Adapted from Berglund et. al., 2009. J. Clin. Invest. 119(8):2412.

## Analytical Core

### M2001 Glucose

Keywords: carbohydrate, diabetes, glucose, hyperglycemia, hypoglycemia, insulin resistance, metabolite

Plasma glucose concentrations are determined for a variety of metabolic experiments (e.g., hyperinsulinemic-euglycemic clamp, hyperglycemic clamp, GTT, ITT) performed by the Metabolism Core and for stand-alone measurements as a marker of perturbed glucose homeostasis in mice. Plasma glucose concentrations are measured by the glucose oxidase method using Analox GM7 Micro-stat Rapid Multi-assay Analyzer (Analox Instruments, Holliston, MA). This instrument requires 5 ul of plasma for rapid (~5 seconds) and accurate measure of glucose concentrations, which is important for select metabolic experiments such as hyperinsulinemic-euglycemic clamp and hyperglycemic clamp.

Alternatively, blood glucose concentrations are measured using a glucometer for those metabolic experiments (e.g., GTT, ITT) that may be repeated in individual mouse.

Plasma and tissue concentrations of labeled-glucose ([3H]glucose and 2-[14C]deoxyglucose) are measured using liquid scintillation counter (Beckman-Coulter).

### M2002 Hemoglobin A1c

Keywords: diabetes, glucose, hyperglycemia, insulin, insulin action, metabolite

Hemoglobin A1c levels rise in response to chronic hyperglycemia and can be measured using Cobas Clinical Chemistry

Analyzer (Roche).

**M2003 Lactate**
Keywords: acidosis, carbohydrate, diabetes, glucose, insulin, insulin action, metabolite

Lactate levels are altered in metabolic syndrome and can be measured using Cobas Clinical Chemistry Analyzer (Roche).

**M2004 Insulin**
Keywords: carbohydrate, diabetes, hormone, hyperinsulinemic clamp, insulin

Insulin is a critical metabolic hormone synthesized by pancreatic beta-cells to regulate glucose homeostasis. Plasma insulin concentrations are determined for a variety of metabolic experiments (e.g., hyperinsulinemic-euglycemic clamp, hyperglycemic clamp) performed by the Metabolism Core and for stand-alone measurements as a marker of insulin resistance in mice. Plasma insulin concentrations are measured using Bio-Plex 200 Luminex System, which requires 5~25 ul of plasma samples for multiplex, high-throughput, and accurate determination of insulin.

Alternatively, plasma insulin concentrations are determined by ELISA using ultra-sensitive or sensitive antibody kits.

**M2005 C-peptide**
Keywords: hormone, insulin, insulin secretion, islet function

C-peptide is synthesized by pancreatic beta-cells when proinsulin is cleaved to form an active insulin and C-peptide. Since a large fraction of insulin secreted by pancreatic beta-cells is cleared and metabolized by liver, systemic levels of insulin may not accurately reflect insulin secretion by beta-cells. For direct assessment of islet insulin secretion, plasma C-peptide concentrations are measured using Bio-Plex 200 Luminex System.

**M2006 Glucagon**
Keywords: counter-regulation, gluconeogenesis, glucose, glucose production, hepatic, hormone, lipids

Glucagon is a key hormone synthesized by pancreatic alpha-cells to regulate hepatic glucose production and glucose homeostasis in post-absorptive state. Glucagon further regulates insulin secretion via paracrine effects. Plasma glucagon concentrations are measured using Bio-Plex 200 Luminex System

**M2007 Leptin**
Keywords: adipokine, diabetes, feeding behavior, food intake, hormone, leptin, obesity

Leptin is an adipocyte-derived hormone that plays an important role in regulating feeding behavior. Since alterations in food intake affect energy balance, leptin levels are important factors in obesity. Plasma leptin concentrations are measured using Bio-Plex 200 Luminex System.

**M2008 Adiponectin**
Keywords: adipokine, hormone, insulin resistance, lipids

Adiponectin is an adipocyte-derived hormone that affects multiple systems in our body including metabolism, vascular biology, and inflammation. Plasma adiponectin concentrations are measured using Bio-Plex 200 Luminex System.

**M2009 Resistin**
Keywords: adipokine, glucose metabolism, hormone, insulin resistance

Resistin is an adipocyte-derived hormone that affects insulin action and hepatic glucose metabolism. Plasma resistin concentrations are measured using Bio-Plex 200 Luminex System.

**M2010 Triglyceride**
Keywords: cardiovascular disease, insulin, insulin resistance, lipids, metabolite, obesity, serum, serum chemicals, tissue

Serum triglyceride levels are elevated in obesity and type 2 diabetes. Tissue triglyceride levels are also associated with insulin resistance. Plasma and tissue triglyceride concentrations are determined using chloroform-methanol lipid extraction assay and Cobas Clinical Chemistry Analyzer (Roche).

### M2011 Non-esterified fatty acids
Keywords: insulin, insulin resistance, lipids, metabolite, obesity

Serum fatty acids levels are elevated in obesity and type 2 diabetes. Fatty acids and their metabolites are shown affect insulin action, glucose metabolism, and oxidative stress. Plasma fatty acids concentrations are measured using Cobas Clinical Chemistry Analyzer (Roche).

### M2012 Cholesterol (total)
Keywords: atherosclerosis, cardiovascular disease, lipids, metabolite, obesity

Alterations in cholesterol metabolism and circulating cholesterol levels are known to affect cardiovascular system and diabetic complications. Plasma total cholesterol levels are measured using Cobas Clinical Chemistry Analyzer (Roche).

### M2013 Cholesterol (HDL)
Keywords: atherosclerosis, cardiovascular disease, lipids, liver, liver function, liver function enzymes, metabolite, obesity

Alterations in cholesterol metabolism and circulating HDL-cholesterol levels are known to affect cardiovascular system and diabetic complications. Plasma HDL-cholesterol levels are measured using Cobas Clinical Chemistry Analyzer (Roche).

### M2014 Cholesterol (LDL)
Keywords: atherosclerosis, cardiovascular disease, lipids, metabolite, obesity

Alterations in cholesterol metabolism and circulating LDL-cholesterol levels are known to affect cardiovascular system and diabetic complications. Plasma LDL-cholesterol levels are measured using Cobas Clinical Chemistry Analyzer (Roche).

### M2015 Ammonia
Keywords: lipids, metabolite, nitrogen, serum chemicals

Plasma ammonia levels are measured using Cobas Clinical Chemistry Analyzer (Roche).

### M2016 Lipase
Keywords: lipids, metabolite, obesity

Lipase is an important enzyme that hydrolyzes circulating triglyceride and breaks down triglyceride into free fatty acids and glycerol. Plasma lipase levels are measured using Cobas Clinical Chemistry Analyzer (Roche).

### M2017 Amylase
Keywords: carbohydrate, enzyme activity, GI function

Amylase is an important enzyme that breaks down complex carbohydrates into glucose molecules. Plasma amylase levels are measured using Cobas Clinical Chemistry Analyzer (Roche).

### M2018 Creatine kinase
Keywords: cardiovascular, enzyme activity, lesion

Plasma creatine kinase levels are measured using Cobas Clinical Chemistry Analyzer (Roche).

### M2019 Alkaline phosphatase
Keywords: enzyme activity, serum chemicals

Plasma ALP levels are measured using Cobas Clinical Chemistry Analyzer (Roche).

### M2020 Lactate dehydrogenase
Keywords: enzyme activity, tissue damage

Plasma LDH (lactate dehydrogenase) levels are measured using Cobas Clinical Chemistry Analyzer (Roche).

**M2021 Albumin**
Keywords: liver, liver function, liver function enzymes, metabolite, protein, serum albumin, serum chemicals

Albumin is a major circulating protein, and altered albumin levels reflect liver dysfunction. Plasma albumin levels are measured using Cobas Clinical Chemistry Analyzer (Roche).

**M2022 Alanine transferase**
Keywords: ALT, liver, liver function, liver function enzymes, metabolite, serum chemicals

ALT (alanine transferase) is a major liver enzyme that regulates amino acid flux into hepatic gluconeogenesis. Thereby, serum ALT levels reflect liver function. Plasma ALT levels are measured using Cobas Clinical Chemistry Analyzer (Roche).

**M2023 Aspartate transferase**
Keywords: liver, liver function, liver function enzymes, metabolite, serum chemicals

AST (aspartate transferase) is a major liver enzyme that regulates amino acid flux into hepatic gluconeogenesis. Thereby, serum AST levels reflect liver function. Plasma ALT levels are measured using Cobas Clinical Chemistry Analyzer (Roche).

**M2024 Bilirubin**
Keywords: liver, liver function, liver function enzymes, metabolite

Bilirubin is primarily synthesized by liver as a component of liver bile that plays an important role in intestinal digestion and absorption of lipid. Plasma bilirubin levels are measured using Cobas Clinical Chemistry Analyzer (Roche).

**M2025 Gamma-glutamyl Transferase**
Keywords: liver, liver function, liver function enzymes, metabolite, serum chemicals

GGT is a major liver enzyme that reflects liver function. Plasma GGT levels are measured using Cobas Clinical Chemistry Analyzer (Roche).

**M2026 Creatinine**
Keywords: cardiovascular, creatinine, kidney, kidney disease, lesion, metabolite

Creatinine is a product of muscle breakdown and is cleared by the renal system. Thereby, serum creatinine levels reflect protein metabolism and renal function. Plasma creatinine levels are measured using Cobas Clinical Chemistry Analyzer (Roche).

**M2027 C-reactive peptide**
Keywords: CRP, inflammation, liver, liver function, liver function enzymes, metabolite, obesity, serum chemicals

CRP (c-reactive peptide) is primarily produced by liver in response to IL-6 stimulation of hepatocytes, and serum CRP levels reflect systemic inflammatory state. Plasma CRP levels are measured using Cobas Clinical Chemistry Analyzer (Roche).

**M2028 Total protein**
Keywords: metabolite

Serum total protein levels are measured using Cobas Clinical Chemistry Analyzer (Roche).

**M2029 Urea/BUN**
Keywords: kidney, kidney disease, metabolite, renal

Circulating and urine levels of urea/BUN reflect renal function. Urea/BUN levels are measured using Cobas Clinical Chemistry Analyzer (Roche).

**M2030 Uric acid**

Keywords: kidney, kidney disease, metabolite, renal

Serum and urine levels of uric acid are measured using Cobas Clinical Chemistry Analyzer (Roche).

### M2031 Electrolytes

Keywords: electrolyte panel, electrolytes, metabolism, pH, potassium, renal function, serum chemicals, serum metabolic panel, sodium

Serum levels of bicarbonate, calcium, iron, magnesium, phosphorus, potassium, and sodium are measured using Cobas Clinical Chemistry Analyzer (Roche).

### M2032 Cytokines Panel I - multiplex

Keywords: chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin action, insulin resistance, monokines, obesity, serum samples, tissue lysates

Chronic and local inflammation is characterized by obesity and type 2 diabetes. Increased levels of cytokines and chemokines are known to affect insulin resistance and diabetic complications. Plasma and tissue lysate concentrations of IL-1, IL-2, IL-3, IL-4, IL-5, IL-6, IL-7, IL-9, IL-12 (p40), IL-12 (p70), IL-13,, IL-17, TNF-alpha, IFN-gamma G-CSF, GM-CSF, KC, MCP-1, MiP-z,, MiP-1b, RANTES, and Eotaxin are measured in multiplexed format using Bio-Plex 200 Luminex System.

### M2033 Cytokines Panel II - multiplex

Keywords: chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin action, insulin resistance, monokines, obesity, serum samples, tissue lysates

Chronic and local inflammation is characterized by obesity and type 2 diabetes. Increased levels of cytokines and chemokines are known to affect insulin resistance and diabetic complications. Plasma and tissue lysate concentrations of IL-15, IL-18, LIF, MIP-2, M-CSF, MIG, VEGF, PDFG-BB, and Basic FGF are measured in multiplexed format using Bio-Plex 200 Luminex System.

### M2034 Amylin (Active)

Keywords: Amylin

Multiplex Luminex measurement of Amylin (Active)

### M2035 Ghrelin

Keywords: ghrelin

Multiplex Luminex measurement of Ghrelin

### M2036 Cytokines Panel III - multiplex

Keywords: chemokines, complications, cytokines, diabetes, immunology, inflammation, insulin, insulin resistance, monokines, obesity

Chronic and local inflammation is characterized by obesity and type 2 diabetes.

Increased levels of cytokines and chemokines are known to affect insulin resistance and diabetic complications. Plasma and tissue lysate concentrations of IL-20, IL-23, IL-27, IL-33, MDC, and TIMP-1 are measured in multiplexed format using Bio-Plex 200 Luminex System.

### M2037 Gastric inhibitory peptide (GIP; Total)

Keywords: Gastric inhibitory peptide

Multiplex Luminex measurement of Gastric inhibitory peptide (GIP; Total)

### M2038 Pancreatic Polypeptide (PP)

Keywords: Pancreatic Polypeptide

Multiplex Luminex measurement of Pancreatic Polypeptide (PP)

**M2039 Peptide YY (PYY; Total)**
Keywords: Peptide YY

Multiplex Luminex measurement of Peptide YY (PYY; Total)

**M2040 Glucagon-like peptide 1 (GLP-1 ).**
Keywords: glucagon, liver, liver function, liver function enzymes, Luminex, peptides

Luminex measurement of Glucagon-like peptide 1 (GLP-1 ).

**M2041 Estradiol (E2)**
Keywords: ELISA, estradiol, plasma, serum

ELISA-based quantitation of estradiol (E2) in serum or plasma.

**M2043 Triiodothyronine (T3)**
Keywords: ELISA, T3, triiodothyronine

Competitive ELISA-based quantitation of triiodothyronine (T3) in serum or plasma.

**M2044 Thyroxine (T4)**
Keywords: T4, thyroxine

Competitive ELISA-based quantitation of thyroxine (T4) in serum or plasma.

**M2045 Thyrotropin-releasing hormone (TRH)**
Keywords: thyrotropin-releasing hormone, TRH

Competitive ELISA-based quantitation of thyrotropin-releasing hormone (TRH) in serum or plasma.

**M2046 Apolipoprotein C3 (ApoC3)**
Keywords: Apolipoprotein C3, apolipoproteins

ELISA-based quantitation of Apolipoprotein C3 (ApoC3) in serum or plasma.

**M2047 Adrenocorticotropic hormone (ACTH)**
Keywords: ACTH, adrenocorticotropic hormone

Multiplex Luminex measurement of Adrenocorticotropic hormone (ACTH)

**M2048 Growth Hormone (GH)**
Keywords: GH, Growth hormone

Multiplex Luminex measurement of Growth Hormone (GH)

**M2049 Prolactin (PRL)**
Keywords: PRL, prolactin

Multiplex Luminex measurement of Prolactin (PRL)

**M2050 Thyroid-stimulating hormone (TSH)**
Keywords: Thyroid-stimulating hormone, TSH

Multiplex Luminex measurement of Thyroid-stimulating hormone (TSH)

**M2051 Progesterone**
Keywords: ELISA, Progesterone

ELISA-based quantitation of progesterone in serum or plasma.

