Project 1

1. **Name of Project:** Molybdenum sulfide nanoparticles as contrast agents for dual energy mammography
2. **Faculty Supervisor:** David Cormode
3. **Faculty Email address:** dcormode@upenn.edu
4. **Radiology Division or Section:** Research
5. **Type of research:** Translational/basic
6. **Specific Skills Needed:** Wet lab experience
7. **Project Description:** Mammography has been shown to reduce deaths from breast cancer due to earlier detection. However, for women with dense breasts, mammography is not very effective. Dual energy mammography (DEM) has recently been shown to be effective for women with dense breasts, however, current contrast agents do not generate strong signals and have side-effects. We are developing novel contrast agents for DEM. A material that should be effective is molybdenum. In this project, molybdenum-based nanoparticles will be synthesized, characterized, tested for their contrast generation and explored for their in vitro and in vivo effectiveness.

Project 2
1.**Name of Project**: Medical Imaging in Orthopedics, Surgical Planning, Engineering
2.**Faculty Supervisor**: Chamith S. Rajapakse, Ph.D., Assistant Professor of Radiology and Orthopedics
3.**Faculty Email Address**: chamith@pennmedicine.upenn.edu
4.**Radiology Division or Section**: Research
5.**Type of Research**: Clinical/Translational/Basic
6. **Specific Skills Needed:** None
7.**Project Description**: This project aims to develop, validate, and translate to the clinic, medical imaging based computational tools for medical applications. This computational approach is intended to improve current standard-of-care tests utilized to diagnose and manage musculoskeletal diseases. Other related projects involve MRI and/or CT guided patient-specific 3D printing, augmented-reality (AR) for surgical planning, and Artificial Intelligence (AI) for Radiology.

Project 3

1**. Name of Project**: Radiology for Early Diagnosis of Bone and Cardiovascular Diseases

2. **Faculty Supervisor**: Chamith S. Rajapakse, Ph.D., Assistant Professor of Radiology and Orthopedics

3. **Faculty Email Address**: chamith@pennmedicine.upenn.edu

4. **Radiology Division or Section**: Research

5. **Type of Research**: Clinical/Translational/Basic

6. **Specific Skills Needed:** None

7. **Project Description**: Current medical imaging technologies used for the management of metabolic bone diseases and cardiovascular risks are mostly based on structural changes in the body, which occur at later stages of disease progression. This project investigates the feasibility of PET imaging in conjunction with structural imaging modalities such as CT and MRI to assess bone metabolism and plaque calcification using NaF and FDG tracers as an early diagnostic tool.

Project 4
1. **Name of Project**: History of development of imaging technique, concept, or thought.
2. **Faculty Supervisor**: Saurabh Jha
3. **Faculty Email address**: Saurabh.jha@uphs.upenn.edu
4. **Radiology Division or Section**: Cardiovascular Imaging
5. **Type of research:** Historical analysis
6. **Specific Skills Needed:** Ability to get to source information
7. **Project Description:** The general theme of these projects is a historical analysis - a look back at how thoughts, research, serendipity, and key moments led to development of imaging techniques and concepts. The researcher would function as a historian of science, and would research and read original articles from journals, and follow their citation trail, back in time, and then synthesize and narrate a story how the science came together. On occasion, the researcher might interview the key people involved in the development of technique.
Here are a few historical developments I wish to interrogate:
a) The origins of receiver operating characteristic curve (ROC) in radiology.
b) Electron beam CT - rise and fall.
c) Development of parallel imaging in radiology.
The expectation is a publication in a peer review journal, or a write up in a popular medical blog.

Project 5

1. **Name of Project:** Monitoring follow-up recommendations in patients undergoing abdominal and pelvic imaging – the Automated Radiology Recommendation Tracking System (ARRTE)

2. **Name of Project Faculty Supervisor**: Tessa S. Cook, MD PhD

3**. Faculty email address**: tessa.cook@uphs.upenn.edu

4. **Radiology Division or Section:** Cardiothoracic/Cardiovascular, Informatics

5. **Type of research**: Clinical, Translational

6. **Specific Skills Needed:** Strong data analysis skills in Excel. Bonus: data wrangling in R

7. **Project Description:** For nearly 4 years, we have been using structured reporting to identify patients with findings indeterminate or suspicious for malignancy in the abdomen (and subsequently pelvis). We have a large database of >100,000 exams and many interesting questions to ask of this data. In particular, we are interested in correlating EMR data (diagnoses, pathology, etc.) with the likelihood of getting follow-up. There is chart review involved for some of this data although there is the possibility of getting some of the data from Penn Data Store (Penn's data warehouse).

Project 6

1. **Name of Project**: Applying Informatics and Artificial Intelligence to Radiology Report and Utilization Data

2. **Name of Project Faculty Supervisor**: Tessa S. Cook, MD PhD 3. Faculty email address: tessa.cook@uphs.upenn.edu 4. **Radiology Division or Section**: Cardiothoracic/Cardiovascular, Informatics

5. **Type of research**: Clinical, Translational 6. **Specific Skills Needed:** R/Python or equivalent 7. **Project Description**: We have a number of robust datasets related to follow-up recommendations in radiology, report discrepancies, protocoling, and resource utilization in radiology, and have a number of interesting questions to ask of the data for anyone interested in doing some data wrangling or programming. This project does not require you to be physically present in the hospital as long as you're able to work on your own computer behind the UPHS firewall.

