Resident Core Curriculum
Musculoskeletal Imaging and Intervention

General Goals: The specific goals include objectives required for every level of training with graduated levels of responsibility. All aspects of musculoskeletal imaging and intervention are incorporated into the residency, including fluoroscopy, radiography, CT, ultrasound, and MRI. During every training rotation, the resident will read the required literature and study the teaching materials. Residents will develop an understanding of the management of patients and the role of diagnostic and therapeutic procedures in their care. Residents should develop competence in the diagnosis of common musculoskeletal conditions, the appropriate diagnostic test, basic patient management and therapeutic interventions they may perform as a musculoskeletal radiologist to help in disease management.

Resident Daily Work Responsibilities (OVERALL BENCHMARKS/OBJECTIVES for Self-Evaluation)

1. Residents assigned to musculoskeletal imaging and intervention will be available for consultations by technologists, clinicians, and other health care providers, except during conference times, when the attending faculty will cover.
2. All residents are expected to develop a working relationship with clinicians.
3. Resident questions will be referred to the supervising faculty covering the service vascular and, if needed, more immediately by the musculoskeletal fellow.
4. Resident review of cases with the supervising faculty will be conducted as many times in the day as necessary to keep an efficient workflow.
5. Resident examinations will be dictated by the end of every working day.
6. Residents will carefully check his/her reports prior review with the supervising faculty.
7. Residents will carefully incorporate input provided by supervising faculty and meticulously proof-read reports prior to approving them for final faculty verification.
8. Residents must be familiar with the operation of all imaging equipment.
9. Residents must acquire knowledge of radiation protection and ways to reduce radiation exposure to both patients and hospital personnel. The resident will be supervised to assure that safe practices are followed.
10. Residents must develop an understanding of patient triage, patient selection, risks, indications, and contraindications for each procedure.
11. Residents will understand the importance of continuity of care.
12. Residents will learn musculoskeletal anatomy and common pathology.
13. Residents will acquire an understanding of the proper preparation of patients for examinations and appropriate follow-up afterward. At the start of every working day, the resident will be familiar with the patient schedule and anticipate need for any procedures.
14. Residents will become knowledgeable about the basic interpretation skills for radiography, computed tomography, ultrasound and MR imaging.
15. Residents will do in-depth reading and study, along with a review of teaching cases, to become knowledgeable about the normal anatomy and physiology and gain a general understanding of the disease entities, their clinical presentations, and modes.
of treatment.
16. Residents will become prepared to pass the certifying examination of the American Board of Radiology.
17. Residents will teach and share knowledge to medical students, radiologic technologist students, and junior residents.

**Supervising Faculty Responsibilities:**

1. Supervising faculty will be available at all times for any questions or consultations needed by the resident.
2. Supervising faculty will review all cases with the residents before the end of the day.
3. Supervising faculty will provide the resident with constructive feedback in any problem areas encountered during the rotation.
4. Supervising faculty will verify resident-generated reports in a timely manner and inform the resident of any major changes made.

**Educational Goals and Objectives (1st Rotation: PGY2 and PGY3):**

**Patient Care and Technical Skills:**

**PCTS1: Consultant**
- Demonstrate knowledge of ACR guidelines and technical standards for diagnostic and therapeutic procedures
- Interact with clinicians when reviewing cases involving radiographs, ultrasound and cross-sectional imaging and show the ability to provide preliminary readings, follow up with attending radiologists, formulate a plan of complex cases, and communicate any changes to referring clinicians.

**PCTS2: Competence in Procedures**
- Gain familiarity with the requirements of the common musculoskeletal procedures (see Technical Requirements)
- Understand patient risks, indications, and contraindications for diagnostic and therapeutic procedures.
- Understand indications for and contraindications to the use of intravenous contrast and be able to monitor its administration
- Define the role of common diagnostic and interventional procedures in the management of patients
- Gain familiarity with and competence in CT protocols (see Learning Resources).

**Medical Knowledge:**

**MK1: Protocol Selection and Optimization of Images**
- Demonstrate the ability to recommend additional imaging studies as appropriate to better assess findings on angiography and interventional imaging studies
- Explain the impact of the radiology findings on patient care, including what imaging studies may/may not be appropriate

**MK2: Interpretation of examinations**
- Develop basic interpretation skills for diagnostic and procedural examinations.
• Develop skills to dictate all cases performed using existing templates.