**M2052 Testosterone**
Keywords: ELISA, Testosterone

ELISA-based quantitation of testosterone in serum or plasma.

**M2053 Bicarbonate**
Keywords:

Measurement of bicarbonate (HCO3-) levels in serum or plasma.

**M2054 Calcium**
Keywords: Ca, Ca2+, plasma, serum, urine

Measurement of calcium levels in serum, plasma, or urine.

**M2055 Magnesium**
Keywords: plasma, serum, urine

Measurement of magnesium levels in serum, plasma, or urine.

**M2056 Phosphate**
Keywords: plasma, serum, urine

Measurement of phosphorus levels in serum, plasma, or urine.

**M2057 Aldosterone**
Keywords: Aldosterone, hormone

ELISA-based quantitation of aldosterone in serum or plasma. Aldosterone, the main mineralocorticoid hormone, is a steroid hormone produced by the zona glomerulosa of the adrenal cortex in the adrenal gland. It is essential for sodium conservation in the kidney, salivary glands, sweat glands and colon. It plays a central role in the homeostatic regulation of blood pressure, plasma sodium (Na+), and potassium (K+) levels.

**M2058 Renin**
Keywords: Renin

ELISA-based quantitation of renin in serum or plasma. Renin, also known as an angiotensinogenase, is an aspartic protease protein and enzyme secreted by the kidneys that participates in the body's renin–angiotensin–aldosterone system (RAAS)—also known as the renin–angiotensin–aldosterone axis—that mediates the volume of extracellular fluid (blood plasma, lymph and interstitial fluid), and arterial vasoconstriction.

**M2059 Tissue Glycogen**
Keywords: Glycogen

Measurement of tissue glycogen content

**M2060 Insulin-like growth factor 1 (IGF-1)**
Keywords: hormone

ELISA-based quantitation of insulin-like growth factor in serum or plasma.

**M2061 Insulin Signaling**
Keywords: Forkhead Box O1, insulin, insulin receptor, insulin receptor substrate-1, insulin receptor substrate-2, phosphorylation, protein kinase B, serine, threonine, tyrosine

Analysis of tyrosine/serine/threonine phosphorylation and total protein levels of insulin receptor, insulin receptor

substrate-1 and 2, protein kinase B (Akt), Forkhead Box O1 (FoxO1)

**M2062 Inflammatory Signaling**
Keywords: phosphorylation, serine, threonine, tyrosine

Analysis of tyrosine/serine/threonine phosphorylation and total protein levels of Signal Transducer And Activator Of Transcription 3 (STAT3), IkappaB kinase (IKK), C-Jun N-terminal Kinase (JNK) 1/2/3, Nuclear Factor kappaB (NF-kB)

**M2063 Metabolic Signaling**
Keywords: phosphorylation, serine, threonine, tyrosine

Analysis of tyrosine/serine/threonine phosphorylation and total protein levels of AMP-activated protein kinase (AMPK), glucose transporter 1 (GLUT1) and 4 (GLUT4), glucose-6-phosphatase, phosphoenolpyruvate carboxykinase (PEPCK), pyruvate dehydrogenase (PDH), pyruvate dehydrogenase kinase (PDK), fatty acid synthase (FASN), fatty acid translocase (FAT/CD36), andcarnitine palmitoyltransferase 1A (CPT1a)

**M2070 Histology - lipid content**
Keywords: histology, lipid

Oil Red O / hematoxylin staining of frozen liver sections for assessment of lipid accumulation

**M2071 Histology - lipid droplet**
Keywords: histology, lipid

Perilipin immunostaining of formalin-fixed or frozen liver sections for quantification of lipid droplets

**M2072 Liver Histology - fibrosis**
Keywords: histology

hematoxylin-eosin / Masson's trichrome / Sirius Red staining of fixed liver sections for assessment of collagen deposition

## Animal Care Core

**M6001 Accelerated Quarantine Service**
Keywords: animal husbandry

Provide an accelerated quarantine service

## Islet Core

**M3001 Pancreas isolation and embedding**
Keywords: islets, pancreas, surgery

Pancreas is micro-dissected free of contaminating tissues, weighed (wet weight), spread longitudinally on tissue cassette inserts, and rapidly fixed in formalin for embedding.

**M3002 Islet histology – paraffin pancreas sections**
Keywords: histology, immunohistochemistry, islets, pancreas

Fixed pancreas is processed to paraffin blocks, and sections cut for histological processing.

**M3003 Islet histology – H&E stained pancreas sections**
Keywords: histology, islets, pancreas, staining

Processing of H&E stained pancreas section slides.

**M3004 Islet histology – insulin immunohistochemistry**

Keywords: histology, immunohistochemistry, insulin, islets

Processing of insulin-stained slides (insulin in brown with blue hematoxylin counterstain) for bright-field microscopy

**M3005 Islet histology – insulin immunofluorescence**
Keywords: histology, immunohistochemistry, insulin, islet, islet function, islets

Processing of insulin-stained slides (insulin in green with nuclei stained with dapi) for fluorescence microscopy

**M3006 Islet histology – insulin and glucagon immunofluorescence**
Keywords: glucagon, histology, immunohistochemistry, insulin, islet, islets, pancreas

Processing of insulin- and glucagon-stained slides (insulin in green, glucagon in red, nuclei stained with dapi) for fluorescence microscopy

**M3007 Islet histology – beta-cell proliferation and cell death**
Keywords: beta cell, imaging, immunohistochemistry, insulin, islet, islets, pancreas, staining

Processing of insulin with BrdU, PCNA or TUNEL stained slides (insulin in green with other stain in red and nuclei stained with dapi) for fluorescence microscopy

**M3008 Islet microscopy – islet images**
Keywords: histology, imaging, islet, islets, pancreas

Processing of low- or high-magnification islet images as tiff files

**M3009 Islet microscopy – exocrine pancreas images**
Keywords: histology, imaging, islets, pancreas

Processing of exocrine pancreas images as tiff files

**M3010 Islet microscopy – beta-cell mass**
Keywords: beta cell, imaging, islets, pancreas

Processing of whole insulin-stained pancreatic slide scan for beta-cell mass calculation

**M3011 Pancreatic beta-cell mass (comprehensive)**
Keywords: beta cell, islet, islets, pancreas

Includes pancreas embedding, sectioning, insulin histochemical stain, whole slide scan, and human-assisted automated determination of islet area to total pancreas area. Pancreas sections are stained using immunohistochemistry for insulin, counterstained with hematoxylin, and permanently cover-slipped. Stained slides are scanned in entirety using a Plustek OpticFilm 8200i Ai Film Scanner. Images are quantified for insulin pixel area and pancreas pixel area, and beta-cell mass calculated by the formula ([insulin/pancreas] x pancreas weight).

**M3012 Pancreas islet architecture analysis**
Keywords: beta cell, glucagon, imaging, immunohistochemistry, insulin, islet, islets, pancreas

Includes pancreas embedding, sectioning, insulin/glucagon immunofluorescence stain, fluorescence microscopy to acquire islet images, and human-assisted automated determination of alpha:beta cell ratio

**M3013 Pancreatic islet isolation**
Keywords: beta cell, islet, islets, pancreas, surgery

Islet isolation is performed by state-of-the-art standardized techniques used in the islet field, using a 3cc insufflation of the pancreas with collagenase via the common bile duct. After thermic, enzymatic and mechanical disruption, pancreatic tissue is filtered and separated by Histopaque ficoll gradient centrifugation. Islets are recovered, washed and sedimented multiple times, and plated in islet growth medium for counting using a standard islet ocular grid. Following isolation, islets are flash-frozen for future analyses (dry pellet or in RNA later) or allowed to recover

overnight in islet medium before perifusion or cell culture experiments.

### M3014 Ex vivo islet analysis for insulin secretion
Keywords: insulin, insulin secretion, islet, islets, pancreas

Islets are cultured overnight on non-adhesive petri-dishes. 25 similarly sized islets are hand-selected and loaded onto chambers in a perifusion machine. The islets are perifused in Kreb's buffer with 0.17% BSA and standard concentrations of glucose (3~16.5 mM) at a flow rate of 100 µL/min. Perifusion solutions are gassed with 95%O2/5%CO2 and islet chambers maintained at 37°C. Perifusate flow-through is collected in 96 well plates maintained at 4°C and stored at -20°C. Insulin content of collected fractions and retrieved islets is measured by the Analytical Core after extraction in acid-ethanol.

### M3015 Ex vivo islet molecular analyses
Keywords: beta cell, islet, islets, pancreas, protein

Islets are either processed for RNA or protein analyses immediately post-isolation or are cultured for 1-4 days and then processed for RNA or protein analyses. This flexible protocol is tailored to the user's experimental needs.

### M3016 Surgery- jugular vein cannulation for chronic infusion
Keywords: cannulation, jugular, surgery

Standard jugular vein cannulation surgery, plus cervical attachment of a stabilization wire for chronic intravenous infusion (to keep catheter from tangling, allowing mouse to roam freely in infusion chamber)

### M3017 Chronic intravenous infusion
Keywords: cannulation, chronic, infusion, intravenous

Following jugular cannulation with cervical wire placement, mouse is single-housed in a round-bottom infusion chamber in a light, temperature and humidity-controlled environment, with ad libitum access to food and water. After a 2-day operative recovery period, continuous intravenous infusion of desired approved infusate is maintained for 24-96 hours using a high-precision syringe pump. Mouse body weight and chow intake are measured daily (recovery and infusion). Tail blood samples to measure glucose and plasma insulin are obtained daily during infusion. At infusion end, blood and tissue can be collected for histology or molecular studies.

## Cardiovascular Core

### M4001 Abdominal Ultrasound
Keywords: cardiac function, cardiovascular, cardiovascular disease, heart, heart rate, in vivo

In vivo analysis of vasculature for atherogenesis

### M4002 Echocardiography
Keywords: cardiac function, cardiac output, echocardiography, heart

In vivo analysis of cardiac structure and function

### M4003 Heart Rate Measurement
Keywords: cardiac function, cardiac output, cardiovascular, heart, heart rate

In vivo analysis of heart rate using the CODA tail cuff system

### M4004 Blood Pressure Measurement
Keywords: blood pressure, cardiac function, cardiac output, cardiovascular disease, heart

In vivo analysis of blood pressure using the CODA tail cuff system

### M4005 Endothelial Function
Keywords: cardiovascular, endothelial denudation, vascular, vascular function, vascular tone

Ex vivo analysis of endothelial function using wire myography of aortic rings

**M4006 Hind Limb Ischemia (HLI) Model**
Keywords: ischemia, vascular, vascular function

A 28-day model of peripheral vascular disease to assess angiogenesis in vivo to compare relative blood flow between ischemic and control limbs over time. Analysis of relative blood flow in the extremities of anesthetized mice using Moor Laser Speckle Contrast Imaging system.

**M4007 Abdominal Aortic Aneurysm (AAA) Model**
Keywords: aortic reactivity, aortic ring, cardiovascular

Model to assess the incidence of AAA formation in mice after 28 days of angiotensin infusion. In vivo AAA quantification using VisualSonics Vevo 3100

**M4008 Coronary Artery Ligation (CAL) Model**
Keywords: artery, cardiac, cardiac function, cardiovascular, coronary ligation, heart

Permanent ligation or ischemia/reperfusion models available to assess cardiac function in vivo. These models have reproducible infarct size and survival ability. Providing long-term monitoring capabilities for metabolic studies, cell injections or novel compound studies.

**M4009 Transverse Aortic Constriction (TAC) Model**
Keywords: aortic reactivity, cardiac function, cardiac hypertrophy, heart failure

Model of aortic stenosis for the study of cardiac hypertrophy or congestive heart failure. Creating phenotypical stresses on mouse models allowing for comprehensive and reproducible screening for cardiovascular complications and consequences of metabolic disease in the mouse. TAC models induce a pressure-overload on the heart and is achieved by placing a constriction around the transverse aorta. We confirmed by Doppler analysis of the flow velocity across the aortic constriction. Additionally, any myocardial remodeling from the TAC mouse model can be monitored by echocardiography. Showing the hearts progression from a compensatory stage to decompensation and ultimately heart failure.

**M4010 Moor Laser Speckle Contrast Imaging**
Keywords: blood flow, ischemia, peripheral vascular disease, vascular disease

The Moor blood flow imager uses the laser speckle contrast technique to deliver real-time, high-resolution blood flow images, providing outstanding performance in a wide range of pre-clinical and clinical research applications. Optical zoom means you can assess small areas right up to a full-size adult hand with a single imager.

**M4011 Aortic morphometry studies**
Keywords: aorta, morphometry

Assessment of atherosclerotic lesions in whole aorta with En-face aorta Oil Red-O staining for plaque quantification as well as aortic root histological cross section staining with Oil-Red-O staining. Cholesterol panels, HDL, LDL, Total Cholesterol

**M4012 Nash Models (nonalcoholic fatty liver disease)**
Keywords:

Research models of nonalcoholic fatty liver disease (NAFLD), including nonalcoholic steatohepatitis (NASH). These models are great tools for investigating the key issues of NASH, why steatosis occurs, what causes the transition from steatosis to inflammatory, progressing the fibrosis of steatohepatitis. Volumetric imaging of preclinical models, measuring liver stiffness, quantify steatosis (fat) and Evaluating inflammation. Using various knock outs mouse models fed high fat diet, high sucrose and fructose, diet high-fat, or high-cholesterol and high-fructose diet.

**M4013 Carotid Artery Ligation Models**
Keywords: artery, carotid

Induced vascular injury models in mice contribute to smooth muscle, endothelial, inflammatory, as well as other

circulating cells leading to vascular remodeling. Partial carotid artery ligation involves ligating all distal branches of the left carotid artery except the superior thyroid artery, creating a low-flow state with commensurate vascular remodeling over 2 or more weeks.

### M4014 Carotid Artery Restriction Models

Keywords: artery, carotid

Induced vascular injury models in mice contribute to smooth muscle, endothelial, inflammatory, as well as other circulating cells leading to vascular remodeling. Partial carotid artery ligation involves ligating all distal branches of the left carotid artery except the superior thyroid artery, creating a low-flow state with commensurate vascular remodeling over 2 or more weeks.

### M4015 Wire Myography Studies

Keywords: artery, vascular

Wire myography is an in vitro technique, allowing us to examine functional responses and vascular reactivity of isolated small resistance arteries. Vessels from various species, including transgenic models, and vascular beds can be examined in a variety of pathological disease states. Vessels are dissected, cleaned, and then mounted onto a four-channel myograph under isometric techniques. Each vessel is then normalized to determine maximum active tension development. This allows the standardization of initial experimental conditions, an important consideration when examining pharmacological differences between vessels.

