Instructions for Faculty:
There are 2 sections required for NIH grants: "Facilities & Other Resources" and "Equipment". This boilerplate document has been organized accordingly, and the corresponding info for each resource has been listed below. Please include the introduction section in your Facilities & Other Resources document.
INCLUDE ONLY THOSE RESOURCES NEEDED FOR YOUR PROPOSED RESEARCH PROJECT.

Facilities & Other Resources

Masonic Cancer Center
The Masonic Cancer Center (MCC) is an NCI-designated Comprehensive Cancer Center dedicated to cancer research, education, and patient care for the citizens of Minnesota. The MCC serves as the hub for cancer research at the University of Minnesota, with its members applying their expertise to the broad problem of cancer with research in cancer causes, prevention, treatment, outcomes, and survivorship. The MCC is part of the health sciences at the University of Minnesota, which includes the U of M Medical School, the Schools of Dentistry, Nursing, and Public Health, and the Colleges of Pharmacy and Veterinary Medicine.

The MCC is organized into six research programs that focus on specific scientific themes: Screening, Prevention, Etiology and Cancer Survivorship; Carcinogenesis and Chemoprevention; Genetic Mechanisms; Cell Mechanisms; Immunology; and Transplant and Cellular Therapy. These programs are supported by Shared Resources, described below.

Masonic Cancer Center Shared Resources
A key goal of the Masonic Cancer Center, University of Minnesota is to provide access to technologies, services and scientific consultation that facilitate interaction and enhance scientific productivity. The shared resources highlighted below provide stability, reliability, cost-effectiveness, and quality control that would be difficult to achieve otherwise. The Masonic Cancer Center's designation by the National Cancer Institute as a comprehensive center includes support for many of these resources. Additional information can be found on the center's website: https://cancer.umn.edu/researchers/resources/shared-resources

Analytical Biochemistry
The Analytical Biochemistry shared resource is directed by Peter Villalta, PhD. It provides state-of-the-art mass spectrometry instrumentation, advanced data analysis, and validated biomarker quantitative assay services, affording a center of expertise for a full range of analytical biochemistry services, in support of the peer-reviewed research of Masonic Cancer Center investigators.

- Mass Spectrometry Services: provides access to a variety of instrumentation including triple quadrupole, ion trap, and hybrid Orbitrap mass spectrometers, coupled with liquid (electrospray and APCI ion sources) and gas (EI and CI ion sources) chromatography. The facility specializes in trace level analysis in biological important compounds, including both quantitative and screening "-omics" analyses. Services also include macromolecule analysis, accurate mass measurement, walk-up mass determination, and ICP-MS metal analysis.
- Bioinformatics and Advanced Data Analysis: coordinated by Scott Walmsley, PhD, this service provides advanced data analysis services of large and complex mass spectrometry "omics" data sets.
- Biomarker Quantification: coordinated by Sharon Murphy, PhD, this services provides sensitive and quantitative methods for determining important compounds in human urine, blood, or DNA, including:
    - Nicotine metabolites in human urine, blood, or dried blood spots
    - Tobacco-specific nitrosamine metabolites in human urine or blood
    - human urinary mercapturic acids of volatile carcinogens and other tobacco toxicants

  Analyses of biomarkers of inflammation and human oral cell or leukocyte DNA from formaldehyde and acetaldehyde are also performed.

Biostatistics
The Biostatistics shared resource is directed by J. Sunil Rao, PhD. The primary objective of the Biostatistics Core of the Masonic Cancer Center is to provide state-of-the-art services in the planning, conduct, analysis,

and reporting of cancer-related basic science studies; population science studies; and clinical science studies. The shared resource provides consultation and collaboration in preparing grant applications, and support during all stages of execution associated with research grants. Biostatistics services are coordinated by Dr. Anne Eaton, and include support in the planning, monitoring, and analysis phases of a study - including protocol designs and protocol reviews. Members of the Core include several faculty of biostatistics who provide services to support grant applications – including the analysis of pilot studies and feasibility data.

