NOTE: This document is for informational purposes only. Required applications and equipment are listed in the RFP.

- **Skeletal muscle spectroscopy and imaging**

  **General Notes:** Some measures will be obtained in resting muscle (mainly lower extremity, but also upper), but most will be collected during muscle contraction protocols, often in conjunction with other modalities such as force or power measures, nerve stimulation and electromyography. Non-magnetic force transducers and electrodes are used for these studies. Protocols require 2-second temporal resolution, localized MRI and MRS (by surface coil and/or volume coil) and high S/N. Studies will be conducted in people from 8-85 years of age, as well as those with, for example, obesity, osteoarthritis, diabetes, peripheral vascular disease, etc.

  **Applications:**
  - spectroscopy (proton, carbon and phosphorus nuclei)
    - surface coil and localized, time-series data to measure intracellular metabolites and energetics (ATP flux)
    - lipid content (intra- and extramyocellular lipids) by spectroscopy and imaging
    - 13C spectroscopy of [glycogen]
    - interleaved MRS with 31P and 1H; 2-s time resolution
    - gated and un-gated acquisitions, capacity to trigger ancillary measures at MR console
  - anatomical imaging
    - tissue (fat, connective, muscle) identification and volume quantification
    - scout images for localizing spectroscopy volumes of interest
  - functional imaging
    - blood oxygen level dependent (BOLD) and arterial-spin labeling (ASL) measures of muscle metabolism and blood flow during exercise
    - tractography, including diffusion tensor imaging (DTI), to measure muscle architecture
    - dual-echo (T1/T2) sequences will be used for interleaved BOLD + proton density measures in exercising muscle, to evaluate perfusion (rate and heterogeneity across tissue bed)
  - chemical shift imaging, 31P and 1H
**Neuroimaging and spectroscopy**

**General Notes:** Standard and evolving neuroimaging and spectroscopy techniques will be applied to studies of the brain and spinal cord. Functional MRI experiments may collect overt speech, eye-tracking, EEG, and/or reaction time and accuracy of button-press responses in addition to BOLD responses to experimental stimuli. Protocols require high resolution, high SNR, maximum field homogeneity and gradient performance for state-of-the-art neuroimaging. Studies will be conducted in children and in young, middle aged and older neurotypical adults, as well as individuals with, for example stroke-induced aphasia, primary progressive aphasia, medial temporal lobe damage, Alzheimer’s Disease or other neurodegenerative conditions, autism and other neurodevelopmental conditions. Studies in these populations are for the purpose of research and will not be diagnostic in nature.

**Applications:**
- structural / anatomical imaging (T1 3D, e.g., MPRAGE; T2 3D, e.g., FLAIR; to identify gray matter, white matter, CSF morphometry, as well as location and volume of structural abnormalities, e.g., lesion from stroke, atrophy from neurodegeneration, small vessel disease); includes acquisition of survey and reference scans for localization
- structural / DTI (min. 72 directions) for high resolution diffusion tensor imaging
- functional imaging (min. 32-channel head coil) to detect BOLD response (e.g., using EPI) to visual, audio, and/or video experimental stimuli; includes acquisition of Field Map; with online head movement computation and the possibility of motion-corrected structural and functional scans
- resting state fMRI to detect functional connectivity, including default mode and salience neural networks
- arterial spin labeling for measuring tissue perfusion
- collection of eye-tracking data and EEG data, simultaneously with collection of BOLD signal, through MRI compatible eye-tracking and MRI-compatible EEG recording systems
- proton spectroscopy of neuronal viability
- 31P spectroscopy of brain energetics
- **Skeletal imaging**
  
  **General Notes**: High-resolution imaging of the spine, hip, knee and ankle joints will be applied to studies of musculoskeletal health and pathology. Some measures will be made in semi-loaded joint but most in unloaded joints. Studies will be conducted in healthy body weight adults of all ages (8-85 years), obese individuals, college athletes, and people with osteoporosis, osteoarthritis, and low-back pain. Protocols will include standard qualitative imaging sequences to assess tissue morphology as well as quantitative imaging sequences to determine tissue mechanical properties. Protocols will also include measure of inflammatory indices in and around the joints.

  **Applications:**
  - cartilage morphology and structure (2D FSE; 3D DESS, T₁ρ, 3D T₂ mapping, sodium)
  - joint soft tissue structural properties, location, pathology (e.g. tendon, ligament, labrum, meniscus, synovium)
  - bone shape, volume, density, internal structure, lesions
  - intervertebral disc shape, volume, structure
  - elastography measures of tissue properties

- **Other tissues**
  - trunk (central) adiposity imaging for locale and volume. Longitudinal tracking of interventions designed to reduce central adiposity
  - cardiac 31P spectroscopy and functional imaging
  - breast imaging (no contrast agents) and tissue elastography measures
  - liver spectroscopy and imaging for fat, glycogen