### M4016 Denervation: Surgical and chemical Models

Keywords: nerve, surgery

The brain is responsible for the coordination of energy balance through signal integration, Providing endocrine hormones and nutrients from the circulatory system, and feedback from sensory nerves. Being critical for various metabolic processes, such as Browning, lipolysis, and adipogenesis. Disruption of these signals is performed using 6-hydroxydopamine (6HODA) or surgicall modification.

### M4017 Parabiosis Models

Keywords: parabiosis, surgery, Vascular Permeability

Surgical joining of two mice through skin vasculature to create a shared physiological system whereby experimental or genetic manipulation of one animal can be assessed through the physiological response of the 2nd joined animal.

### M4018 Jugular vein and carotid artery catheterization

Keywords: arterial, artery, carotid, catheterization, jugular

Arterial catheterization allows investigators to sample arterial blood or other infusion/sampling purposes, while venous catheter can be used to sample venous blood in long-term experiments Vascular catherization allows infusion of compounds, substrates, and tracers into the circulation.

## Humanized Mouse

### M5001 Humanized Mouse (normoglycemic NSG mouse)

Keywords: mouse husbandry and transfer, mouse models

Normoglycemic NOD-scid IL2rgamma null (NSG) mouse transplanted with human islets.

Although mouse models of diabetes have facilitated our understanding of human disease, there are notable differences in physiology particularly relating to islet composition and function between mice and humans. A “humanized mouse” is defined as an immunodeficient mouse engrafted with human primary haematopoietic cells and tissues to generate a functional human immune system. Information about the NSG mouse can be found in the following article: Friedline RH, et al. FASEB J. 2016;30:1328-1338.

### M5002 Humanized Mouse (STZ-induced diabetic NSG mouse)

Keywords: mouse husbandry and transfer, mouse models

Hyperglycemic NOD-scid IL2rgamma null (NSG) mouse with streptozotocin (STZ) injection and transplanted with

human islets.

Although mouse models of diabetes have facilitated our understanding of human disease, there are notable differences in physiology particularly relating to islet composition and function between mice and humans. A "humanized mouse" is defined as an immunodeficient mouse engrafted with human primary haematopoietic cells and tissues to generate a functional human immune system. Information about the NSG mouse can be found in the following article: Friedline RH, et al. FASEB J. 2016;30:1328-1338.

### M5003 Humanized Mouse (spontaneous-diabetic NSG-Ins2 Akita mouse)

Keywords: diabetes, mouse husbandry and transfer, mouse models

Spontaneous and non-reversible, hyperglycemic NOD-scid IL2rgamma null (NSG) mouse with genetic ablation of Ins2 gene (Ins2 Akita) and transplanted with human islets.

Although mouse models of diabetes have facilitated our understanding of human disease, there are notable differences in physiology particularly relating to islet composition and function between mice and humans. A "humanized mouse" is defined as an immunodeficient mouse engrafted with human primary haematopoietic cells and tissues to generate a functional human immune system. Information about the NSG mouse can be found in the following article: Friedline RH, et al. FASEB J. 2016;30:1328-1338. Information about the Ins2Akita mouse can be found in the following article: Hong EG, et al. Am J Physiol. 2007;293:E1687-E1696.

### M5004 Humanized Mouse (induced-diabetic NSG-RIP-DTR mouse)

Keywords: diabetes, mouse husbandry and transfer, mouse models

NOD-scid IL2rgamma null (NSG) mouse with transgenic expression of diphtheria toxin (DTR) under the control of the rat insulin promoter (RIP) and transplanted with human islets.

Although mouse models of diabetes have facilitated our understanding of human disease, there are notable differences in physiology particularly relating to islet composition and function between mice and humans. A "humanized mouse" is defined as an immunodeficient mouse engrafted with human primary haematopoietic cells and tissues to generate a functional human immune system. Hyperglycemia is induced by injection of 5 ng of diphtheria toxin. Information about the NSG mouse can be found in the following article: Friedline RH, et al. FASEB J. 2016;30:1328-1338.

### M5005 Phenotypic assessment of transplanted human islets

Keywords: beta cell, diabetes, glucose tolerance, insulin, islet, islets, pancreas

Functional characterization of engrafted human islets is processed by immunohistological staining for insulin, for their total insulin content using acidified ethanol extraction of the insulin from the human islet graft, for proliferation as determined by Ki67 staining or BrdU incorporation and co-staining for insulin-positive cells, by their ability to secrete human C-peptide or human insulin using human-specific ELISA kits, and by glucose tolerance test (GTT). This phenotyping service may involve other Phenotyping Cores (Metabolism, Analytical, and Islet Core)

### M5006 Phenotypic assessment of transplanted stem cell-derived beta-cells

Keywords: beta cell, diabetes, glucose, glucose tolerance, imaging, immunohistochemistry, insulin, islet, islets, pancreas

Functional characterization of engrafted stem cell-derived beta-cells is processed by immunohistological staining for insulin, for their total insulin content using acidified ethanol extraction of the insulin from the human islet graft, for proliferation as determined by Ki67 staining or BrdU incorporation and co-staining for insulin-positive cells, by their ability to secrete human C-peptide or human insulin using human-specific ELISA kits, and by glucose tolerance test (GTT). This phenotyping service may involve other Phenotyping Cores (Metabolism, Analytical, and Islet Core)

## Microbiome Core

### M7001 Consultation - Study Design

Keywords: consultation, study design

Consultation for study design

### M7002 Sample DNA Extraction & Quality Control Analyses

Keywords: DNA, extraction

DNA extraction and quality control analysis

**M7003 16S rRNA gene sequencing**
Keywords: gene sequencing, sequence based species quantitation

16S rRNA gene sequencing

**M7004 Consultation - Sequence Data Analysis**
Keywords: gene sequencing, sequence based species quantitation

Analysis of 16S rRNA gene sequencing data

**M7005 Consultation - Post-analysis Data Preparation**
Keywords:

Assistance with figure preparation for manuscripts

**M7006 Consultation - Data Upload**
Keywords:

Assistance with data upload to the NCBI Sequence Read Archive (SRA)

**M7007 Fecal Microbiota Transplant (FMT)**
Keywords: gut, microbiome

Fecal microbiota transplant to selectively alter gut microbiome

**M7008 Antibiotic Treatment**
Keywords: antibiotic treatment, gut, microbiome

Chronic and acute antibiotic treatment to alter gut microbiome.

## UNIVERSITY OF MICHIGAN MEDICAL SCHOOL

## Animal Care and Germ-Free Mouse Core

**MI1003 Quarantine per diem**
Keywords:

All rodents shipped to the U-M from non-approved vendors and/or other institutions must be quarantined for approximately three weeks to avoid the possible introduction of infectious agents to the University’s rodent colonies. Animals in quarantine are tested for viral, bacterial, and parasitic agents.

If animals test positive for rodent viral, bacterial, or parasitic infections while in quarantine, they must be treated for the infection and, if appropriate, re-derived by embryo transfer via the Transgenic Animal Model Core or used in non-survival experiments. The same is true for rodents that are known to be positive at the time of shipment to U-M. Accordingly, ULAM Veterinary Staff strongly discourages investigators from acquiring research animals with known rodent viral, bacterial, or parasitic infections.

Investigators are responsible for paying all quarantine-associated costs, including technician time, laboratory testing, and per-diems. Once the animals are released from quarantine, ULAM will transfer them to the appropriate animal housing room.

Study teams who wish to have animals shipped to the University of Michigan from other institutions or non-commercial (approved) vendors should contact the ULAM Rodent Health Surveillance Team at ulam-rhst@umich.edu(link sends e-mail) or (734) 936-1699 at least two weeks in advance of desired delivery date.

**MI1004 Intra-University trucking**
Keywords:

To facilitate the movement of animals and equipment across campus, ULAM operates a temperature-controlled truck that can assist with the following:

Delivery of animals received at the ULAM Dock to other buildings on campus

Transfer of animals and/or equipment between buildings

Pickup of animals shipped to Detroit Metro Airport

A minimum 48-hour notice is required for all trips. Study teams are charged for truck driver labor (hourly, in 15 minute increments), and mileage for these services.

Truck Labor Rate/Hour $30.84

Truck Labor Rate/Hour Overtime $46.26

Truck Mileage/Per Mile $1.75

Questions or concerns pertaining to the shipment of animals to and from U-M should be directed to the Rodent Health Surveillance Team at ulam-rhst@umich.edu or (734) 936-1699.

To arrange for transportation services through ULAM, please email ulam-truck@umich.edu or call (734) 936-2011 or (734) 936-6163.

### MI1005 Animal Health Surveillance - PCR Rodent Infectious Agent testing

Keywords: animal husbandry, pathogen detection

This service detects viruses, bacteria and parasites in animals by screening noninvasive samples with a PRIA® (PCR Rodent Infectious Agent) Panel (10 samples batched in one tube).

### MI1006 Animal Health Surveillance - Pinworm PCR

Keywords: mouse husbandry and transfer, pathogen detection

Technical time from Vet Techs or Rodent Health Techs to evaluate pinworm infections via PCR

### MI1007 Technician Service Fee / Special Procedures

Keywords: animal husbandry, animal procedures, dosing, gavage, mouse husbandry and transfer, TST, venipuncture

Technical service fees per hour for special procedures like dosing, sample collection, gavage, IV, IP or IM dose administration, blood collection, tagging and tailing, health checks, etc.

### MI1008 Mouse Microchipping

Keywords: mouse husbandry and transfer

Microchip implantion. Small subcutaneous device is implanted into the mouse that transmits a unique identification code. For wean age or older mice. Mice may need to be anesthetized or sedated for implantation.

### MI1010 Lab Sendout Processing Fee

Keywords:

Shipping costs in addition to specific assay

### MI1011 Complete blood count (CBC)

Keywords: CBC, Hb HT, MCH, MCHC, NCV, PLT, RBC, WBC

Hemavet instrument: WBC, RBC, Hb HT, NCV, MCH, MCHC, PLT, requires 50-100 µL of whole blood

### MI1012 Blood smear (prep only)

Keywords: blood

A blood smear is a blood test used to look for abnormalities in blood cells. Manual preparation of blood smear.

**MI1013 Reticulocyte count**
Keywords: RBC, reticulocytes

Percent of reticulocytes in RBC count. 50-100 µL whole blood required.

**MI1014 Blood Chemistry**
Keywords: ALB, ALP, ALT, AST, blood chemistry, BUN, Ca, cholesterol, CK, creatinine, electrolytes, glucose, T. Bili, T. Prot, triglycerides

Full Chem Panel Includes: ALB, ALP, ALT, AST, BUN, Ca, Chol, CK, Creat, Gluc, T. Bili, T. Prot, Trig, Electrolytes

Mini Chem Panel includes: ALB, ALP, ALT, Ca, BUN, Creat, T.Pro, Gluc, T.Bili

270µL serum required

**MI1015 Blood Chemistry - Mini Liver Panel**
Keywords: ALT, AST, serum

Alanine aminotransferase (ALT) and aspartate aminotransferase (AST) tests. Require 50 µL serum

**MI1016 Blood Chemistry - Renal Panel**
Keywords: BUN, creatinine, serum

Blood urea nitrogen (BUN) and Creatinine tests. Requires 50 µL serum

**MI1017 Blood Chemistry - Additional Chemistries per animal**
Keywords: blood chemistry, clinical chemistry

A La Carte price for individual clinical chemistry analyses

**MI1018 Urinalysis - Complete Panel**
Keywords: urinalysis, urine

Routine analysis (Catalog #MI1019) + casts, bacteria, mucous, epithelial cells, crystals

**MI1019 Urinalysis - Routine Panel**
Keywords: urinalysis, urine

Determine color, clarity, specific gravity, pH, Protein, Glucose, Ketones, Urobilinogen, Bilirubin, Blood, #RBC and #WBC per HPF in urine.

**MI1020 Urinalysis - Aerobic General Culture**
Keywords: bacteria, urine

Urine culture is used to diagnose a urinary tract infection (UTI) and to identify the bacteria causing the infection. This test will screen for Aerobic bacteria. The samples are sent to Diagnostic Center for Population and Animal Health (DCPAH) for testing.

**MI1021 Urinalysis - Anaerobic Culture**
Keywords: bacteria, urine

Urine culture is used to diagnose a urinary tract infection (UTI) and to

identify the bacteria causing the infection. This test will screen for Anaerobic

bacteria. The samples are sent to Diagnostic Center for Population and Animal

Health (DCPAH) for testing.

**MI1022 Urinalysis - Fungal Culture**
Keywords: urine

Urine culture is used to diagnose a urinary tract infection (UTI) and to identify the bacteria and fungus causing an infection. This test will screen for fungi. The samples are sent to Diagnostic Center for Population and Animal Health (DCPAH) for testing.

**MI1023 Urinalysis - General Culture plus sensitivity**
Keywords: bacteria, urine

Urine culture is used to diagnose a urinary tract infection (UTI) and to identify the bacteria causing the infection. This test will provide a general culture plus sensitivity analysis. A sensitivity analysis is a test that determines the "sensitivity" of bacteria to an antibiotic. It also determines the ability of the drug to kill the bacteria. The samples are sent to Diagnostic Center for Population and Animal Health (DCPAH) for testing.

**MI1025 White Blood Cell (WBC) Differential Count**
Keywords: WBC

White Blood Cell (WBC) Differential Count

**MI1026 Verify Ampule (autoclave control)**
Keywords: autoclave control

Validation for proper autoclave temperature; indicator can be submitted up to 72 hrs after autoclave cycle.

**MI1027 Necropsy Small Animal-standard**
Keywords: necropsy

Selected organs collected from mouse necropsy. Typically liver, kidney, adrenals, heart, lung, GIT

**MI1028 Full tissue collection starting with fixed whole carcass**
Keywords: necropsy, surgery

Whole mouse carcass submitted in formalin fixative.

**MI1029 Necropsy technician fee**
Keywords: necropsy

Necropsy technician time required for catalog items MI1027, MI1028.

**MI1030 Decalcification**
Keywords: bone, decalcification

Decalcification of mineralized bony tissue. Variable lengths of time may be needed based on the extent of mineralization.

**MI1031 Histology - Trim/Cassette (Paraffin or OCT)**
Keywords: histology

Provide services to trim tissues and mount them in cassettes.

**MI1033 Histology - Paraffin Process & Embed**
Keywords: histology

Fixed tissue is processed through graded alcohols and xylene and ultimately paraffin embedded. Final result will be fixed paraffin embedded tissue in cassettes.

**MI1034 Histology - Tissue Sections, Paraffin Unstained Slide**

Keywords: histology

Paraffin embedded tissues are sectioned resulting in unstained tissue section(s) on slide.

**MI1035 Histology - Tissue Sections, Paraffin H&E Stain**
Keywords: histology

Paraffin embedded tissues are sectioned, mounted on slides, H&E stained and coverslipped.