Cancer Genomics
Drs. Betsy Hirsch and Kenneth Beckman direct the Cancer Genomics Shared Resource, which provides comprehensive genomic services and many state-of-the-art technologies via the MCC Cytogenomics Shared Service and the University of Minnesota Genomics Center (UMGC).

Cytogenomics
The Cytogenomics shared resource is directed by Betsy Hirsch, PhD. The Cytogenomics Shared Resource provides services for characterizing the chromosomal status of malignant and nonmalignant human and animal cells. The wide array of assays offered are aimed at identifying numerical and structural genomic aberrations that have a potential role in the etiology of tumor development. The wide diversity of technologies offered ensures that investigators have the means of confirming novel findings by multiple independent methods. The approaches used are continuously evolving to include state-of-the-art techniques and now include whole-genome microarray analysis and multiple ligation-dependent probe amplification (MLPA) in addition to fluorescence in situ hybridization (FISH), G-banding, and spectral karyotyping (SKY). Conventional karyotyping is used to provide critical quality control for experiments using embryonic stem cells, induced pluripotent cells, and other genetically manipulated cells.

University of Minnesota Genomics Center
The UMGC provides genomic technologies and services to researchers and clinicians at the University of Minnesota and to external academic and industry scientists throughout the U.S. and internationally. UMGR exists to advance the use of genomics, and achieve this mission by acquiring state-of-the-art instrumentation and offering an array of complete services, including next-generation sequencing, long-read sequencing, expression analysis, genotyping, epigenomics, single-cell and spatial genomics, metagenomics, as well as related support services such as nucleic acid extraction and quality control.

Cancer Informatics
The Cancer Informatics Shared Resource (CISR) is directed by Dr. Jinhua Wang. CISR provides Masonic Cancer Center members with cutting-edge genomics and clinical data science, ML methods, advanced natural language processing research and application development, data storage infrastructure, and expert consulting and collaboration to support all aspects of their research. This shared resource is comprised of two groups: Bioinformatics and Clinical Informatics.

Cancer Bioinformatics
Bioinformatics services are coordinated by Aaron Sarver, PhD. With a focus on data associated with a large-scale molecular studies, bioinformatics services are developed on an ad hoc basis depending on the needs of the given researcher. Most often, bioinformatics research scientists may serve as collaborative partners in the development of custom databases and analysis pipelines involving large data sets generated in high throughput projects.

Bioinformatics services include:
Planning
- Design experiments involving large-scale molecular studies
- Referrals to MSI software and staff for other molecular studies
- Referrals to external software and databases sources (e.g., EnsEMBL, FANTOM)
- Write bioinformatics components of grant proposals
- Identify leading-edge technologies to be incorporated in research plans

Analysis

- Conduct analysis of high throughput molecular data (e.g., mRNA, miRNA, insertional mutagenesis studies, ChIP-seq)
- Assist with the interpretation of results
- Recommend presentation and visualization methods
- Author bioinformatics component of manuscripts

Clinical Informatics Shared Services (CISS)
Clinical Informatics services are coordinated by Steve Johnson, PhD. The mission of this resource is to provide state-of-the-art centralized clinical informatics services for the support of Masonic Cancer Center operations, research, and quality of care improvement effort. These services include access to rich clinical and genomics database, data extraction and preparations, secure and robust informatics infrastructure, advanced analytics, application development as well as collaborative science opportunities with highly qualified informatics consultants and faculty.