Project 7
1. **Name of Project**: Molecular Imaging of Breast Cancer with the Novel Radiotracer ^{18}F-Fluoroglutamine
2. **Faculty Supervisor**: Austin Pantel, MD
3. **Faculty email address**: austin.pantel@uphs.upenn.edu
4. **Radiology Division or Section**: Nuclear Medicine and Clinical Molecular Imaging
5. **Type of Research**: Translational
6. **Specific Skills Needed:** None
7. **Project Description**: Molecular imaging provides quantitative measures of in vivo biology that could be used to characterize tumors and guide targeted therapies. In this project, we will study the novel radiotracer, ^{18}F-Fluoroglutamine, as a marker of glutamine metabolism in breast cancer. From our work in mouse models, we have insight into the behavior of this tracer. We are now ready to translate this work into humans. We will soon open the first trial of this radiotracer in the US to focus on breast cancer. A medical student could integrate into all phases of this translational research project: from mouse experiments and analysis, to patient recruitment and follow-up, to human image analysis. This project is ideally suited for a student with an interest in quantitative analysis, bench-to-bedside translation, and early phase imaging trials.

Project 8

1. **Name of Project:** Investigating Combined Potential of Multiparametric MRI and Molecular Signatures in Redefining Treatment Response in Patients with Glioblastoma
2. **Faculty Supervisor:** Sanjeev Chawla, Ph.D.
3. **Faculty Email Address:** Sanjeev.Chawla@uphs.upenn.edu
4. **Radiology Division or Section:** Neuroradiology Division
5. **Type of Research:** Translational
6. **Specific Skills Needed:** None
7. **Project Description:** Glioblastomas (GBMs) are typically treated with surgical resection followed by concurrent chemo-radiotherapy (CCRT) and adjuvant temozolomide (TMZ). Treatment outcome is generally monitored by clinical MR imaging. A new enhancing lesion near surgical cavity can reflect either tumor progression (TP) or treatment-related changes known as pseudoprogression (PsP). Accurate identification of TP is critical as early surgical intervention in these patients reduces mortality and increases their quality of life. On the other hand, PsP patients are continued on TMZ therapy. Our previous study has demonstrated that logistic regression model derived from multiparametric diffusion tensor imaging (DTI) and dynamic susceptibility contrast (DSC)-perfusion imaging can differentiate TP from PsP. In this study, we propose to validate our previously developed classification model. Additionally, it has been reported that promoter methylation of O6-methyl-guanine methyl transferase (MGMT) gene is associated with development of PsP condition. The aim of this study is (1) To validate the utility of previously developed classification model in differentiation of TP from PsP. (2) To develop a decision support system by incorporating information from 3D-echo planar spectroscopic imaging (3D-EPSI), a novel spectroscopic technique and MGMT promoter methylation profile besides using DTI and DSC imaging modalities in distinguishing TP from PsP. Data from different imaging parameters and MGMT promoter methylation status will be combined to generate a classification model. We hypothesize that synergistic interaction among imaging parameters and genetic profile will provide a greater discrimination power in differential diagnosis of TP and PsP.

Project 11
1. **Name of Project:** Artificial Intelligence and Machine Learning for evaluation of bone and soft tissue tumors
2. **Faculty Supervisor**: Ronnie Sebro, MD, PhD
3. **Faculty email address**: Ronnie.sebro@uphs.upenn.edu
4. **Radiology Division or Section**: MSK
5. **Type of Research**: Translational
6. **Specific Skills Needed:** Excel skills, interest in radiology, and willingness to learn imaging techniques.
7. **Project Description**: "A picture is worth a thousand words". Most radiology studies are made of several pictures, but most radiology reports are only a few sentences long. Each image contains a tremendous amount of information that is often (incompletely) summarized by the radiologist. Here, we plan to harvest the tremendous advances in computing power and machine learning to better understand bone and soft tissue tumors. Bone and soft tissue tumors are very rare mesenchymal tumors with a very poor prognosis. We hypothesize that key imaging features of these tumors will be associated with tumor grade, and prognosis. The student will learn: research techniques, how to write a paper, biostatistics, computing skills, and learn about bone and soft tissue sarcomas. Students can get exposure to the role of the radiologist at the weekly Sarcoma Tumor Board and get to interact with patients at the Sarcoma Walk for the Cure.

Project 12
1. **Name of Project:** Patient-oriented Radiology Reporting
2. **Faculty Supervisor**: Charles E. Kahn, Jr., MD, MS
3. **Faculty Email address**: charles.kahn@uphs.upenn.edu
4. **Radiology Division or Section**: Administration / Informatics
5. **Type of research (clinical, translational, basic):** Clinical
6. **Specific Skills Needed:** None
7. **Project Description:** Patients and their family members are increasingly interested to read their radiology reports through online patient portals, but the reports' language poses challenges for lay readers. The PORTER (Patient-Oriented Radiology Reporter) system incorporates an illustrated lay-language glossary of radiology terms to annotate radiology reports. Of 4,090 PORTER concepts, 75% are linked to a Wikipedia page. We have built a semi-automated process to select images from Wikipedia illustrate each concept. The project would be to identify appropriate images for the vocabulary terms. Students with interest and experience in programming also could become involved in further development of the system.