**MI1036 Histology - Tissue Sections, Frozen Unstained Slide**
Keywords: histology

OCT embedded tissue is sectioned using a cryostat and mounted on slides.

**MI1037 Histology - Tissue Sections, Frozen H&E Stained**
Keywords: histology

OCT embedded tissues are sectioned on a cryostat, mounted on slides, H&E stained and coverslipped.

**MI1038 Histology - Special Stain, Masson Trichrome (MTC)**
Keywords: histology

Mounted tissue is stained using the Masson's trichrome three-color staining protocol. This special stain is used to stain for collagen

**MI1040 Histology - Special Stain, Toluidine Blue**
Keywords: histology

Mounted tissue is stained using the Toluidine Blue staining protocol. This special stain is used to stain for mast cell granules. Price is for paraffinized tissues, not for thick sections for TEM.

**MI1041 Histology - Special Stain, Prussian Blue**
Keywords: histology

Prussian blue is a common stain used by pathologists to detect the presence of iron in biopsy specimens, such as deposits of storage ferritin in bone marrow biopsy samples.

**MI1042 Histology - Special Stain, Picrosirius Red**
Keywords: histology

Picrosirius red is used to study collagen fibrils in different tissues.

**MI1043 Histology - Speical Stian, Verhoeff Van Gieson**
Keywords: histology

Van Gieson's stain is a mixture of picric acid and acid fuchsin. It is the simplest method of differential staining of collagen and other connective tissue.

**MI1044 Histology - Special Stain, Gram**
Keywords: bacteria, histology

Differential staining for gram positive and gram negative bacteria

**MI1045 Histology - Speical Stain, Luxol Fast Blue (LFB)**
Keywords: histology

Luxol fast blue stain is commonly used to observe myelin.

**MI1046 Histology - Special Stain, Warthin Starry**
Keywords: bacteria, histology

The Warthin–Starry stain is a silver nitrate-based staining method for the detection of spirochetes, Helicobacter, Treponema, and small bacilli: Campylobacter, Bartonella, Legionella

**MI1047 Histology - Special Stain, Other**
Keywords: histology

In addition to the listed catalog items of special stains, the center can provide other special stains that are not listed. Please consult with the center core personnel for your specific needs.

**MI1048 Immunohistochemistry - Tier 1 (ALDH1, Amylase, aSMA, CD45R-B220, CD3, Caspase-3, F4/80, GFAP, GFP, Insulin, Ki67, Ly-6G, Lyve-1, Mac2, Neurofilament)**
Keywords: immunohistochemistry

Immunohistochemistry refers to the process of selectively imaging antigens in cells of a tissue section using antibodies. This tier will assess the specific immunohistochemical markers listed in the name. The client must supply the antibody.

**MI1049 Immunohistochemistry - Tier 2 Tier 2 (AE1/AE3 + 8/18, CD4, CD8a, CD31, Estrogen Receptor, Glucagon, c-erbB2/HER2, Progesterone, Von Willebrand Factor)**
Keywords: immunohistochemistry

Immunohistochemistry refers to the process of selectively imaging antigens in cells of a tissue section using antibodies. This tier will assess the specific immunohistochemical markers listed in the name. The client must supply the antibody.

**MI1053 Histology Technician Labor**
Keywords: histology, immunohistochemistry

Histotechnician time for immunohistochemistry and histology.

**MI1054 Pathologist Hourly**
Keywords: histology, immunohistochemistry

Slides are reviewed and interpreted by a pathologist. A report will be provided to the client.

**MI1055 Aperio 20X scan, Semi-automated, >50 slides**
Keywords: histology, immunohistochemistry

Digital capture of each slide at 20X magnification using Aperio Slide Scanner.

**MI1056 Aperio 20X scan, Semi-automated, batch of 20-50**
Keywords: histology, immunohistochemistry

Digital capture of a batch of slides at 20X magnification using Aperio Slide Scanner.

**MI1057 Aperio 20X scan, Semi-automated, each**
Keywords: histology, immunohistochemistry

Digital capture of large batch of slides at 20X magnification using Aperio Slide Scanner.

**MI1058 Aperio Technician Labor**
Keywords: histology, immunohistochemistry

Technician time per hour for labeling, file mgmt. Digital capture of a slide with folding or other abnormalities requiring manual oversight using the Aperio Slide Scanner

**MI1059 Histology - Negative Control (mouse tissue)**
Keywords:

**MI1060 Histology - Stain (mouse tissue)**
Keywords:

**MI1063 Germ Free Mice - C57BL/6**
Keywords: free, germ, germ free, germ-free

Germ Free mice are free of all exongenous micro-organisms. They can be used in the Michigan facility or shipped to other facilities in germ-free shipping containers. Unit cost is per mouse and does not include shipping.

**MI1064 Germ Free Mice - Swiss Webster**
Keywords: free, germ, germ free, germ-free

Germ Free mice are free of all exongenous micro-organisms. They can be used in the Michigan facility or shipped to other facilities in germ-free shipping containers. Unit cost is per mouse and does not include shipping.

**MI1065 Germ Free Mice - BALB/c**
Keywords: free, germ, germ free, germ-free

Germ Free mice are free of all exongenous micro-organisms. They can be used in the Michigan facility or shipped to other facilities in germ-free shipping containers. Unit cost is per mouse and does not include shipping.

**MI1066 Germ Free Mice - IL-10 Knockout**
Keywords: free, germ, germ free, germ-free

Germ Free mice are free of all exongenous micro-organisms. They can be used in the Michigan facility or shipped to other facilities in germ-free shipping containers. Unit cost is per mouse and does not include shipping.

**MI1067 Germ Free Mice - Rag1 Knockout**
Keywords: free, germ, germ free, germ-free

Germ Free mice are free of all exongenous micro-organisms. They can be used in the Michigan facility or shipped to other facilities in germ-free shipping containers. Unit cost is per mouse and does not include shipping.

**MI1068 Germ Free - Per Diem**
Keywords: free, germ, germ free, germ-free

**MI1069 Germ Free Mice - Shipping**
Keywords: free, germ, germ free, germ-free

Germ Free Shipper is $800.00 plus the cost of shipping the animals using World Courier.

**MI1070 Germ Free - Rederivation**
Keywords: free, germ, germ free, germ-free

Hysterectomy derivation of new germ free mouse strains. Requires submission of 10 breeding pairs of donor strain Includes date-mating, hysterectomy, fostering, and weaning of pups as well as all per diems for breeders, fosters, and litters, and screening for sterility. Does not include shipping or per diem beyond weaning age.

Please contact Germ-Free Mouse Facility Director, Dr. Kathryn Eaton at kateaton@umich.edu for more information.

**MI1071 Germ Free - Technician Time**
Keywords: free, germ, germ free, germ-free, mouse husbandry and transfer

Technician time per hour for services including treatments, inoculations, fecal collections, body weight determination, blood and urine collection, etc.

**MI1072 Germ Free - Microbial community establishment**
Keywords: free, germ, germ free, germ-free

Please contact Germ-Free Mouse Facility Director, Dr. Kathryn Eaton at kateaton@umich.edu for more information.

**MI1073 Germ Free - Surgical manipulation**
Keywords: free, germ, germ free, germ-free

Please contact Germ-Free Mouse Facility Director, Dr. Kathryn Eaton at kateaton@umich.edu for more information.

**MI1074 Germ Free - Experimental Design and consultation**
Keywords: free, germ, germ free, germ-free

Please contact Germ-Free Mouse Facility Director, Dr. Kathryn Eaton at kateaton@umich.edu for more information.

**MI1080 Histology - Special Stain, Oil Red O (ORO)**
Keywords: histology, immunohistochemistry

**MI1081 Immunohistochemistry - Stain, Negative Control**
Keywords: histology, immunohistochemistry

**MI1082 Immunohistochemistry - Stain, Non-IVAC Primary Antibody**
Keywords: histology, immunohistochemistry

**MI1083 Immunohistochemistry - Stain, Titration Slide**
Keywords: histology, immunohistochemistry

**MI1084 Immunohistochemistry - Stain, Frozen IHC or Immunofluorence Slide**
Keywords: histology, immunohistochemistry

## Metabolism, Bariatric Surgery and Behavior Core

**MI2001 Catheterization of jugular vein**
Keywords: catheterization, surgery, vein

Catheterization of jugular vein

**MI2002 Catheterization of carotid artery**
Keywords: artery, catheterization, surgery

Catheterization of carotid artery

**MI2003 Catheterization of jugular vein AND carotid artery**
Keywords: artery, catheterization, surgery, vein

Catheterization of jugular vein AND carotid artery

**MI2004 Catheterization of portal vein**
Keywords: catheterization, surgery, vein

Catheterization of portal vein

**MI2005 Catheterization of portal vein AND carotid artery**
Keywords: artery, catheterization, surgery, vein

Catheterization of portal vein AND carotid artery

**MI2006 Catheterization of stomach or bladder**
Keywords: bladder, catheterization, stomach

Catheterization of stomach or bladder

**MI2007 Partial pancreatectomy**
Keywords: pancreas, surgery

Partial pancreatectomy

**MI2008 Parabiosis (a surgical union of two mice)**
Keywords: parabiosis, surgery

Parabiosis (a surgical union of two mice)

**MI2010 Glucose Tolerance Test (OGTT or IPGTT) including blood glucose and plasma insulin**
Keywords: blood, glucose, glucose tolerance, insulin

Glucose Tolerance Test (OGTT or IPGTT) including blood glucose and plasma insulin

**MI2011 Glucose Tolerance Test (OGTT or IPGTT) w/o plasma insulin**
Keywords: glucose, glucose tolerance, insulin, plasma

Glucose Tolerance Test (OGTT or IPGTT) w/o plasma insulin

**MI2012 Intravenous Glucose Tolerance Test (IVGTT with dual surgical catheterization) including blood glucose and plasma insulin**
Keywords: blood, catheterization, glucose, glucose tolerance, insulin

Intravenous Glucose Tolerance Test (IVGTT with dual surgical catheterization) including blood glucose and plasma insulin

**MI2013 Intravenous Glucose Tolerance Test (IVGTT with dual surgical catheterization) w/o plasma insulin**
Keywords: catheterization, glucose, glucose tolerance

Intravenous Glucose Tolerance Test (IVGTT with dual surgical catheterization) w/o plasma insulin

**MI2015 Intravenous Glucose Tolerance Test using portal vein delivery**
Keywords: glucose, glucose tolerance, portal, vein

Intravenous Glucose Tolerance Test using portal vein delivery

**MI2016 Insulin or Pyruvate Tolerance Test**
Keywords: insulin, pyruvate tolerance test, tolerance

Insulin or Pyruvate Tolerance Test

**MI2017 Hyperinsulinemic-euglycemic clamp (3H-glucose + 14C-2DG)**
Keywords: euglycemic clamp, hyperinsulinemic clamp

Hyperinsulinemic-euglycemic clamp (3H-glucose + 14C-2DG)

**MI2018 Hyperinsulinemic-euglycemic clamp (3H-glucose OR 14C-2DG)**
Keywords: hyperinsulinemic clamp

Hyperinsulinemic-euglycemic clamp (3H-glucose OR 14C-2DG)

**MI2019 Hyperinsulinemic-euglycemic clamp w/o tracers**

Keywords: hyperinsulinemic clamp

Hyperinsulinemic-euglycemic clamp w/o tracers

**MI2020 Hyperinsulinemic-euglycemic clamp using portal vein infusion**
Keywords: hyperinsulinemic clamp, portal, vein

Hyperinsulinemic-euglycemic clamp using portal vein infusion

**MI2021 Hyperinsulinemic-euglycemic clamp + steady-state plasma NEFA**
Keywords: hyperinsulinemic clamp, NEFA, plasma

Hyperinsulinemic-euglycemic clamp + steady-state plasma NEFA

**MI2022 Hyperinsulinemic-euglycemic clamp + hepatic glycogen synthesis**
Keywords: glycogen synthesis, hepatic, hyperinsulinemic clamp

Hyperinsulinemic-euglycemic clamp + hepatic glycogen synthesis

**MI2023 Hyperglycemic clamp**
Keywords: hyperglycemic clamp

Hyperglycemic clamp

**MI2024 Hyperinsulinemic-hypoglycemic clamp**
Keywords: hyperinsulinemic clamp

Hyperinsulinemic-hypoglycemic clamp

**MI2025 VO2 &VCO2 with spontaneous activity and food intake @Room temperature (22 °C)**
Keywords: VCO2 production, VO2 consumption

VO2 &VCO2 with spontaneous activity and food intake (CLAMS, Columbus Instruments) @Room temperature (22 °C)

**MI2026 VO2 &VCO2 with spontaneous activity and food intake, Thermoneutrality (30 °C) and/or cold (as low as 4 °C)**
Keywords: VCO2 production, VO2 consumption

+subcu temp $8.70/per mouse, per day (3 day minimum)

+IP temp $16.70/per mouse per day (3 day minimum)

VO2 &VCO2 with spontaneous activity and food intake (CLAMS, Columbus Instruments) Thermoneutrality (30 °C) and/or cold (as low as 4 °C)

**MI2027 VO2 &VCO2 with spontaneous activity and food intake, plus body temperature (implantable BMDS electronic transponder)**
Keywords: VCO2 production, VO2 consumption

VO2 &VCO2 with spontaneous activity and food intake (CLAMS, Columbus Instruments) Plus body temperature (implantable BMDS electronic transponder)

**MI2028 Non-shivering thermogenesis using injection of norepinephrine (including 24hours acclimation at 30°C)**
Keywords: thermogenesis

Non-shivering thermogenesis using injection of norepinephrine (including 24hours acclimation at 30°C)

**MI2029 Body Composition (Bruker Minispec LF 90II)**
Keywords: body composition

Body Composition (Bruker Minispec LF 90II)

**MI2030 Body Temperature (microchips implanted)**
Keywords: body temperature

Body Temperature (microchips implanted in sub-cu or IP under light isoflurane anesthesia, Bio Medic Data Systems)

**MI2031 Digestible Energy Content**
Keywords: fecal matter, food intake

Digestible Energy Content including measuring food and/or fecal samples collected during a 48-hour single housing period (Bomb Calorimeter, Parr 6200 and 1108P oxygen bomb)

**MI2032 Fat Tolerance Test, Oral gavage (olive or corn oil)**
Keywords: corn oil, fat tolerance, gavage, olive oil

Fat Tolerance Test, Oral gavage (olive or corn oil)

**MI2033 Fat Tolerance Test, Intravenous injection (20% Intralipid)**
Keywords: carotid, catheterization, fat tolerance, jugular

Fat Tolerance Test, Intravenous injection (20% Intralipid) including dual catheterization of jugular vein and carotid artery

**MI2034 Hepatic TG Secretion (Poloxamer 407 or Triton WR-1339)**
Keywords: hepatic, secretion, triacylglycerides

Hepatic TG Secretion (Poloxamer 407 or Triton WR-1339)