Clinical Informatics services include:
- Access to clinical, genomic, and OnCore data
- Dataset preparation and extraction
- Creation of data repositories and registries
- Natural language processing
- Application development and support
- Data de-identification
- Access to a secure and robust informatics infrastructure
- Access to informatics resources, including Informatics Consultants, Data Analysts, and Database Engineers Developers

Cancer Research Translational Initiative (CRTI)
The Cancer Research Translational Initiative (CRTI) is led by Emmanuel Antonarakis, MD and Deepa Kolaseri, PhD. It serves as the one-stop-shop for translation mechanism by which basic cancer research is translated into clinical trials and studies and into the broader community. CRTI supports both therapeutic and non-therapeutic investigator-initiated translational research through investment and specialized infrastructure. CRTI staff offer a comprehensive infrastructure and coordinated integration of services from MCC shared resources to quickly develop and implement highly complex Phase I clinical trials. CRTI provides clinical trial data management, cancer biospecimen management, industry partnership, and consultation services. Beyond it initial interest in supporting translational research for investigator-initiated first-in-human experimental therapeutic trials, CRTI's mission has expanded to support investigator-initiated studies from the areas of Cancer Prevention and Control, Population Science Research, and Biomarker Discovery.

Data Solutions Group (DSG)
The Data Solutions Group (DSG) is MCC's comprehensive data management group. DSG is managed by CRTI and is directed by Deepa Kolaseri, PhD. The DSG is responsible for developing and standardizing data management plans that aid in the collection, analysis, integration, and reporting of quality data for all investigator-initiated clinical trials in the MCC portfolio. It supports CTO-managed investigator-initiated trials, non-CTO-managed cancer trials, and MNCCTN trials. DSG staff provides both REDCap and OnCore support. It provides data support throughout the life-cycle of a trial, from trial initiation to trial closeout and data publication.

Clinical Trials Office
The MCC Clinical Trials Office (CTO) was established in 2001 to enhance MCC members' ability to conduct clinical cancer research. The CTO is comprised of trained clinical trial professionals that assist MCC investigators in developing, activating, and completing scientifically meritorious clinical trials in a high-quality, cost-effective, and efficient manner. The CTO provides the infrastructure and operational support necessary to facilitate the safe and ethical conduct of clinical research that adheres to institutional policies and federal regulations. Support is provided from protocol inception to study close out, and includes the following services:
- Protocol Writing

- Protocol Training
- Clinical Research Coordination
- Project Management
- IND & IDE Management
- Regulatory Compliance
- Quality Assurance

Comparative Pathology
The mission of the Comparative Pathology Shared Resource (CPSR), led by Dr. Davis Seelig, is to provide comprehensive and ever-evolving support and training in all aspects of comparative pathology to MCC members who use laboratory animals in their research. This support includes training MCC researchers in the design of appropriately powered animal studies; guiding researchers and their lab staff in the collection and storage of animal tissues; the preparation of histological and immunohistochemical (IHC) sections from appropriately processed fixed or frozen tissues; and expert gross and histopathologic analysis by experienced veterinary pathologists.

The CPSR strives to meet the unique needs of researchers regardless of the size and scope of the project. Investigators may use resources for all of their comparative pathology needs or may request selected components. Services include:

- Histology: Production of high quality tissue sections from frozen and fixed tissues
    - Fixed tissue processing, embedding in paraffin, sectioning and staining
    - Frozen tissue sectioning and staining (with or without cryoprotection in sucrose gradient)
    - Decalcification, processing and sectioning of bones
- Immunohistochemistry (IHC): Detection of cell antigens in frozen and fixed animal tissue sections.
    - Immunohistochemical (IHC) staining for antigens in fixed and frozen tissues.
    - Single and double label Immunofluorescent (IF) staining for antigens in fixed and frozen tissues.
    - Proliferating cell detection with BRDU labeling and Ki-67 staining
    - Apoptotic cell detection with TUNEL and cleaved caspase 3 staining.
    - Custom development of new IHC protocols according to the needs of researchers.
- Pathology: Description and interpretation of gross and microscopic lesions across numerous animal model systems
    - Gross and microscopic imaging.
    - Assistance with necropsies.
    - Phenotypic characterization of genetically modified mice.
    - Quantitative and semi-quantitative lesion analysis.
    - Evaluation of blood smears, cytology, and interpretation of clinicopathologic data.
    - Consultations on experimental design, sample collection, fixation, stains, and immunohistochemistry.
    - Assistance or collaboration in manuscript preparation, including (lesion description, data summary, data analysis, and interpretation, publication quality image production).
    - Assistance in grant preparation, including intra- and extramural applications.