**System-Based Practice:**
**SBP1: Quality Improvement (QI)**
- Familiarity with departmental procedures, contrast safety, and sedation required in the performance of examinations
- Make suggestions to improve methods and systems utilized in radiology whenever appropriate

**SBP2: Health Care Economics**
- Demonstrate knowledge of ACR appropriateness criteria and cost effective imaging evaluation of common disorders
- Show ability to interact with clinicians regarding cost effective and streamlined evaluation for differing clinical entities

**Practice-Based Learning and Improvement:**
**PBLI1: Patient safety: contrast agents; radiation safety; MR safety; sedation**
- Aware of the basic principles of radiation protection in order to reduce as much as possible the radiation dose to the patient and reduce exposure to healthcare providers
- Recognize and treat reactions to intravenous contrast
- Understand the indications and contraindications to the different types of contrast, dosages and side effects.

**PBLI2: Self-Directed Learning**
- Show evidence of independent study using textbooks from reading list to fulfill first rotation knowledge requirements (see Knowledge Requirements)
- Demonstrate appropriate follow up of interesting cases
- Research interesting cases as directed by faculty
- Identify, rectify, and learn from personal errors
- Incorporate feedback into improved performance
- Efficiently use electronic and print sources to access information
- Prepare one teaching file case per week describing the imaging findings of an interesting case, providing a practical differential diagnosis, the diagnosis whenever possible and a brief discussion of the disease entity.
- Able and willing to participate in clinical conferences in which imaging studies are used to guide patient care/evaluations and be able to demonstrate understanding of how imaging relates to the clinical care of the patient

**Professionalism:**
**PROF1: Professional Values and Ethics**
- Demonstrate respect for patients, families, and all members of the healthcare team
and be able to discuss significant radiology findings

- Respect patient confidentiality at all times
- Present oneself as a professional in appearance and communication
- Demonstrate a responsible work ethic with regard to work assignments
- Develop skills for evaluating and consenting patients with attention to their needs

Interpersonal and Communication Skills:

**ICS1: Effective Communication with Patients, Families, and Care Givers**

- Communicate with the patient at all times during the procedures to ensure that patient remains comfortable

**ICS2: Effective Communication with Members of the Health Care Team**

- Communicate effectively with all members of the health care team (technologists, medical students, fellows, residents, allied health providers, support staff, and attending physicians/radiologists)
- Call results to the referring physicians and show ability to interact with referring physicians
- Develop a working relationship with clinicians that refer patients
- Adequately explain each examination to the patient in order to ensure that the patient feels comfortable and to provide patient care that is compassionate, appropriate, and effective
- Use the PACS, voice recognition systems, and hospital information systems to become proficient in dictating reports of significant radiographic findings in a concise and clear manner

Monitoring and Assessment of Resident Performance

The resident’s progress will be monitored by the faculty on the service. Written evaluations, organized by the core competencies, will be conducted by the resident education attending in collaboration with the other section attendings on a monthly basis utilizing the New Innovations system. Deficiencies or substandard performance will be discussed personally and privately with the resident and will be brought to the attention of the Residency Program Director. Resident performance is based on direct observation, report quality, multi-source professional evaluations, productivity on service, performance on the structured curriculum, participation in conferences and other performance evaluation methods as determined necessary.
Educational Goals and Objectives (2nd and 3rd Rotations PGY3, PGY 4 and PGY5):

The objectives above as well as the following:

Patient Care and Technical Skills: PCTS1: Consultant
- Demonstrate knowledge of ACR practice guidelines and technical standards for musculoskeletal procedures
- Familiarity with available medical records and how to access them for the purposes of patient care
- Round in the morning on the “big cases” where resident is primary operator
- Act as a consultant to referring clinical services

PCTS2: Competence in Procedures
- Familiarity with most common musculoskeletal procedures
- Perfect diagnostic examination techniques and be very skilled and efficient in performing and interpreting all diagnostic and interventional procedures
- Observe musculoskeletal procedures and assist more senior residents and faculty as needed
- Know the proper preparation of patients for diagnostic and interventional procedures and the appropriate follow-up afterwards
- Gain familiarity with and competence in MRI protocols (see Learning Resources).