**MI2038 Automated Arterial Blood Sampling and/or Intravenous Infusion in undisturbed and unrestrained mice, Blood sampling only**
Keywords: arterial, artery, blood sampling, intravenous

Automated Arterial Blood Sampling and/or Intravenous Infusion in undisturbed and unrestrained mice, Blood sampling only

**MI2039 Automated Arterial Blood Sampling and/or Intravenous Infusion in undisturbed and unrestrained mice, Intravenous Infusion only**
Keywords: arterial, artery, blood sampling, infusion, intravenous

Automated Arterial Blood Sampling and/or Intravenous Infusion in undisturbed and unrestrained mice, Intravenous Infusion only

**MI2040 Automated Arterial Blood Sampling and/or Intravenous Infusion in undisturbed and unrestrained mice, Blood sampling AND intravenous infusion**
Keywords: arterial, artery, blood sampling, intravenous

Automated Arterial Blood Sampling and/or Intravenous Infusion in undisturbed and unrestrained mice, Blood sampling AND intravenous infusion

**MI2041 Exercise Training**
Keywords: exercise, training

Exercise Training

**MI2042 Test of Running Capacity (run to exhaustion), Without measuring VO2 and VCO2**
Keywords: exercise, exercise stress test, Running Capacity

Test of Running Capacity (run to exhaustion), Without measuring VO2 and VCO2

**MI2043 Test of Running Capacity (run to exhaustion), With measuring VO2 and VCO2 (VO2max)**
Keywords: exercise, exercise capacity, exercise stress test, Running Capacity, VCO2 production, VO2 consumption

Test of Running Capacity (run to exhaustion), With measuring VO2 and VCO2 (VO2max)

**MI2044 Running Wheel Activity (Med Associates)**
Keywords: Activity, exercise, running wheel, wheel running

Running Wheel Activity (Med Associates)

**MI2046 Body Weight Recording**
Keywords: body weight

Body Weight Recording

**MI2047 Manual Food or Water Recording**
Keywords: food intake, water intake

Manual Food or Water Recording

**MI2048 Orogastric Gavage**
Keywords: gavage, orogastric

Orogastric Gavage: A medical process involving the insertion of a plastic tube through the mouth, past the throat, and down into the stomach.

**MI2049 Pair-Feeding**
Keywords: feeding, pair-feeding

Pair-feeding is a technique in which the amount of food provided to a control group of mice is matched to that consumed by the experimental group, so as to determine the extent to which the effect of a treatment on body weight or body composition occurred independently of changes of energy intake

**MI2050 Rectal Temperature Recording (YSI 4600 precision thermometer)**
Keywords: Temperature

Rectal Temperature Recording (YSI 4600 precision thermometer)

**MI2052 24-hour Urine and/or Fecal Collection**
Keywords: fecal matter, feces, urine

24-hour Urine and/or Fecal Collection

**MI2053 Tissue Dissection/Collection**
Keywords: dissection, tissue

Tissue Dissection/Collection (under pentobarbital/ketamine/isoflurane anesthesia or immediately after decapitation/cervical dislocation; tissues are immediately frozen in liquid N2, stored at -80°C, and delivered with dry ice)

**MI2054 Tail Vein Blood Sampling (plasma or serum)**
Keywords: blood sampling, plasma, serum

Tail Vein Blood Sampling (plasma or serum)

**MI2055 Retro-orbital bleeding (under isoflurane anesthesia)**
Keywords: blood sampling

Retro-orbital bleeding (under isoflurane anesthesia)

$1.80/sample for EDTA plasma extraction (using EDTA coated micro tube)

$2.60/sample for blood glucose (glucometer),

$2.50/sample for plasma glu

**MI2056 Tail Vein Injection**
Keywords: injection, tail vein

Tail Vein Injection

**MI2057 IP Injection**
Keywords: injection

Intraperitoneal injection or IP injection is the injection of a substance into the peritoneum (body cavity)

**MI2058 Plasma glucose (using a colorimetric kit)**
Keywords: glucose, plasma

Plasma glucose (using a colorimetric kit)

**MI2059 Plasma insulin (using a ELISA kit)**
Keywords: insulin, plasma

Plasma insulin (using a ELISA kit)

**MI2060 Plasma NEFA (using a colorimetric kit)**
Keywords: NEFA, plasma

Plasma non-esterified fatty acids (NEFA) (using a colorimetric kit)

**MI2061 Plasma TG (using a colorimetric kit)**
Keywords: plasma, triacylglycerides

Plasma triglyceride (TG) (using a colorimetric kit)

**MI2062 Tissue glycogen content**
Keywords: glycogen synthesis, tissue

Tissue glycogen content

**MI2063 Tissue TG content**
Keywords: tissue, triacylglycerides

Tissue triglyceride (TG) content

**MI2064 Laboratory Assistance and Training**
Keywords: training

Laboratory Assistance and Training

**MI2065 Surgical Training and Supplies, Surgical cannulations of Jugular vein and/or carotid artery**
Keywords: artery, cannulation, carotid, jugular, surgery, training, vein

Surgical Training and Supplies, Surgical cannulations of Jugular vein and/or carotid artery

**MI2066 Surgical Training and Supplies, Carotid catheters (micro-renathane)**
Keywords: artery, carotid, catheterization, surgery

Surgical Training and Supplies, Carotid catheters (micro-renathane) – 2 sizes for mice with BW 15-25g and 26-35g, respectively

**MI2067 Surgical Training and Supplies, Jugular vein catheters (silicon tubing)**
Keywords: catheterization, jugular, surgery, vein

Surgical Training and Supplies, Jugular vein catheters (silicon tubing)

**MI2068 Surgical Training and Supplies, Dual-catheter Exteriorizing Connector**
Keywords: catheterization, surgery, training

Surgical Training and Supplies, Dual-catheter Exteriorizing Connector (for subcutaneous implantation between shoulder blades)

**MI2070 APC Housing Per diem (Transfer of care from ULAM to APC)**
Keywords: mouse husbandry and transfer

**MI2071 Breeding Colony Care**
Keywords: mouse husbandry and transfer

**MI2072 Technician Time**
Keywords: mouse husbandry and transfer

**MI2073 Data Analysis**
Keywords: data analysis

**MI2500 Spatial Object Recognition**
Keywords: behavior, cognitive function, learning, memory

Spatial Object Recognition

**MI2501 Novel Objective Recognition**
Keywords: cognitive function

Novel Objective Recognition

**MI2502 Morris Water Maze**
Keywords: water maze

The Morris water maze is a behavioral procedure widely used in behavioral neuroscience to study spatial learning and memory. It enables learning, memory, and spatial working to be studied with great accuracy and can also be used to assess damage to particular cortical regions of the brain.

**MI2503 Home Cage (Ethovision or Photobeam)**
Keywords: Activity, behavior, Motor

Home Cage (Ethovision or Photobeam)

**MI2504 Open Field Test (Ethovision or Photobeam) Moto Activity**
Keywords: Activity, behavior, Motor, physical activity

Open Field Test (Ethovision or Photobeam) Moto Activity

**MI2505 Open Field Test (Ethovision or Photobeam) Anxiety**
Keywords: anxiety, behavior

Open Field Test (Ethovision or Photobeam) Anxiety

**MI2506 Elevated Plus Maze (Ethovision)**
Keywords: anxiety, behavior

The elevated plus maze is a well-characterized behavioral paradigm, one of the most used tests for anxiety research. The maze contains two open arms and two closed (wall-sheltered) arms and relies upon the animal's natural tendency to stay in enclosed spaces and their unconditioned fear for open spaces and heights. In short, anxious animals will spend more time in the closed arms than less anxious animals.

**MI2507 Novelty Suppressed Feeding Test**
Keywords: anxiety, behavior, depression

This task assesses the ability of the animal to resolve a conflict between a context that induces heightened anxiety and a drive to approach an appetitive stimulus. This task is also used as a marker task for assessing potential anxiolytic drug efficacy in humans, as mice require chronic administration of anxiolytics to show decreased anxiety-like behavior on this task.

**MI2508 Forced Swim Test**
Keywords: anxiety, behavior, depression

This task is used to assess depressive-like behavior (or a form of learned helplessness). Animals that are considered more depressive tend to give up sooner and more completely when faced with a high degree of adversity.

**MI2509 Tail Suspension Test**
Keywords: anxiety, behavior, depression

This task is used to assess depressive-like behavior (or a form of learned helplessness). Animals that are considered more depressive tend to give up sooner and more completely when faced with a high degree of adversity.

**MI2510 Conditioned Place Preference**
Keywords: behavior, reward

Conditioned place preference (CPP) is a form of Pavlovian conditioning used to measure the motivational effects of objects or experiences

**MI2511 Wheel Running (home cage, low profile RF running wheels)**
Keywords: behavior, reward

Wheel Running (home cage, low profile RF running wheels)

**MI2512 Operant Conditioning**
Keywords: behavior, reward

An operant conditioning chamber permits experimenters to study behavior conditioning (training) by teaching a subject animal to perform certain actions (like pressing a lever) in response to specific stimuli, such as a light or sound signal.

**MI2513 Locomotor sensitization/tolerance**
Keywords: behavior, reward

Locomotor sensitization/tolerance

**MI2514 General Activity**
Keywords: behavior

General Activity

**MI2515 Training**
Keywords: behavior

Training

## Microvascular Complications Core

**MI30001 Optokinetic measurements of visual acuity and contrast sensitivity**
Keywords: contrast sensitivity, visual acuity

Quantify the spatial vision of lab animal

**MI30002 Retinal microstructure imaging by optical coherence tomography (OCT)**
Keywords: OCT, retinal layer

Acquire the microstructure image of retina in live animal

**MI30003 Retinal vascular permeability**
Keywords: permeability, retinal layer

Quantify albumin leakage from blood vessels into the retina

**MI30004 Retinal cell death**
Keywords: apoptosis, retinal layer

Measure retinal cell death with ELISA

**MI30005 Electroretinogram (ERG)**
Keywords: neural control

Full-field dark-adapted and light-adapted ERGs for studying the electrophysiology and neural function of the eye

**MI30006 Fundus imaging**
Keywords: imaging, retinal layer

Acquire fundus image of retina in live animal

**MI30007 Intravitreal injection**
Keywords: injection

Intravitreal (intraocular) delivery of test compound into the eye

**MI30021 Sciatic Motor NCV**
Keywords: conduction, Motor, NCV, nerve, SMNCV, velocity

The sciatic nerve conduction assay measures conduction velocity of the largest caliber motor axons in the sciatic nerve. Isoflurane is used to anesthetize the animal and the procedure takes approximately 15 minutes per animal. The maximum number of mice per day is 18.

**MI30022 Sural Sensory NCV**

Keywords: conduction, NCV, nerve, sensory activation, Sural, velocity

The sural nerve conduction assay measures conduction velocity of the largest caliber sensory axons in the lower leg (sural nerve). Isoflurane is used to anesthetize the animal and the procedure takes approximately 15 minutes per animal. The maximum number of mice per day is 18

### MI30023 Intra-epidermal Nerve Fiber Density

Keywords: fiber density, IENFD, nerve

Intra-epidermal nerve fiber density measures the small fiber nerve density in foot skin. Maximum number of mice per day is 18. Investigators should contact the center prior to harvesting the mouse to confirm proper processing. Failure to process tissue appropriately will destroy the small fibers.

### MI30024 Thermal Hindpaw Withdrawal

Keywords: hindpaw, hp, thermal

Thermal hindpaw withdrawal measures the latency of withdrawal to a thermal stimulus. The assay takes several hours and the maximum number of mice per day is 18. Mice need several days to acclimate prior to testing.

### MI30025 Cryoembedding

Keywords: cryoembedding

Investigators should make arrangements regarding the fixation, solutions used, shipping and the orientation of the tissue desired before animals are harvested and sent to core.

### MI30026 TBARS

Keywords: lipids peroxidation, TBARS

TBARS is a measure of lipid peroxidation. MDA (malondialdehyde) is formed from the decomposition of unstable peroxides of polyunsaturated fatty acid and TBARS is measured through a controlled reaction with MDA and thiobarbituric acid. Please contact core for tissue amounts and shipping instructions.

### MI30050 Qualitative light microscopic renal histopathology

Keywords: histology, microscopy

This includes evaluation of arteriolopathy, tubulointerstitial disease of any type, and general glomerular morphology.

### MI30051 Quantitative mesangial matrix evaluation

Keywords: Mesangial matrix

PAS stain and morphometric analysis of mesangial matrix expansion.

### MI30052 Quantitative electron microscopic measurement of glomerular basement membrane

Keywords: GBM thickness, Glomeruli, microscopy

Electron microscopic ultrastructural evaluation and quantitiation of glomerular basement membrane thickening.

### MI30053 Podocyte counts/glomerulus

Keywords: Glomeruli, Podocyte

Estimation of podocyte density to assess podocyte loss.

### MI30054 Glomerular harvest for protein or RNA

Keywords: Glomeruli, protein, RNA

Isolation of glomeruli for molecular analysis.

### MI30055 Immunoblot for glomerular lysates

Keywords: Glomerular protein, Glomeruli, protein

Analysis of protein expression from isolated glomeruli.

**MI30056 24 hour urine collection for albumin and creatinine**
Keywords: Albuminuria, creatinine, urinalysis, urinary albumin excretion (UAE), urine

Metabolic cages are used to collect urine for analysis of kidney function.

**MI30057 Spot urine collection for albumin and creatinine**
Keywords: kidney, urinalysis, urinary albumin excretion (UAE), urine

Faster, but less precise, method for urine collection for analysis of kidney function.

**MI30058 Glomerular filtration rate (GFR) determination with minipump inulin clearance**
Keywords: glomerular filtration, kidney

Gold standard method for measuring kidney function employing subcutaneously implanted osmotic minipump releasing inulin, followed by timed collections of blood and urine.

**MI30059 Tail cuff Blood Pressure (BP) determination**
Keywords: blood pressure, tail-cuff

Standard noninvasive method for measuing blood pressure with miniaturized cuff using CODA® mouse tail-cuff system (Kent Scientifics)

## Microbiome Core

**MI4001 Study design consultation**
Keywords: consultation, study design

Study design consultation for microbiome experiments. Initial consults are included as part of the MMPC.

**MI4002 DNA extraction single plate with controls**
Keywords: DNA, extraction, isolation

DNA extraction using the MoBio PowerMag Microbiome kit for epMotion. Up to 94 client samples/controls and 2 core controls

**MI4003 Illumina 16S rRNA gene sequencing, V4 region 0.25 run**
Keywords: gene sequencing, RNA

Illumina 16S rRNA gene sequencing V4 region MiSeq 2x250, PE- one 96 well plate, 0.25 MiSeq run

**MI4004 Analysis of Sequencing Data - Mothur pipeline**
Keywords: gene sequencing, RNA

Analysis of data of 16S rRNA gene sequencing data using the Mothur pipeline.