The CPSR occupies a 2242 square foot laboratory located in the College of Veterinary Medicine on the St. Paul campus of the University of Minnesota. The laboratory is fully equipped for tissue trimming, histological preparation, and immunohistochemistry, and includes workbenches for 8 individuals, dedicated necropsy space, microfuges, water baths, high-speed centrifuges, one –80 ºC and three –20 ºC freezers, three 4 ºC freezer/refrigerators, and 2 ovens.

Flow Cytometry
The Flow Cytometry shared resource is directed by Chris Pennell, PhD and coordinated by Paul Champoux. It provides state-of-the-art flow cytometry and cell sorting services, scientific consultation, customer training and technical support to advance scientific discovery in a reliable and cost-effective manner. Flow cytometry is an essential component of cancer biology research because it permits multiparameter cell analyses and the physical isolation of phenotypically defined cell subsets for subsequent analysis or manipulation. The

University Flow Cytometry Resource provides access to both customer-operated flow cytometry analyzers and staff-operated fluorescence-activated cell sorters in several locations across the University campus.

Genome Engineering
The genetic alteration of human cancer cell lines and genes related to cancer allows researchers to design experiments to elucidate the mechanisms of cancer and to test new therapies. The goals of the Genome Engineering Shared Resource (GESR) are to utilize state-of-the-art CRISPR/Cas9-mediated precise genome engineering to efficiently generate the desired modifications in mammalian (most frequently human) cells in an ccurate and timely manner to accelerate an individual PI's intellectual goals and research agenda. The GESR can engineer human cell lines that allow researchers to design mechanistic and therapeutic studies related to specific cancers. Genome editing is technically challenging, time consuming, and demands a level of expertise not found in most clinical laboratories, and is thus most easily provided by the GESR.

Since its inception in October 2015, a total of 60 individual researchers have availed themselves of one or more of GESR's genome-editing services. These services have included the production of gene knockouts and conditional knockouts and the incorporation of single-nucleotide knock-in mutations in cancer cell lines from multiple sources including breast, pancreas, ovary, liver, and bone. In addition, knockout cell lines from nonhuman cells, including mouse, dog, and rat, have been generated. To date, the resource has successfully generated a total of 66 knockout cell lines (5 conditional), 20 knock-in cell lines, and 11 gene-tagged cell lines.

The GESR is co-directed by Drs. Branden S. Moriarity and Beau Webber and coordinated by Walker Lahr, with support from 2 technical research personnel, Huiyan "Summer" Ma and Christopher Meiers.

Minnesota Cancer Center Shared Resource Network
All Masonic Cancer Center members have access to the Minnesota Shared Resource Network, a collaboration between Minnesota's two NCI-Designated Comprehensive Cancer Centers—the Masonic Cancer Center and the Mayo Cancer Center. This network establishes common policy and procedures necessary to incentivize inter-institutional collaboration, improve access, increase visibility and overall cancer-related usage, and avoid redundant services provided by each center's Shared Resources.

The goals of this network are to:

1) Reduce duplication of services provided by the respective cancer centers to their users;
2) Mutually reduce cost burden for the NCI-designated cancer center research members (commensurate with internal rates);
3) Reduce the investigator burden caused by service agreement policies; and
4) Develop a track record of shared resource collaboration between the Minnesota cancer centers.

Through the network, the Mayo Clinic Cancer Center Shared Resources available to MCC members are:

- Proteomics
- Pathology Research Core
- Genome Analysis
- Biospecimen Accessioning and Processing (NIH Precision Medicine Initiative)
- Microscopy and Cell Analysis