Medical Knowledge:
MK1: Protocol Selection and Optimization of Images
- Recommend the appropriate diagnostic study based on the clinical scenario and understand the relative strengths of each modality
- Protocol cases, in consultation with the attending, to assure that the examination is appropriate and of sufficient quality to address the clinical concerns of the patient and referring physician
- Demonstrate knowledge of indications for the examinations requested (when the reason for the examination is not clear, the resident will effectively communicate with the patient and referring physician until clarified)
- List appropriate indications and contraindications for those studies performed by the musculoskeletal section

MK2: Interpretation of Examination
- Given appropriate images, demonstrate a thorough knowledge and understanding of the musculoskeletal anatomy
- Review all studies with the supervisor faculty attending
- Identify common pathology in order to interpret routine studies with accuracy appropriateness to the level of training when presenting to the attending
- Become proficient in detecting musculoskeletal abnormalities on all imaging studies
- Develop interpretation skills for fluoroscopic, ultrasound and CT-guided procedures to optimize diagnostic and therapeutic outcomes.
- Relate the imaging findings to the clinical condition and its pathology
- Understand the clinical management of the conditions encountered.


**Systems-Based Practice:**

**SBP1: Quality Improvement (QI)**
- Familiarity with departmental procedures, contrast safety, and sedation required in the performance of examinations
- Make suggestions to improve methods and systems utilized in radiology whenever appropriate

**SBP2: Health Care Economics**
- Demonstrate knowledge of ACR appropriateness criteria for musculoskeletal studies and cost-effective imaging evaluation

**Practice-Based Learning and Improvement:**

**PBLI1: Patient safety: contrast agents; radiation safety; MR safety; sedation**
- Understand the physics of radiation protection and how to apply it to routine studies
- Understand the indications for utilization of iodinated contrast in diagnostic and interventional studies.
- Understand the indications for gadolinium contrast in diagnostic and interventional studies.

**PBLI2: Self-Directed Learning**
- Show evidence of independent study using textbooks from reading list to fulfill second and third rotation knowledge requirements (see Knowledge Requirements)
- Identify, rectify and learn from personal errors
- Incorporate feedback into improved performance
- Demonstrate evidence of independent reading and learning through use of printed and electronic resources
- Follow up on abnormal or interesting cases through personal communication with the referring physician or patient medical records
- Define the role of diagnostic and interventional procedures in the management of patients
- Understand the role of musculoskeletal radiology in the diagnosis and treatment of patients

**Professionalism:**

**PROF1: Professional Values and Ethics**
- Demonstrate respect for patients and all members of the healthcare team (technologists, nurses, and other healthcare workers)
- Respect patient confidentiality at all times
- Present oneself as a professional in appearance and communication
- Demonstrate a responsible work ethic in regard to work assignments
- Observe ethical principles when recommending further work-up
- Promptness and availability at work are required of every resident
- Dress appropriately for work
Interpersonal and Communication Skills:
ICS1: Effective Communication with Patients, Families, Care Givers
• Appropriately obtain written or verbal informed consent
• Obtain written consent for more complex procedures and answer all questions the patient or family may have
• Explain the nature of the examination or findings in an examination to patients and their families when needed

ICS2: Effective Communication with Members with the Health Care Team
• Communicate effectively with all members of the healthcare team
• Communicate effectively the results of studies to referring clinicians whenever needed (for emergent studies, this will be accomplished in a timely manner)
• Effectively convey the findings of examinations through accurate dictation of reports
• Assist with supervision and teaching of medical and radiology technologist students
• Develop a working relationship with clinicians that refer patients
• Produce concise reports that include all relevant information
• Use appropriate language in communicating to clinicians through reports or consultations so proper management decisions can be made
• Thorough dictations will be made with indications, techniques, findings, and conclusions
• Dictate and correct reports in a timely fashion to avoid delay in patient disposition
• Competent in using PACS, voice recognition systems, and the patient information systems in the daily accomplishment of the workload and instruct others in their use

Monitoring and Assessment of Resident Performance

The resident’s progress will be monitored by the faculty on the service. Written evaluations, organized by the core competencies, will be conducted by the resident education attending in collaboration with the other section attendings on a monthly basis utilizing the New Innovations system. Deficiencies or substandard performance will be discussed personally and privately with the resident and will be brought to the attention of the Residency Program Director. Resident performance is based on direct observation, report quality, multi-source professional evaluations, and productivity on service, performance on the structured curriculum, participation in conferences and other performance evaluation methods as determined necessary.
Other Requirements/ Expectations