# VANDERBILT UNIVERSITY SCHOOL OF MEDICINE

## Metabolic Regulation Core

**V3000 Jugular Vein or Carotid Artery Catheterization**
Keywords: artery, catheterization, surgery, vein

Jugular Vein or Carotid Artery Catheterization (please specify in your order).

### V3001 Cannulation of cerebral ventricle

Keywords: central control, CSF, surgery

Implantation of a cerebral ventricle cannula allows investigators to evaluate physiological responses following central administration of various compounds. Anesthetized mice are placed in a digital stereotaxic apparatus (0.001 mm accuracy, Cartesian Instruments) specifically designed for mice. The dorsal scalp will be shaved, wiped with a betadine solution, and then a small midline incision over the dorsal surface is made to allow access to the cranium. After the affixed centering scope is used to "zero" lambda and bregma landmarks, a single guide cannula (2.5 mm length, 26-gauge, Plastics One) is positioned 1.0 mm above the lateral ventricle (coordinates: 0.6 mm posterior to bregma, 1.5 mm lateral to midline, 1.4 mm below the surface of the skull) and fixed to the skull using two stainless steel screws and dental cement. The incision in the scalp is then closed with surgical thread. Animals are removed to a post-surgical warming bed, and then individually housed for several hours until fully awake. Animals will be allowed to recover from surgery for a minimum of 7 days prior to testing, during which time a 30-gauge dummy cannula is left inside the guide cannula to prevent blockage.

### V3002 Jugular vein and carotid artery catheterization

Keywords: artery, blood vessel, catheterization, chronic, insulin, insulin action, surgery, vein

Arterial catheterization allows investigators to sample arterial blood as required for adequate glucose clamping (Niswender et al. J. Biol. Chem, 1997, Halseth et al. Am. J. Physiol. 1999) or other infusion/sampling purposes (Rottman et al. Am. J. Physiol. 1999) Catheterization of the right jugular vein allows the infusion of hormones, substrates, and tracers into the systemic circulation. The jugular venous catheter can be used to sample venous blood in long-term experiments because the jugular vein catheter will work for almost a month.

Arterial catheters are made from polyethylene tubing (PE-10) that is connected to silicone tubing (0.3 mm I.D., and 0.64 mm O.D.), 25 mm long. Jugular vein catheters are made from silicone tubing (0.3 mm I.D., and 0.64 mm O.D.). These catheters are connected to stainless steel tubes (0.3 mm I.D., 0.41 mm O.D., 15 mm) bent into an L shape. On the free end of the L shaped stainless steel tube a 20 mm piece of micro-renathane tubing (0.36 mm I.D., and 0.84 mm O.D.) is attached. The L shaped stainless steel tubes, attached to an arterial and a jugular vein catheter, are bundled together with silicone tubing (0.76 mm I.D. and 1.65 mm O.D.) and anchored with silastic medical adhesive (Silicone Type A). The catheters and the micro-renathane-stainless steel tubing will be heat sterilized.

The mouse is anesthetized and its skin on the interscapula and ventral surface of the neck is depilated by plucking. The depilated area is sterilized with 10% povidone-iodine. A small longitudinal incision (about 5 mm) is made in the skin over where the anterior jugular, acromeodeltoid, and cephalic veins join together. The connective tissues surrounding this junction are carefully removed. Two thin threads of silk (6-0 Silk, Davis+Gech) are passed under the jugular vein below the level of the junction. They are separated by about 3 mm. The cephalic thread, placed just below the joint, is tied to prevent bleeding. A small incision is then made just below the ligature, and the catheter is pushed 13 mm into the lumen. The catheter is fixed with the second thread and the thread previously used to tie the jugular vein. The common carotid artery is separated from the vagus nerve and muscle, and then two thin threads of silk (6-0 Silk, Davis+Gech) are passed under the artery. The cephalic thread is tied to prevent bleeding and then the artery is clamped by small bulldog clamp. A small incision is made just below the ligature, and the catheter is inserted into the lumen. The clamp is taken off and the catheter is pushed in 10 mm. The catheter is fixed with a second thread and the thread previously used to prevent bleeding. A blunt needle (16 gauge) is carefully inserted through the incision on the interscapula and pushed subcutaneously until the end comes out through the incision in the neck. The catheters will be carefully seized and pulled slowly through the needle. The incisions in the skin are then sutured. The catheters are connected to the stainless steel tubes. The bent portion of the stainless steel tubing is implanted under the skin and the incision is sutured. The implanted catheter is flushed with saline containing 200 U heparin/ml and 1 mg ampicillin/ml. Then the micro-renathane tubing is closed with a stainless steel wire. The mouse is injected subcutaneously with 150 mg/kg ampicillin. The total duration of the operation is about 50 min. Animals are removed to a post-surgical warming bed, and monitored until fully awake. Postoperative body weight and food intake are measured daily.

### V3003 Glucose Tolerance Test (Oral, i.p., Intravenous, or gastric catheter)

Keywords: carbohydrate, diabetes, glucose intolerance, glucose tolerance, insulin, insulin action, insulin resistance, insulin sensitivity

Oral glucose tolerance tests are performed on conscious mice with catheters chronically implanted directly in the stomach and the carotid artery. Intravenous glucose tolerance tests are performed on conscious mice with catheters chronically implanted in the jugular vein and carotid artery. Glucose will be given at 1g/kg or 2g/kg. These doses lead to peak blood glucose levels of 250 mg/dl to 400 mg/dl in wild type C57/bl/6 mice.

### V3004 Glucose turnover

Keywords: carbohydrate, clamp, diabetes, endogenous glucose production, flux, glucose flux, glucose kinetics, glucose

turnover, insulin, insulin action, insulin resistance, isotopes, kinetics, liver, liver function, tracers

A primed (2 µCi) continuous infusion of [3-3H]glucose (0.4 µCi/min) is used to assess the rates of glucose appearance (Ra) and disappearance (Rd). Tracer is infused to allow a steady state to be reached then blood samples are taken to assess arterial glucose specific activity. Ra will be estimated as the ratio of the rate of infusion of [3-3H]glucose and the steady state plasma [3H] glucose specific activity (dpm/mg). Under steady state conditions, the rate of glucose disappearance (Rd) equals the rate of glucose appearance. The rate of glucose clearance is calculated by dividing the Rd by the arterial glucose concentration. Application of this technique is described by Niswender et al. J. Biol. Chem. 1997, and She et al. Mol. Cell. Biol. 2000.

### V3005 Hyperinsulinemic clamp

Keywords: clamp, diabetes, endogenous glucose production, glucose, glucose disposal, glucose uptake, hyperinsulinemic clamp, insulin, insulin action, insulin resistance

The hyperinsulinemic clamp is used to measure insulin action in vivo. Hyperinsulinemic clamps are performed on conscious mice with catheters chronically implanted in the jugular vein and carotid artery. A continuous infusion of insulin is given. Glucose levels are monitored in arterial samples every 5-10 min using an Accuchek glucose analyzer that allows the analysis of glucose with only 1 µl of blood. Glucose is infused in the jugular vein catheter at rates necessary to achieve the desired glucose level, based on feedback from arterial glucose measurements. These methods allow assessment of the responsiveness of the body to insulin. Blood from a donor animal is infused to maintain blood volume. By combining this technique with the tracer method one can also examine the impact of insulin on suppression of endogenous glucose production. (1, 2)

1. Ayala JE, Bracy DP, Malabanan C, James FD, Ansari T, Fueger PT, et al. Hyperinsulinemic-euglycemic Clamps in Conscious, Unrestrained Mice. J Vis Exp. 2011:e3188.

2. Halseth AE, Bracy DP, Wasserman DH. Overexpression of hexokinase II increases insulin and exercise-stimulated muscle glucose uptake in vivo. Am J Physiol. 1999 1/1999;276(1 Pt 1):E70-E7.

### V3006 Hyperglycemic clamp

Keywords: clamp, diabetes, glucose, hyperglycemic clamp, insulin, insulin resistance, insulin secretion, insulin sensitivity

The responsiveness of the pancreas to glucose is assessed using the hyperglycemic clamp. Hyperglycemic clamps are performed on conscious mice with catheters chronically implanted in the jugular vein and carotid artery. Our clamps include 11 arterial insulin measurements and 3 arterial c-peptide measures.

A defined hyperglycemic stimulus is created using a primed variable glucose infusion to raise the glucose level to twice basal for 120 min. An established priming algorithm is used to elevate glucose quickly.

Mice with extra copies of the glucokinase gene locus were demonstrated to have a blunted insulin response to hyperglycemia using this technique (Niswender et al. J. Biol. Chem. 1997).

### V3008 Glycogen synthesis

Keywords: carbohydrate, diabetes, flux, glycogen synthesis, isotope, liver, liver function, tracer

Using [U-14C]glucose, the incorporation of the carbon of glucose into glycogen can be measured. If the ratio of [14C]UDP-glucose to blood glucose specific activity is assessed the fraction of glycogen formation from direct and indirect pathways can be calculated.

### V3009 Amino acid kinetics

Keywords: amino acid flux, amino acid kinetics, isotopes, metabolite

The turnover of phenyalanine (3H ring 2,3,4,5,6 phenylalanine) , glutamine (U-14C-glutamine) and leucine (1-14C-leucine) is assessed by a primed continuous infusion of their respective isotopes for 2 hours (0.2-0.4 µCi/min). Blood samples (20 µl) are taken after a steady state is reached to assess plasma amino acid specific activity. Blood samples are mixed with an equal volume of 6% sulfosalicylic acid. Incorporation of tracer in tissue protein is used to assess tissue specific protein synthesis.

### V3010 Tissue specific glucose uptake

Keywords: 2-deoxyglucose, carbohydrate, diabetes, glucose metabolic index, insulin, insulin action, insulin sensitivity, tissue specific glucose uptake

Tissue specific glucose uptake is assessed by measuring the tissue specific uptake of [2-3H]-deoxyglucose([2-3H]DG). [2-3H]DG is infused (0.2 µCi/min) for 40 minutes or injected (12 µCi) . Arterial plasma samples are taken to determine the time course of [2-3H]DG during the 40 min period. [2-3H]DG is transported into cells and phosphorylated to yield [2-3H]DG-6-phosphate which is trapped in muscle. After 40 min mice are anesthetized with an intravenous infusion of pentobarbital and tissues of interest are rapidly removed and frozen in liquid nitrogen. This method has been applied during insulin- and exercise-stimulated conditions (Halseth et al. Am. J. Physiol. 1999).

### V3011 Tissue specific fatty acid uptake

Keywords: 125I-BMIPP, flux, isotope, lipids, obesity, tissue specific fatty acid uptake, tracer

Tissue fatty acid uptake is assessed by measuring tissue-specific incorporation of circulating 125I-BMIPP (Rottman et al. Am. J. Physiol. 2002). The beta-methyl modification of the long-chain fatty acid BMIPP (beta-methyl-p-iodophenylpentadecanoic acid) causes terminal trapping in the TCA cycle. Studies in man and a variety of small animal models, including rodents, have shown that BMIPP uptake and metabolism closely tracks that of endogenous long-chain fatty acids in a variety of normal and pathophysiologic states.

BMIPP is dissolved in proprionic acid, and incorporation of 125I is catalyzed with CuSO4. After extraction, the purified 125I-BMIPP is dissolved in ursodeoxycholic acid, filtered, and adjusted to defined activity. This stable compound is suitable for direct intravascular injection. Serum levels are stable in tracer amounts after injection, and tissue incorporation is measured by gamma counting of freeze-clamped samples in protocols compatible with the simultaneous assay of, for example, [2-3H]DG.

### V3013 Exercise capacity/Exercise Stress Test (metabolic response to exercise)

Keywords: Activity, endurance, exercise capacity, exercise stress test, exercise tolerance

Exercise is an integrated measure of fitness. Abnormal exercise capacity and decreased activity are a hallmark of most severe cardiovascular and metabolic diseases, and changes in exercise capacity are sensitive and early markers of cardiac and metabolic dysfunction. Thus abnormalities can be revealed with exercise that may not otherwise be manifested. Gas exchange techniques can be used during treadmill exercise in the mouse to describe the metabolic cost of exercise. Substrate fluxes and metabolism can be assessed isotopically during exercise in chronically catheterized mice (Halseth et al. Am. J. Physiol. 1999).

Treadmill exercise can be used to quantify the capacity of a mouse for either endurance or high intensity exercise. Peak exercise capacity and VO2 max will be measured using a closed gas exchange treadmill. Acclimated mice will exercise will at 10 m/min, 0° grade, increased to 14 m/min, 3 minutes later and then increased by 4 m/min a every 3 min thereafter up to 46 m/min or until mouse is exhausted. Exhaustion is defined as the mouse sitting on the shock pad and unable to get off. Time to exhaustion and speed at exhaustion is recorded.

### V3017 Assess real time imaging of cellular metabolic events

Keywords: imaging, metabolism, microcirculation, real time imaging

Assess real time imaging of cellular metabolic events will be done.

### V3018 In vivo optical imaging of gene expression

Keywords: Function, gene expression, GFP, imaging, luciferase, transcription

In vivo optical imaging of gene expression will be done.

### V3094 Direct jugular vein injection and blood sampling

Keywords: blood sampling, blood vessel, conscious animal, drug infusion, vein

Direct jugular vein injection and blood sampling is done on conscious mouse.

### V3099 Albuminuria

Keywords: complications, diabetes, kidney, kidney disease, protein, urinary albumin excretion (UAE), urine

Mouse urinary albumin excretion rate can be determined by two methods: (1) measuring the albumin to creatinine ratio in spot urine sample; (2) measuring albumin concentration in urine collected over 24 hours using metabolic cage. Urinary albumin and creatinine concentration will be determined using cartridge-based DCA2000 (Bayer Diagnostics) or ELISA kits (Exocell Inc).

### V4005 Glycemic Control using Minimed
Keywords: glucose

Blood glucose levels over 72 hours can be monitored in conscious mice using Medtronic MiniMed CGMS System (Medtronic). In this system, blood glucose level is determined based on glucose concentration in interstitial fluid. A correlation between glucose levels in the blood and interstitial fluid in mice has been previous demonstrated. A fiber probe will be implanted subcutaneously. This probe will detect interstitial glucose levels every ten seconds over three days and the signals will be stored in a glucose monitor. The probe will be removed after the experiment and the mice can be sent back to the researcher.