Mouse Genetics Laboratory
The Mouse Genetics Laboratory (MGL) Shared Resource provides Masonic Cancer Center (MCC) & and Office of Academic Clinical Affairs (OACA) members with access to state-of-the-art technologies required to create and efficiently study genetically modified mice. Genetically modified mice have been vital tools for cancer studies for many years, enabling researchers to determine the roles of specific genes in cancer-relevant traits such as immune evasion, tumor initiation, and metastasis. MGL produces transgenic and knockout mice; cryopreserves mouse sperm and embryos; performs embryonic stem cell gene targeting, assists with mouse embryo manipulation; and provides scientific consultation. These services provide MCC

members convenient, cost-effective access to genetically modified mice. The MGL is directed by Timothy Hallstrom, Ph.D., who has 15 years of experience with mouse genetics research. Day-to-day operations of the MGL are managed by Yun You, PhD, who was previously the supervisor of the Transgenic Group in the Mouse Genetic Core Facility at Memorial Sloan Kettering Cancer Center.

Proteogenomics
Proteogenomics integrates now-readily-available next-generation DNA/RNA sequencing data with high-resolution mass spectrometry-based proteomics data to identify and quantify expressed proteins. The Proteogenomics Share Resource offers cutting-edge proteogenomic services to MCC members conducting basic, translational, and clinical cancer research. Services include:

- Study design, planning and strategy
- Design of pilot studies
- Analysis of pilot study data
- Testing and optimization of new software tools and workflows customized to user studies
- Introduction to example workflows and training of laboratory members in the use of bioinformatics tools to advance their research
- Assistance with publications and grant proposal preparation
- Making software tools and data available as required for publication and funding agencies

The Proteogenomics Shared Resource is led by Director Dr. Tim Griffin and Coordinator Dr. Pratik Jagtap, who are leaders of the Galaxy for proteomics (Galaxy-P) project. Both have long track records in the application of proteogenomic and metaproteomic informatics to cancer research.

Translational Therapy Laboratory
The Translational Therapy shared resource is co-directed by Drs. Martin Felices, PhD and John Wagner, MD. The purpose of the Translational Therapy Shared Resource (TTSR) is to provide state-of-the-art translational research support services to MCC members to facilitate the monitoring of clinical trials and the development of novel cellular and immune-based therapies. TTSR works directly with members of the MCC scientific programs at the preclinical, clinical, and laboratory levels, with the goal of developing clinical trials to test novel therapies.

TTSR has two major components: the Translational Therapy Laboratory (TTL) and Molecular and Cellular Therapeutics (MCT). TTL provides immune monitoring and biorepository management; it is the central laboratory that processes research blood samples from patients enrolled in clinical trials. MCT is a cGMP-compliant production facility.

Equipment (INCLUDE AS NEEDED)

Analytical Biochemistry
The shared resource has the following instrumentation:

- 9 Triple Quadrupole LC-MS/MS Instruments (Thermo Scientific)
  - Quantum Ultra AM (1)
  - Quantum Discovery Max (2)
  - TSQ Vantage (3)
  - Quantiva (3)

- 1 Ion Trap LC-MS/MS Instruments
  - Thermo Scientific LTQ

- 5 Hybrid Orbitrap LC-MS^n Instruments (Thermo Scientific)
  - Exactive, Velos, Elite, Fusion, Lumos

- GS-MS Instruments
  - Triple Quadrupole: Thermo Scientific TSQ 7000
  - Single Quadrupole: Thermo Scientific ISQ 9000

- ICP-MS (Perkin Elmer SCIEX Elan DRC II)

- HPLC-UV (Thermo Scientific Vanquish UHPLC)

Biostatistics
Not applicable.

Cancer Genomics
- **Karyotyping and FISH:** Brightfield and fluorescence microscopes and imaging equipment.
- **Short-read NGS:** 1 Illumina NovaSeq 6000, 1 Illumina NextSeq 2000, 6 Illumina MiSeq.
- **Long-read NGS:** Pacific Biosciences Sequel II System and Oxford Nanopore GridION X5.
- **Single-cell genomics:** 10X Genomics Chromium X platform. Spatial genomics: 10X Genomics Visium and NanoString GeoMx platforms.
- **Methylation platforms:** Illumina Platform including Illumina iScan scanner and autoloader and Tecan Infinium automation accessory.
- **Non-NGS expression platforms**: Four ABI 7900HT 384-well real-time PCR instruments; NanoString nCounter Gen2 platform; Fluidigm BioMark HTP real-time qPCR/digital PCR platforms.
- **Digital PCR:** Bio-Rad QX200 Droplet-digital PCR platform.