Learning Resources

1. Core curriculum lectures given at noon given throughout the year
2. Teaching file in the Terrastation Drive (\10.60.52.20\Radiology\MSK Radiology, 2016\MSK Teaching Files\PPT TFs).
3. Teaching files in Mypacs (search by attending)
4. Montage (http://pacs-montage.mcvh-vcu.edu/accounts/login/?next=/)
5. Didactic lectures (\10.60.52.20\Radiology\MSK Radiology, 2016\MSK Resident Material)
8. Review of all cases in which the resident was involved. Familiarity with references and current literature is expected.

Required Conferences

1. Rheumatology Conference (First Friday of the month, NOW Reading Room/Remote)
2. Sports Medicine Conference (First Tuesday of the Month, Stony Point Reading Room/Remote)
3. MSK Journal Club (2nd Friday of the month, Remote)
4. Biopsy Conference (3rd Friday of the month, Remote)
5. Arthroscopy Conference (4th Friday of the month, Remote)
6. Noon Conference (First and third Thursdays)

Schedule

Schedule of first rotation (Week 1-4):

8:00 AM - 12:00 AM: Review of radiographs (primary focus) and read out with attending. Attend ultrasounds with fellow and attending. Attend joint injections and aspirations with fellow and attending.

12:00-1:30: Conference and lunch.

1:30 - 2:30 PM: Review of radiographs and read out with attending. Attend ultrasounds with fellow and attending. Attend joint injections and aspirations with fellow and attending.

2:30- end of work-day: Dedicated curriculum study time. Otherwise follow a general daily schedule of attending any scheduled morning conference, assist in protocoling studies and responding to questions posed by phone and in person by technologists, referring technologists. Assist in teaching medical students. Assist in procedures as considered appropriate to level of training.
Duties to be completed prior to or during first rotation:
1. Completion of the Rotation #1 assignments including reading, powerpoints and quizzes in Blackboard (https://blackboard.vcu.edu).
2. Observe and participate in fluoroscopic guided joint aspirations and injections.

Tasks to complete the first week of first rotation
1. Have procedural technique in-service by Kathleen Miller, PA
2. General rotation overview by attending.
3. Participate in all conferences, including review of journal club articles and preparation for group discussion.

Schedule of second rotation (Week 5-8):
8:00 AM-12:00 PM: Interpret radiographs and cross-sectional imaging assigned by a fellow and read-out with the attending. Attend and perform musculoskeletal ultrasounds in the company of fellows and attendings. Participate in the performance of joint aspirations and injections, including arthrography. Procedure schedules are in the Cerner Scheduling Appointment Library: MSK Rooms. Residents are expected to identify joint procedures prospectively, review prior imaging and be prepared to discuss technique.

12:00 PM-1:30 PM: Conference and lunch.

1:30 PM- end of work-day: Image interpretation, participation in procedures and read-out, as in the morning session. Most fluoroscopic procedures occur in the afternoon on Main 3.

Tasks to complete during second rotation
1. Completion of the Rotation #2 assignments including reading, powerpoints and quizzes in Blackboard (https://blackboard.vcu.edu).
2. Participate in fluoroscopic guided joint aspirations and injections, and assist in other image guided procedures including bone and soft tissue biopsies.
3. Participate in all conferences, including review of journal club articles and preparation for group discussion.

Schedule of third rotation (Week 9-12):
8:00 AM-12:00 PM: Interpret radiographs and cross-sectional imaging assigned by a fellow and read-out with the attending. Attend and perform musculoskeletal ultrasounds in the company of fellows and attendings. Review procedure schedule, review imaging and be prepared to discuss technique. The resident will participate in joint procedures and in biopsies. Most biopsies occur in the morning on Main 3. Procedure schedules are in the Cerner Scheduling Appointment Library: MSK Rooms.

12:00 PM-1:30 PM: Conference and lunch.