### V4006 Personnel Training
Keywords: advice, course, training

Personnel Training (experimental or surgical training)

### V4007 Surgical Training
Keywords: surgery, training

Surgical training for a variety of surgery techniques (catheterization, telemetry, bariatric surgery, implants)

## Cardiovascular Pathophysiology

### V3030 In vitro Morphology, Morphometrics and Histology (isolated heart)
Keywords: cardiac function, isolated organ and cell perfusion, morphology

A limited necropsy is conducted, noting gross observations, and removing and weighing the heart and lungs separately. After fixation, the heart is sectioned in a standard four-chamber view. Digital photographs on each heart is recorded and archived in a web-accessible format. Chamber and mural dimensions will be measured. The fixed hearts will be maintained in a physical archive, while one slice will be paraffin embedded. 4-5 sections will be cut and prepared for H& E and Masson trichrome. Digital photomicrographs will be recorded and archived together with summary evaluations. A cardiologist with special expertise in mouse cardiac development and histology reviews all gross and microscopic sections.

### V3031 Echocardiography, in vivo morphology, systolic and diastolic function; Stress echocardiography
Keywords: cardiac function, diastolic, ECG, echo, echocardiography, EKG, electrocardiography, morphology, pulsed Doppler, strain imaging, stress, systolic, vascular function

Echocardiography is a non-invasive technique that can detect the presence of localized or generalized hypertrophy or thinning of the myocardium of the left ventricle (LV) and the presence of regional or global wall motion abnormalities associated with systolic dysfunction. The application of transmitral Doppler analysis allows the detection of abnormal filling patterns associated with LV diastolic dysfunction.

The core employs two echocardiography systems, one for high resolution imaging and a high throughput lower resolution imaging system. Echocardiography can be performed on conscious as well as anesthetized mice. In addition to imaging under basal conditions, the mice may undergo stress testing following the administration of dobutamine.

(1) Low-Resolution Echocardiography. A 15 MHz linear-array transducer (Sonos 5500, Agilent) is used for high throughput echocardiography in conscious mice. Measurements include LV wall thickness in the intraventricular septum and posterior wall, diastolic and systolic LV diameter, and heart rate. Fractional shortening and ejection fraction are computed as a measure of systolic function. This system also allows for transmitral Doppler analysis that can detect abnormal filling patterns associated with LV diastolic dysfunction.

(2) High-Resolution Echocardiography. The Vevo 2100 Imaging System (VisualSonics) utilizes a ultra-high frequency 18-38 MHz linear-array transducer with a digital ultrasound system for superior imaging of mouse cardiac morphology and function as well as Doppler analysis. Measurements include those described for the low-resolution echo. In addition, the VevoStrain analysis software provides a highly sensitive speckle-tracking based echocardiographic imaging technique that offers quantitation of the velocity of the walls, displacement, strain, strain rate, and time to peak analysis.

### V3034 Vascular morphology
Keywords: atherosclerosis, blood vessel, circulation, histology, vascular, vascular function

A variety of tissues (heart, aorta, kidney, brain) can be processed in four µm sections. Aortic sections are examined for wall thickening, perivascular fibrosis, and fibrin deposition. The inner border, the lumen outer border, the tunica media are traced in each arterial image with Masson's trichrome stain and imaged at a magnification of 200X. The lumen ratio (the medial thickness to internal diameter and the area fibrosis (collagen deposition stained with aniline blue) surrounding blood vessels are calculated and compared. Perivascular fibrosis is determined as the ratio of the area of fibrosis surrounding the vessel wall to the total vessel area.

### V3036 Tail vein injections

Keywords: cardiac, drug infusion, vein

Tail vein injections are done in the conscious mouse.

### V3095 Myocardial infarction

Keywords: artery, cardiac injury, cardiac remodeling, coronary ligation, heart failure, infarct

Models of Cardiac Injury and Pressure Overload

Cardiovascular complications in metabolic diseases typically represent additive or synergistic effects of compound insults, i.e. phenotypic stresses (hypertension, myocardial infarction, etc.) and genetics. The ability to superimpose phenotypic stresses on transgenic or knockout mouse models allows for comprehensive and reproducible screening for cardiovascular complications and consequences of metabolic disease and diabetes in the mouse.

The core employs three widely used surgical models to induce cardiac stress or injury: 1) myocardial infarction, 2) myocardial ischemia-reperfusion injury, and 3) transverse aortic constriction.

Myocardial Infarction. The mouse myocardial infarction (MI) model is achieved by ligating a suture around the left main coronary artery of the LV thereby causing the infarction. The MI model is widely used for evaluating the response to myocardial injury or dysfunction. It also forms the basis for the majority of studies of myocardial repair, often obtained with stem cell injection. This model has been reliably implemented in the core with excellent survival, reproducible infarct size, and the ability to couple the infarction with long-term monitoring, stem cell injection, or metabolic studies. As an alternative to the coronary ligation method, an infarct can be induced by LV placement of a cryoprobe. This provides a smaller and more precisely sized infarct, with clear delineation of the border zone.

### V3096 Myocardial ischemia reperfusion

Keywords: artery, cardiac injury, ischemia, reperfusion injury

Models of Cardiac Injury and Pressure Overload

Cardiovascular complications in metabolic diseases typically represent additive or synergistic effects of compound insults, i.e. phenotypic stresses (hypertension, myocardial infarction, etc.) and genetics. The ability to superimpose phenotypic stresses on transgenic or knockout mouse models allows for comprehensive and reproducible screening for cardiovascular complications and consequences of metabolic disease and diabetes in the mouse.

The core employs three widely used surgical models to induce cardiac stress or injury: 1) myocardial infarction, 2) myocardial ischemia-reperfusion injury, and 3) transverse aortic constriction.

Myocardial Ischemia Reperfusion. Myocardial ischemia reperfusion injury is achieved in the same way as the MI model, except the suture is occluded for 10-15 minutes of ischemic time followed by release of the suture and reperfusion.

### V3097 Transverse aortic constriction

Keywords: artery, cardiac injury, heart failure, hypertension, hypertrophy, pressure overload, TAC

Models of Cardiac Injury and Pressure Overload

Cardiovascular complications in metabolic diseases typically represent additive or synergistic effects of compound insults, i.e. phenotypic stresses (hypertension, myocardial infarction, etc.) and genetics. The ability to superimpose phenotypic stresses on transgenic or knockout mouse models allows for comprehensive and reproducible screening for cardiovascular complications and consequences of metabolic disease and diabetes in the mouse.

The core employs three widely used surgical models to induce cardiac stress or injury: 1) myocardial infarction, 2) myocardial ischemia-reperfusion injury, and 3) transverse aortic constriction.

Transverse Aortic Constriction. Transverse aortic constriction (TAC) or aortic banding induces a pressure-overload on the heart and is achieved by placing a constriction around the transverse aorta. A successful TAC is confirmed by

Doppler analysis of the flow velocity across the aortic constriction. Myocardial remodeling in the TAC mouse can be sequentially monitored by echocardiography as the heart progresses from the compensatory stage to decompensation and heart failure.

### V3098 GFR-FITC-Inulin; HPLC Cr

Keywords: glomerular filtration, HPLC

GFR will be measured in conscious mice based on the decay rate of plasma FITC-inulin following a single bolus intravenous injection of FITC-inulin. This method does not require urine collection, and GFR can be periodically measured in same mouse.

Additional approach for determining GFR in conscious mouse is based on creatinine clearance rate. Mouse 24-hour urine will be collected using metabolic cage. Plasma and urinary creatinine concentration will be determined using HPLC approach.

### V4000 Renal Blood Flow (Doppler)

Keywords: blood flow, blood pressure

Mouse renal cortical and medullary blood flow can be measured using a laser-doppler flowmeter (Tansonic Systems Inc). This system will also monitor blood pressure and heart rate. Renal function including urinary electrolyte excretion can be studied.

### V4002 Osmometer Plasma/Urine

Keywords: osmolality, urine

Plasma and urine osmolality will be determined using a freezing point osmometer (Precision System Osmette). This measurement requires 50 µl of plasma or urine.

### V4003 Urine Ca/Phosphorus Excretion

Keywords: urine

Calcium and phosphorus are two important electrolytes in the urine. The concentration of urinary calcium and phosphorus will be determined using colorimetric assay (BioAssay Systems). The measurement for calcium and phosphorus requires 5 µl and 50 µl of urine, respectively.

### V4004 Urine pH

Keywords: pH, urine

The pH can be determined in as little as 5 µl of urine (or other body fluid) using a Mini Combo pH Electrode (World Precision Instruments).

## Analytical Resources Core

### V3050 Insulin

Keywords: carbohydrate, diabetes, hormone

30-100 ul plasma for duplicate analysis is typical, but the required sample volume depends on the hormone concentration and dilution factor. The assay range is 0.01-0.5 ng/ml (sensitive assay) and 0.1-10 ng/ml (regular assay) with 300 ul (so with 30 ul the detection range is 0.1-5 ng/ml for the sensitive assay and 1-100 for the regular assay). 5-day double antibody assay. Interspecies and human-specific assays are available.

### V3051 Glucagon - ELISA

Keywords: counter-regulation, hormone, lipids

25 or 60 ul plasma for duplicate analysis, depending on the assay. Improved sensitivity and specificity and smaller sample volume compared to RIA. *Requires a minimum # of samples before it can be performed. Little or no cross-reactivity to peptides oxyntomodulin, glicentin, mini-glucagon, GLP-1, GLP2 or GRPP. Detection range 2-180 or 1.5-130 pmol/l (5-453 pg/ml), respectively.

### V3052 Corticosterone

Keywords: glucocorticoid, hormone, stress

15 µl plasma for duplicate analysis. 1-day double antibody assay. Detection range: 25-1000 ng/ml.

### V3053 Catecholamines (epinephrine & norepinephrine only)

Keywords: hormone, stress

50 ul plasma or supernatant from tissue prep (not urine). Needs EGTA-glutathione added at the time of collection (if not added see FAQ). 1-day assay. Detection range: 25-1000 pg/ml (smaller extraction volume allow for measurement of concentrations >1000 pg/ml). Store samples at -70°C.

### V3054 Leptin (Luminex assay)

Keywords: adipokine, diabetes, feeding behavior, hormone, leptin, obesity

Available as a Luminex assay. The first analyte within a panel is $39.93 and each additional analyte within the same panel is $6.60, per sample in duplicate (e.g., to measure three analytes from panel 1= $39.93+$6.60+$6.60 and two analytes from panel 2 = $39.93+$6.60)

### V3055 C-peptide (Luminex assay)

Keywords: hormone, insulin, insulin action, insulin secretion

Available as a Luminex assay. Needs EDTA/Trasylol added at the time of collection. The first analyte within a panel is $39.93 and each additional analyte within the same panel is $6.60, per sample in duplicate (e.g., to measure three analytes from panel 1= $39.93+$6.60+$6.60 and two analytes from panel 2 = $39.93+$6.60)

### V3059 PRL (prolactin)

Keywords: fertility, hormone, prolactin

Prolactin is assayed in a double-antibody RIA format. 25 micro liters of plasma is required for the assay. A dilution step is required and is 5-day double antibody assay. The lower limit of detection if 1.5ng/ml.

### V3060 ACTH

Keywords: adrenocorticotropic hormone, corticotropin, glucocorticoid, hormone, stress

55 ul plasma for duplicate analysis is typical, but the required sample volume depends on the hormone concentration and dilution factor. The assay range is 5-100 pg/ml with 300 ul (so with 55 ul the detection range is 27-545 pg/ml). 5-day double antibody assay.

### V3067 Testosterone

Keywords: hormone, sex, steroid

25 ul (male) or 35 ul (female) for duplicate analysis is typical, but the required sample volume depends on the hormone concentration and dilution factor. The assay range is 0.005-1 ng/ml with 300 ul (so with 25 ul the detection range is 0.06-12 ng/ml). 2-day double antibody assay.

### V3070 Plasma lipids

Keywords: cholesterol, fatty acids, lipids, metabolism, obesity

Enzymatic Free Fatty Acid Test Price - $15.60

Total plasma cholesterol and triglyceride are measured by standard enzymatic assays. HDL cholesterol is measured with the enzymatic method after precipitation of VLDL and LDL using dextran sulfate and Mg++. Using these data LDL cholesterol can be calculated using the Friedewald equation, if triglyceride levels are below 400 mg/dl. Investigators may request a total plasma lipid profile or specific plasma lipid measurements.

Free fatty acids are extracted from plasma using heptane/isopropanol. The heptane layer containing FFA is removed, plated on silica gel plates and developed in petroleum ether, ethyl ether, and acetic acid. The FFA band is scraped from the plate and FFA are eluted with heptane /isopropanol. The solvent is removed, and the FFAs are methylated. Methylated fatty acids are analyzed by gas chromatography. Depending on the assay a variety of chromatograph conditions and columns are utilized. A computer identifies each fatty acid peak and can provide data in a number of different ways including quantitation of mass of fatty acid, percent distribution of fatty acids present, quantitation of

total lipid in the sample.

### V3071 Lipid extraction, separation, quantification

Keywords: fatty acids, lipids, metabolism, obesity

Total plasma cholesterol and triglyceride are measured by standard enzymatic assays. HDL cholesterol is measured with the enzymatic method after precipitation of VLDL and LDL using dextran sulfate and Mg++. From these data LDL cholesterol is calculated using the Friedewald equation, as long as triglyceride levels are below 400 mg/dl. Investigators may request a total plasma lipid profile or specific plasma lipid measurements. Plasma FFAs are analyzed with a commercially available enzymatic kit from Wako Life Sciences. Free fatty acids are extracted from plasma using heptane/isopropanol and separated from other lipid classes by thin layer chromatography. The FFAs are methylated and analyzed by gas chromatography. Data: (1) total FFAs present (mg/ml plasma); (2) percent distribution of individual fatty acids in the FFA fraction. Tissue/Cell Lipid Analyses (Phospholipid, Diglycerides, Free Fatty Acids, Triglycerides, and Cholesterol Esters)

Lipids are extracted by the Folch-Lees method. Internal standards are added, and the lipid classes are separated by thin layer chromatography. The appropriate band(s) are scraped from the TLC plate, and the fatty acids from the lipid ester classes are methylated and analyzed by gas chromatography. Results: (1) total amount of lipid class present; (2) fatty acid profiles of the lipid classes presented as percent of total fatty acids. Total unesterified cholesterol is analyzed in the lipid extract by gas chromatography after addition of appropriate internal standard. An aliquot of the lipid extract is dried and saponified at 80 C in 1 N KOH in 90% methanol for 1 hour. The non-saponifiable sterol is extracted into hexane, concentrated under nitrogen, solubilized in carbon disulfide and analyzed by gas chromatography.

Lipoprotein fractions are separated from 100 microliters of plasma (or serum) by gel filtration column chromatography. Approximately 40 fractions (0.5 ml) are collected and the amount of triglyceride and cholesterol in each fraction is determined using microtiter plate, enzyme-based assays. Profiles of triglyceride and cholesterol are constructed. Calibration of the column with purified lipoprotein fractions permits quantitation of each lipid in various lipoprotein classes.