Cancer Informatics
Not applicable.

Cancer Research Translational Initiative (CRTI)
Not applicable.

Clinical Trials Office
Not applicable.

Comparative Pathology
- Automated immunostainers: 1 DAKO, 1 Biocare
- intelliPATH™
- Sakura TEC5 embedding station and Tissue-Tek
- VIP5 tissue processor
- Leica CM 3050 cryostat and RM2125 and RM2155 microtomes
- CBG Biotech Solvent Recycler
- Nikon SMZ 1000 dissecting microscope
- Nikon Eclipse E800, e600, and 80i light and fluorescent microscopes equipped with Nikon DSRi2 and SPOT Insight color digital cameras
- BX40 and BH-2 Olympus microscopes for use in the laboratory by histotechnologists
- BX40 Olympus Microscope equipped for light and fluorescent microscopy
- ImageJ/Fiji software for histomorphometry
- OsteoMeasure histomorphometry system

Flow Cytometry
- Equipment located in the Masonic Cancer Research Building:
  - BD FACSymphony A3 5-laser/30-parameter cell analyzer (2022)
  - BD FACSymphony A3 5-laser/30-parameter cell analyzer with plate loader for high-throughput acquisition (2022)
- Equipment located in the Cancer & Cardiovascular Research Building:
  - BD FACSymphony 5-laser/30-parameter cell analyzer (2013)

    - BD Fortessa X-20 5-laser/20-parameter (2014)
    - BD LSR II 3-laser/16-parameter cell analyzer (2009)
    - Cytek Aurora 3-laser/41-parameter spectral cell analyzer (2015)
    - BD FACSAria IIu 4-laser/16-parameter cell sorter (2013)
- Equipment located in the Wallin Medical Biosciences Building:
    - BD Fortessa 5-laser/20-parameter cell analyzer (2009)
    - BD LSR II 4-laser/16-parameter cell analyzer (1997)
    - Sony MA-900 4-laser/14-parameter cell sorter (2018)
- Equipment located in the Microbiology Research Facility:
    - BD FACSAria IIu 4-laser/16-parameter cell sorter (2009)

Genome Engineering
Genome edits all cell lines by CRISPR/Cas9 using an Invitrogen Neon Electroporator.

Minnesota Cancer Center Shared Resource Network
Not applicable.

Mouse Genetics Laboratory
The MGL has the following major equipment:

- 2 complete microinjection stations with Leica or Olympus inverted microscopes and Eppendorf micromanipulators and injectors, and a digital video camera hooked to the Leica microscope for teaching activity
- 1 laminar flow hood with a dissection microscope
- 1 tissue-culture inverted Olympus microscope
- 2 additional binocular microscopes
- 3 water-sleeved CO2 incubators
- Taylor Wharton auto-filled liquid nitrogen tanks for frozen cells, embryos, and sperm incubators
- 1 4-foot tissue-culture biological safety cabinet
- 1 Eppendorf microcentrifuge, table-top centrifuge, and microfuge
- 1 Sutter automated pipette puller
- Water baths
- 1 BioRad Xcell electroporator
- 1 refrigerator/freezer, Bio-Cool embryo freezer, and upright –80 degrees C & –20 degrees C freezers

Proteogenomics
Not applicable.

Translational Therapy Laboratory

- The sample processing area and an adjacent space used for specialized assays contain biological safety cabinets, incubators, microscopes, counters, refrigerators, centrifuges, and freezers.
- Eight large-capacity liquid nitrogen (LN2) storage tanks and a clinical-grade controlled-rate freezer are housed in this building and in Diehl Hall.
- The Standard BioTools Helios Mass Cytometer (CyTOF) is located on the 6th floor of MCRB.