1:30 PM- end of work-day: Interpreting radiographs and assigned cross-sectional imaging when arrive. Review procedure schedule, review imaging and be prepared to discuss technique. The resident will participate in joint procedures and in biopsies. Most fluoroscopic procedures in the afternoon on Main 3.
Tasks to complete during third rotation
2. Participate in fluoroscopic guided joint aspirations and injections, and assist in other image guided procedures including bone and soft tissue biopsies.
3. Participate in all conferences, including review of journal club articles and preparation for group discussion.

Reading List:

Second Rotation: Musculoskeletal MRI, Author: Helms, Major, et al. (2nd Edition)

Third Rotation: Musculoskeletal Imaging: The Requisites (3rd edition)

Conference Schedule

- Rheumatology
- Sports Medicine
- MSK Journal Club
- Biopsy
- Arthroscopy
- MSK Noon Conference
**Knowledge Requirements**

The following outline should serve as a guide to our expectations for your learning during the four-year radiology residency. Everything cannot be learned in your first month rotation. The numbers in parentheses (1-3) following each item refer to the recommended order of concentration for that topic (e.g. 1 = 1st rotation).

A. Arthritis
   1) General
      a) Understand a system for the evaluation of arthritides in general (i.e.“target approach” and “ABCs of arthritis” (1)
      b) Know routine and special radiographic views for arthritis evaluation. (1)
      c) Know sophisticated techniques for arthritis evaluation (3)
      d) Have some familiarity with current management options for common arthritides (2)
   2) Specific Arthritides (typical radiographic presentations)
      a) Rheumatoid arthritis (1)
      b) Juvenile rheumatoid arthritis (2)
      c) Osteoarthritis
         1. Peripheral joints (1)
         2. Spine (1)
         3. DISH (1)
         4. Ossification of the Posterior Longitudinal Ligament (3)
      d) Erosive osteoarthritis (1)
      e) Reiters arthritis (1)
      f) Psoriatic arthritis (1)
      g) Ankylosing spondylitis (1)
      h) Miscellaneous spondyloarthropathies (Bechets, Familial Mediterranean Fever, relapsing polychondritis) (3)
      i) Gout (1)
      j) Calcium Pyrophosphate Dihydrate Deposition Disease (CPPD) (1)
      k) Hydroxyapatite Deposition Disease (HADD) (2)
      l) Neuropathic arthropathy (1)
      m) Hemochromotosis and Wilson’s Disease (3)
      n) Multicentric reticulohistiocytosis (3)
      o) Pigmented villonodular synovitis (2)
      p) Synovial chondromatosis (3)
      q) Septic joint (1)
   3) Specific arthritides: Unusual presentations or complications
      a) Rheumatoid arthritis (2)
      b) Degenerative joint disease (2)

B. Tumors and Tumorlike Lesions of the Musculoskeletal System
   1) General approach to solitary bone lesions (1)
      a) Matrix, margins, and periosteal reaction: radiologic-pathologic correlation (1)
      b) Aggressive vs. unaggressive traits (1)
      c) Common sites for specific tumors (1)
      d) Approach to radiologic workup of solitary bone lesions (1)
2) Specific lesions (radiologic appearances, basic epidemiology)
   a) Bone forming lesions
      1. Osteoma (2)
      2. Osteoblastoma (3)
      3. Bone island, osteoma, osteochondroma (1)
      4. Osteosarcoma (conventional, parosteal, and periosteal) (1)
   b) Cartilage forming lesions
      1. Enchondroma (1)
      2. Chondroblastoma (2)
      3. Chondromyxoid fibroma (3)
      4. Juxtacortical chondroma (3)
      5. Chondrosarcoma (1)
   c) Fibrous lesions
      1. Non-ossifying fibroma, fibrous cortical defect, “cortical desmoid” (1)
      2. Desmoplastic fibroma (3)
      3. Fibrosarcoma and malignant fibrous histiocytoma (MFH) (3)
   d) “Round cell” lesions
      1. Ewing’s sarcoma (1)
      2. Hematologic malignancies: lymphoma, leukemia (2)
      3. Plasmacytoma and myeloma (1)
   e) Miscellaneous lesions
      1. Giant cell tumor (1)
      2. Solitary bone cyst (1)
      3. Aneurysmal bone cyst (2)
      4. Histiocytosis X and eosinophilic granuloma (2)
      5. Hemangioma, lymphangioma, and angiomatosis of bone (3)
   f) Metastatic disease, both lytic and blastic (1)
3) Soft tissue masses
   a) Lipoma, liposarcoma (3)
   b) Fibroma, fibromatosis, fibrosarcoma (3)
   c) Malignant fibrous histiocytoma (3)
   d) Synovial sarcoma (3)
   e) Epithelioid sarcoma (3)
   f) Rhabdosarcoma (3)
   g) Ganglion (3)
   h) Myositis ossificans (2)