### V3072 Fatty acid profiles of lipid esters by gas liquid chromatography

Keywords: GCMS, lipids, metabolism

Total lipids are extracted and lipid classes separated by TLC as described above. Lipid ester spots are scraped from the plates and methylated. Fatty acids of lipid esters can be methylated without removal of the lipid from the silica gel. However, in some applications, we have found it advantageous to elute the lipid from the silica gel prior to methylation. The fatty acid profile of the lipid class is also determined. By this method total lipid mass and fatty acid profile for each lipid is determined.

### V3073 Quantitation of individual phospholipid classes

Keywords: cholesterol, lipids, metabolism, phospholipids

Individual phospholipid classes are isolated by one dimensional TLC. A total lipid extract is applied to high performance TLC plates. To quantitate the individual classes, the spots are scraped from the plate, eluted and phosphorus is determined. To determine the fatty acid composition of the individual phospholipid classes, the spots are scraped from the plates and fatty acids methylated.

### V3074 Short chain fatty acid analysis by gas liquid chromatography

Keywords: GCMS, lipids, metabolism, short chain fatty acid

Plasma short chain fatty acids are analyzed by the following procedure: to 200 ul of EDTA plasma in a 1.5 ml Eppendorf microfuge tube is added 20 µl of internal standard and 1 ml of absolute ethanol. The sample is mixed thoroughly, centrifuged, and the supernatant is recovered. The sample is evaporated using a Speed Vac and dissolved in 15 µl water, and prior to injection 5 µl of orthophosphoric acid (25%) is added. The short chain fatty acids are separated on a 6' x 2 mm glass column packed with SP-1200/1%H3PO4 on 80/100 Chromosorb W AW.

### V3075 Fast Protein Liquid Chromatographic (FPLC) Lipoproteins Separations

Keywords: cholesterol, fatty acids, lipids, lipoproteins, metabolism

Lipoprotein fractions are isolated using columns arranged in tandem to achieve complete resolution of the major lipoprotein classes from 1-2 ml of plasma. The columns are equilibrated in 50 mM phosphate-buffered saline and calibrated using lipoprotein fractions isolated by ultracentrifugation. Fractions (0.5 ml) are collected and the

appropriate tubes containing the desired lipoprotein fraction(s) combined. The position of the major lipoprotein classes are determined by cholesterol (or triglyceride) assay on the column fractions using a microtiter plate enzyme-based assay. As an alternative method lipoproteins can be isolated by fast protein liquid chromatography.

This includes analysis of the composition of the fraction (protein and lipid) as well as morphologic analysis (sizing) by negative stain electron microscopy. For compositional analysis the lipoprotein fractions protein is analyzed using the BCA method with a modification to eliminate lipid interference. The samples are then lyophilized and delipidated using ethanol and ether. Lipid components are separated by TLC and analyzed by GLC and/or colorimetric assays.

### V3076 Morphometric determinations (aorta)

Keywords: atherosclerosis, blood vessel, histology, vascular, vascular function

Mice are sacrificed and flushed with 30 ml saline. The heart with ascending aorta is embedded and snap-frozen in liquid N2. Cryosections of 10 um thickness are taken from the region of the proximal aorta. Cryosections are stained with Oil Red O and counterstained with hematoxylin. In addition to the aortic cross-sections, whole aortas will be analyzed in "en face" preparations to evaluate the distribution and characteristics of atherosclerotic lesions in the distal aorta. After the removal of the heart and the aortic arch, the entire remainder of the thoracic and abdominal aorta is dissected from the carcass. An incision is then performed longitudinally and for the total length of the specimen, so to expose the inside face. The open face aorta is pinned out on a black cardboard submerged in saline, and then stained with Oil Red O.

### V3080 Gross examinations and necropsy

Keywords: gross examination, histology, necropsy, organs, tissue, tissues

The standard necropsy procedure for diabetic mice includes an examination of the pancreas, heart, liver, eyes, peripheral nerves, peripheral vasculature, fat, and kidneys. Complete, intermediate, or limited necropsies will be performed with or without the aid of a dissecting microscope. Gross pathologic findings will be described, documented by digital photography and organs will be weighed.

### V3081 Tissue preparation, embedding, sectioning and routine staining

Keywords: embedding, histology, organs, sectioning, staining, tissue, tissue preparation

The default fixative will be 4% paraformaldehyde. This offers investigators the option of later performing in situ hybridization or laser microdissection and capture of protein, DNA or RNA from select populations. This fixative provides a minimal degree of cross-linking of the proteins, thereby rendering antigenic sites more accessible. Other fixatives are used as appropriate. If frozen sections are needed, tissues will be snap frozen in liquid nitrogen and sectioned on a cryostat. When molecular analyses are required, tissue samples can also be rapidly placed in Trizol or RNA extraction solutions and stored at -80°C until investigators retrieve their samples.

### V3082 Tissue microdissection

Keywords: diabetes, histology, immunology, insulin, insulin action, laser microdissection, organs, tissue, tissues

Potential applications of laser dissection include the selective microdissection of islet cells for gene expression studies, harvesting and analysis of specific glomerular cells in diabetic nephropathy, and harvesting endothelial cells from diseased microvasculature. This Core has available a PixCell II™ laser capture microdissection device (Arcturus Engineering) and a PALM microdissection scope. These workstations perform laser capture microdissection simply, quickly and precisely. They are capable of locating single cells or large groups of cells and, using a simple aim-and-shoot method to extract them for subsequent molecular analysis (DNA, RNA, or protein).

### V3083 Screen/optimize immunohistochemical protocols for mouse-specific commercial and custom-designed antisera

Keywords: histology, immunohistochemistry, organs, tissue, tissues

To stain mouse tissues with mouse monoclonal antisera we utilize Mouse-on-Mouse (MOM) kits (Vector Labs), Ark kits (DAKO Corp) or HistoMouse Kits. Although peroxidase-based protocols will be the mainstay of the Subcore with visualization by brown DAB or red AEC chromagens, staff is familiar with the alkaline phosphatase-based kit and its detection with the fuschin chromagen. Fluorescently-tagged primary, secondary, or tertiary antibodies in frozen sections, cultured cells, or for co-localization studies will be used as required to tailor protocols to address investigator needs. Non-fluorescent double immunostaining will also be performed in the Pathology Subcore using the Double Label Kit provided by DAKO. When prospective antisera fail to recognize antigenic sites in paraffin embedded sections or produce non-specific staining patterns, we advise investigators to proceed with frozen sectioning.

**V3090 Amino Acids - Full Profile (HPLC)**
Keywords: amino acids, hormone, HPLC, imaging, metabolite, modeling and simulation

50 ul plasma or supernatant from tissue prep (not urine). Detection range: >1 umol/l.

**V3091 Amino Acid - gluconeogenic profile**
Keywords: amino acids, HPLC, metabolite

50 ul plasma or supernatant from tissue prep (not urine). Detection range: >1 umol/l.

**V4010 Ghrelin - Active (RIA)**
Keywords: hormone

30-60 ul plasma for duplicate analysis is typical, but the required sample volume depends on the hormone concentration and dilution factor. The assay range is 5-100 pg/ml with 300 ul (so with 30 ul the detection range is 50-1000 pg/ml). 5-day double antibody assay. Needs Pefabloc SC (AEBSF) added at the time of collection.

**V4011 Ghrelin - Total (RIA)**
Keywords: hormone

30-60 ul plasma for duplicate analysis is typical, but the required sample volume depends on the hormone concentration and dilution factor. The assay range is 100-1000 pg/ml with 300 ul (so with 30 ul the detection range is 1000-10,000 pg/ml). 5-day double antibody assay.

**V4012 Glucose (Enzymatic)**
Keywords: hormone

Glucose is measured by a glucose oxidation method using the Analox GM9 Glucose Analyzer. 40 ul of plasma for duplicate analysis. Detection range: 20-900 mg/dl.

**V4014 Purine Nucleotides (HPLC)**
Keywords: hormone

100 ul supernatant

**V4015 T3 (RIA)**
Keywords: hormone

30-60 ul plasma for duplicate analysis is typical, but the required sample volume depends on the hormone concentration and dilution factor. The assay range is 0.05-5 ng/ml with 300 ul (so with 30 ul the detection range is 0.5-50 ng/ml). 5-day double antibody assay.

**V4016 T4 (RIA)**
Keywords: hormone

30 ul plasma for duplicate analysis is typical, but the required sample volume depends on the hormone concentration and dilution factor. The assay range is 0.5-20 ng/ml with 300 ul (so with 30 ul the detection range is 5-200 ng/ml). 5-day double antibody assay

**V4017 Luminex Assays**
Keywords: hormone, Luminex

Mouse Single Plex Adiponectin Panel

Mouse Cytokine/Chemokine Panel 1

Mouse/Rat IGF-1 Panel

Mouse Th17 Panel

Mouse High Sensitivity T Cell

Mouse Metabolic Hormone Panel

These are most frequently used assays. For more information, go to https://www.vumc.org/hormone/assays

**V4018 Acetaminophen**
Keywords: assay, hormone

Acetaminophen

**V4020 Cortisol - Salivary**
Keywords:

30 ul plasma minimum

**V4021 Creatinine**
Keywords: creatinine

30 ul plasma minimum

## Body Weight Regulation Core

**V3012 Indirect calorimetry / energy expenditure in the Promethion**
Keywords: Activity, basal metabolic rate, body composition, carbon dioxide, CO2 production, energy expenditure, food intake, gas exchange, indirect calorimetry, obesity, oxygen, oxygen consumption, respiratory quotient, water intake, wheel running

Whole body VO2 and VCO2 is measured continuously in conscious mice using a Promethion system (Sable Systems Int). The system is sensitive enough to measure small changes in VO2, VCO2 and RQ. They can be used to measure resting or exercising (running wheels or treadmill) gas exchange and energy expenditure. The Promethion is very advanced, allowing for measurement and control of food or water intake. In the Promethion the animals are housed in regular home cages with normal bedding. Activity is measured using beam breaks and converted to pedestrian locomotion. Food and water intake are very accurately quantified. The system integrates all of these data to monitor behaviors and patterns. Body weight and composition is included and measured before and after the metabolic cages.

All mice remain in the Promethion cages for 5 days with continuous data collection, allowing for acclimation while also providing extensive data. Full data is reported to the investigator in excel format.

**V3014 Spontaneous exercise activity**
Keywords: Activity, exercise, running wheel, spontaneous exercise activity, wheel running

Spontaneous exercise activity is measured using a recording wheel placed in the cage during a 48 h period. The light dark cycle will be stringently controlled to minimize diurnal variations and training effects will be minimized by placing an identical wheel in the cage for the 24 hrs preceding the test measurement. Variables recorded include total distance traveled, peak speed and exercise duration.

**V3015 Food Consumption**
Keywords: energy balance, food intake, ingestion, spontaneous exercise activity, wheel running

Food consumption is assessed using an automated feeding apparatus that continually measure feeding behavior in an unobtrusive manner by allowing animals free access to food cups that are mounted on balances. The apparatus currently is capable of measuring and time-stamping individual weights from 16 balances simultaneously every 30 seconds and downloading the data directly to a computer for subsequent analysis. Therefore, cumulative food consumed and the time at which feeding bouts occur are continuously monitored. All feeding studies are done after the animal has acclimatized to the facility for at least 24 hours.

**V3016 Exploratory locomotor activity**
Keywords: energy expenditure, exercise, exploratory locomotor activity

Exploratory locomotor activity

### V3032 Telemetry (in vivo chronic arterial blood pressure measurement)

Keywords: Activity, blood pressure

heart rate

activity

temperature

blood glucose

arrhythmia, cardiac, cardiovascular disease, diastolic, ECG, echo, EKG, glucose, systolic, telemetry, vascular function

Because of difficulties in making physiological measurements in anesthetized mice, a commercially-available system for recording mean arterial blood pressure, heart rate, systolic, diastolic, and mean pressure are used. The primary probe is the PA-C10 which is completely implantable, reducing animal stress, and ensuring the most reliable data. Probes to measure ECG and blood glucose are also available.upon request. This service includes probe implantation, probe removal, data acquisition, and a partial probe refurbishment fee.

### V3033 Blood pressure measurements

Keywords: blood pressure, blood vessel, cardiac function, circulation, hypertension, hypotension, tail-cuff, telemetry, vascular, vascular function

Blood pressure (BP) represents an integrated measure of overall cardiovascular function, and is affected by stroke volume, heart rate, inotropic state, and vascular tone. Abnormalities of BP regulation (primarily hypertension, but also hypotension) are associated with major cardiovascular morbidity and mortality, and are epidemiologically associated with diabetes and obesity.

Three complementary technologies are available for the measurement of BP: 1) non-invasive tail-cuff plethysmography, 2) direct arterial measurement by intracarotid catheterization, and 3) telemetry via implanted catheter.

(1) Tail-cuff Plethysmography. Plethysmography (tail-cuff) is performed using a tail-cuff BP apparatus (BP-2000, Visitech Systems, Inc.). This technology is non-invasive and there is good concordance with the direct BP measurements described below.

(2) Carotid Catheterization. Direct arterial measurements are obtained via a chronically placed catheter in the carotid artery. The catheter is connected to a TXD-310 transducer and BP measured using a Digi-Med BPA 400 (Micromed). Experiments using this approach are typically coordinated with metabolic measurements.

A dual catheter approach (arterial and venous) allows for BP measurements in response to specific pharmacological infusions in the awake or anesthetized state; and enables evaluation of both peripheral and central mechanisms of BP regulation.

(3) Telemetry. Telemetered direct BP measurement is performed using an implanted micro-miniature device (PA-C10, DSI) implanted subcutaneously with the catheter typically placed in the right carotid artery. The mouse is housed individually in a cage placed over the receiver platform and BP data digitally recorded via the DATAquest A.R.T. system (DSI). Advantages of this approach include the ability to continuously record BP over a period of weeks, to assess the diurnal range in BP, and stress artifact induced by animal handling is avoided.

### V4024 Bariatric Surgery (Roux-en-Y, VSG, biliopancreatic diversion, sham controls)

Keywords: absorption, adipose, bacteria, body composition, body weight, food intake, gut, gut hormones, microbiome, surgery

Bariatric surgery (Roux-en-Y gastric bypass, vertical sleeve gastrectomy, biopancreatic diversion, and appropriate sham controls) . The modified gastric bypass in the mouse: In this procedure the stomach is bypassed and the food flows through the bypass arm directly into the jejunum.

The biliopancreatic diversion procedure in the mouse: This procedure is historically thought to be a malabsorptive procedure and has several variations in the human. In brief, the biliary and pancreatic secretions are physically separated from gastrointestinal chyme flow until a point near the terminal small bowel. In theory this leads to significant malabsorption, though when this procedure is done clinically many times a gastric restriction component is also added.

### V4026 Body Composition Analysis by NMR

Keywords: body composition

Body composition analysis by NMR analysis (Bruker Minispec). This measurement does not require anesthesia of the mouse. Body composition will provide lean mass, fat mass, total body weight, adiposity (%) and % lean mass for each mouse.