C. Normal anatomy, normal variants, and congenital – developmental diseases
   1) Normal anatomy, normal variants, and normal development of the skeleton (1-3)
   2) Anomalies, congenital, and developmental
      a) Aplasias (3)
      b) Hypoplasias (3)
      c) Fusion, hypersegmentation (3)
      d) Congenital hip dysplasia (2)
      e) Foot deformities
         1. Pes planus (2)
2. Tarsal coalition (2)
3. Metatarsus adductus (3)
4. Clubfoot (3)
f) Miscellaneous
1. Blount's disease (3)
2. Sprengel's deformity (3)
3. Madelung's deformity (3)
4. Pectus deformity (2)
g) Discoid meniscus (3)

3) Dysplasia
a) Dwarfisms
1. achondroplasia (2)
2. miscellaneous dwarfisms (3)
b) Dysplasia of cartilage
1. Enchondromatosis (Olliers disease) (3)
2. Multiple familial exostosis (3)
3. Dysplasia epiphysealis hemimelica (3)
c) Dysplasia of bone
1. Ostogenesis imperfecta (2)
2. Osteopetrosis (2)
3. Osteopoikilosis, melorheostosis, osteopathia striata (3)
4. Pyknody sostosis (3)
5. Diaphyseal dysplasia (3)
d) Miscellaneous dysplasias
1. Nail patella syndrome (3)
2. Poland syndrome (3)

4) Primary disturbance of growth
a) Marfan's syndrome (3)
b) Progeria (3)

5) Mucopolysaccharidoses (3)
6) Neurofibromatosis (2)
7) Tuberous sclerosis (3)
8) Chromosomal aberrations
a) Down's syndrome (3)
b) Turner's syndrome (3)
9) Miscellaneous constitutional disorders
a) Ehler-Danlos (3)
b) Arthrogryposis (3)

D. Inflammation/Infection
1) Osteomyelitis – typical imaging manifestations
a) Acute (1)
b) Chronic, including Brodie abscess (1)
c) TB (3)
2) Soft tissue inflammation
a) Abscess (2)
b) Pyomyositis (3)
c) Bursitis, tendonitis, synovitis (2)
3) Sarcoidosis (2)
4) Imaging strategies for infection:
   a) “uncomplicated” (2)
   b) “complicated” (2)

E. Effects of Trauma
1) Fractures
   a) General terms, description (1)
   b) Specific fractures (1-3)
      1. Skull, skull base (1)
      2. C-Spine: General classification and mechanisms (1)
         i. C1 arch fracture (Jefferson, isolated posterior arch) (1)
         ii. C2-dens fractures (I, II, III) (include os odontoideum),
            Hangman’s fracture, hyperextension teardrop fracture) (1)
         iii. Simple compression fractures (1)
         iv. Burst fractures (1)
         v. Hyperflexion sprain (1)
         vi. Hyperflexion teardrop fracture (1)
         vii. Hyperextension injury (1)
         viii. Unilateral interfacetal dislocation (1)
         ix. Bilateral interfacetal dislocation (1)
         x. Clay shoveler’s fracture (1)
      3. Thoracic and Lumbar spine: 2 and 3 column theory (2)
         i. Simple compression fracture (traumatic and osteoporotic) (1)
         ii. Burst fracture (1)
         iii. Fracture/dislocation (1)
         iv. Chance fracture (seatbelt fracture) (2)
         v. Transverse process fracture (1)
         vi. Spondylolysis and spondylolisthesis (1)
      4. Pelvis – classification and mechanisms
         i. No break in ring (1)
         ii. One break in ring (1)
         iii. > One break in ring (1)
      5. Acetabulum fractures
         i. Anterior/posterior column anatomy (1)
         ii. Specific fractures (1)
      6. Femur fractures
         i. Pipkin fractures and hip dislocations (2)
         ii. Subcapital fractures (1)
         iii. Intertrochanteric fractures (1)
         iv. Subtrochanteric fractures (1)
         v. Femoral shaft fractures (1)
         vi. Condyle fractures (1)
      7. Patellar fractures (1)
      8. Soft tissue injuries to the knee
         i. Meniscal tears (2)
         ii. Ligamentous injury including ACL, PCL, MCL, LCL (2)
         iii. Cartilage injury and degenerative changes (3)
iv. Bone marrow edema (BME) (2)
v. Miscellaneous tendon and muscle injuries, especially patellar tendon, and quadriceps rupture (3)
vi. Effusions, hemarthrosis, etc. (2)

9. Tibial fractures
i. Plateau fractures - classification (3)
ii. Shaft fractures (1)
iii. Distal fractures (see ankle)

10. Ankle fractures
i. Classification – Weber, Lauge-Hansen (3)
ii. Triplane fracture (2)
iii. Pilon fracture (2)
iv. Osteochondral fracture (2)

11. Foot fractures
i. Calcaneus (1)
ii. Talus and subtalar dislocation (1)
iii. Fifth metatarsal avulsion & Jones fracture (1)
iv. Lisfranc fracture/dislocations (1)
v. Distal foot fractures (metatarsals, phalanges) (1)

12. Thoracic Cage
i. Ribs (1)
ii. Clavicle (1)
iii. AC joints separation, classification (1)
iv. Sternal fractures (1)
v. Sternoclavicular joint dislocation (2)

13. Shoulder girdle
i. Scapular fractures (1)
ii. Proximal humerus (Neer classification) (2)
iii. Dislocations, anterior and posterior (1)
iv. Scapulo thoracic dissociation

14. Humeral shaft fractures (1)

15. Elbow
i. Supracondylar and intercondylar fractures (1)
ii. Radial head fractures (1)
iii. Olecranon fractures (1)
iv. Dislocation with or without fracture (1)
v. Avulsions, especially in children (1)
vi. Nursemaid's elbow (2)

16. Forearm, distal radius, and ulna
i. Monteggia fracture (1)
ii. Galeazzi fracture (1)
iii. Both bone forearm fracture (BBFA Fx) (1)
iv. Distal radial fracture (Colles, Smith’s, Bartons’s and Reverse Bartons’s) (1)
v. Torus fractures and bowing fractures (1)

17. Wrist-Hand
i. Scaphoid (1)
ii. Triquetrum (1)
III. Lunate and perilunate dislocations (1)
iv. Scapholunate dissociation (1)
v. DC, VC, SLAC hamate fracture (1)
vi. Fracture dislocations (1)
vii. 1st Metacarpal fractures including Bennett’s and Rolando’s (1)
viii. Volar plate fractures (1)
ix. Extensor hood injuries and mallet finger (1)
x. DISI, VISI, and SLAC instability patterns (3)

18. Soft tissue injuries
   i. Shoulder - Rotator cuff impingement, labral abnormalities, SLAP lesions, biceps injuries (3)
   ii. Elbow - collateral ligament tears, biceps tear (3)
   iii. Wrist - ligamentous injuries (3)
   iv. Hip - avulsions, labral abnormalities (3)
   v. Knee - see above section (2)
   vi. Ankle - ligamentous injuries, tendonitis, and tears, Achilles tendon abnormalities (3)

19. Salter injuries in children (1)
20. Stress fractures, including wrist, femur, tibia, and feet (2)
21. Insufficiency fractures including sacrum and pelvis (2)
22. Orthopedic hardware (2)

23. Complications of fractures or fracture fixation
   i. Malunion (3)
   ii. Nonunion (3)
   iii. Infection (3)
   iv. Degenerative joint disease (3)
   v. Reflex sympathetic dystrophy (3)

24. Osteonecrosis
   i. Pathophysiology (2)
   ii. Imaging strategies (2)
   iii. Specific locations - proximal humerus, proximal femur, other locations, osteochondritis dessicans (2)

25. Miscellaneous
   i. Foreign bodies/gas (1)
   ii. Loose bodies - recognition (1)
   iii. Recognizing effusions and fat/fluid levels (1)
   iv. Vacuum phenomenon (1)

F. Metabolic Bone Disease
   1) Osteoporosis
      a) General manifestations (2)
      b) Bone mineral density techniques (3)
      c) Basic epidemiology (3)
      d) Specific types
         1. Senile, postmenopausal (2)
         2. Disease (2)
         3. RSD (Sudeck’s atrophy) (2)
         4. Transient osteoporosis TOP (3)
5. Scurvy (3)

2) Osteomalacia, renal osteodystrophy, and rickets
   a) Metabolic pathways and causes (2)
   b) Specific causes
      1. Dietary (3)
      2. Gastrointestinal (3)
      3. Renal disease (3)
      4. Tubular dysfunction (3)
      5. Vitamin D dependent rickets (3)
   c) Renal osteodystrophy - radiologic manifestations (2)

3) Parathyroid disease
   a) Primary, secondary and tertiary hyperparathyroidism (2)
   b) Radiographic manifestations - typical (2)

4) Acromegaly and gigantism (3)

5) Thyroid disorders (3)

6) Cushing syndrome (3)

7) Poisoning
   a) Heavy metal/lead (3)
   b) Fluorosis (3)
   c) Hypervitamin A and D (3)

8) Hemochromatosis (3)

9) Hypophosphatiasis (3)

10) Ochronosis (3)

G. Systemic and collagen vascular diseases
1) Systemic lupus erythematosus (2)
2) Scleroderma (2)
3) Dermatomyositis and mixed connective tissue disease (3)
4) Polyarteritis nodosa (3)
5) Hematological
   a) Sickle cell disease (1)
   b) Thalassemia (3)
   c) Hemophilia (3)
   d) Myelofibrosis and myeloid metaplasia (3)
   e) Extramedullary hematopoiesis (3)
      1. Histiocytosis X (3)
      2. Sphingolipidosis: Gaucher disease (3)
      3. Amyloid deposition (3)

H. Miscellaneous disorders
1) Paget's disease
   a) Pathophysiology (2)
   b) Typical manifestations (1)
   c) Complications including fracture, sarcoma (3)

2) Fibrous dysplasia
   a) Pathophysiology (3)
   b) Typical manifestations (2)
c) Associated conditions (3)
3) Tumoral calcinosis (3)

I. Miscellaneous gamuts
1) Periosteal reaction (2)
2) Dense bone (generalized) (3)
3) Osteopenic bone (generalized) (3)
4) Soft tissue calcifications (3)
5) AVN – causes and sites (2)
6) Solitary lesions, epiphyseal, periarticular, metaphyseal, diaphyseal (2)
7) Metastatic disease – blastic lesions, common types (2), lytic lesions, common types (2)

Technical Requirements

A. Skills
1) Arthography/aspiration/injection
   a) Sites:
      1. Hip (native & THR) (2)
      2. Shoulder (2)
      3. Wrist (3)
      4. SI joint (3)
      5. Facet joint (3)
   Note: Experience with hip and shoulder aspirations as the primary operator should be achieved by end of the first year. General knowledge of other sites only.

2) Musculoskeletal and Bone Biopsy (3)
   a) Understand Trephine technique, Bonopty and OnControl systems
   b) Understand FNA technique
   c) Hands on experience as primary operator by end of 4th year
3) Disc Biopsy: knowledge of technique (3)
4) Fluoroscopy – basic operating skills and familiarity with principles (1)

B. Technical knowledge/physics
1) Plain radiography
   a) Image production and artifacts (1)
   b) Basic positioning and standard views from trauma and non-trauma (1)
   c) Specialized views (i.e., Sunrise, tunnel, carpal tunnel, Broden’s) (2)
   d) Quality control knowledge
      1. density (2)
      2. artifacts (2)
      3. positioning (2)

Editorial note: An accomplished radiologist can position patients better than a good technologist and can generally give advice on difficult cases.
2) CT
   a) Knowledge of CT technique
      1. KV, MAS, FOV (2)
      2. Hounsfield units (HU), window/level (2)
      3. Spiral vs. incremental technique (2)
      4. Algorithms (3)
      5. Use of reconstructed images (3)
   b) Anatomy: specific to musculoskeletal which should include:
      1. Shoulder girdle (2)
      2. Pelvis (2)
      3. Ankle/foot (2)
      4. Spine (2)
      5. Wrist (2)