HAN 427  :  Nuclear Medicine Procedures (6 credits: 5 credits hours lecture and 1 credit hour LAB)
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Meeting Time   :  Monday & Wednesday  1:00 - 3:30
Location   :  Seminar Room 1A (except 4/23; Seminar Room 2B)
LAB   :  Tuesday, 5:00 – 7:00, Seminar Room 3A

Description:
Methods, principles and instrumentation employed for Nuclear Medicine imaging is provided. This is followed by an examination of the preparation and performance of planar, Single Photon Emission Tomography (SPECT) and Positron Emission Tomography (PET) nuclear medicine imaging procedures. Information necessary to perform liver, spleen, hepatobiliary, gastric reflux, gastrointestinal bleeds, lung, endocrine, central nervous system imaging and/or functional studies is provided. In vitro nuclear medicine procedures are presented. Principles of sensitivity, specificity, accuracy, and predictive values of diagnostic testing are also examined.

Goal:
To provide students with a working knowledge of nuclear medicine imaging and in vitro procedures.

Behavioral Objectives are consistent with the Joint Review Committee on Education in Nuclear Medicine Technology (JRCNMT) standards for accreditation.

Upon completion of this course, students will be able to:

BONE IMAGING

Review of Anatomy and Physiology
1. Describe the matrix structure and composition of bone.
2. Describe the restructuring and repair process of bone, including the hormonal control system.

Pathology
3. Describe the characteristics and causes of common bone pathologies; identify the population most susceptible to the disease; and give a brief overview of potential treatments.

Radiopharmaceuticals
4. Describe the radiopharmaceuticals used for bone imaging including their physical and chemical properties, biorouting route and method of administration, and discuss the advantages and disadvantages of each agent.
5. Specify the dose range for bone imaging agents and discuss the resulting radiation dose to various organs and tissues.
6. Discuss kit and dose preparation and any special precautions that should be taken to assure the quality of bone imaging agents.

Contraindications and Adverse Reactions
7. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with bone imaging, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceuticals.

Patient Preparation
8. Describe the preparation of the patient for a bone scan.
9. List the indications for a routine bone scan and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
10. Describe the procedures for routine static planar and whole body bone imaging, including equipment, protocol, dose and administration technique, administration-to-acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, image formatting and potential pitfalls.
3-Phase and 4-Phase Imaging
11. List the indications for a 3-phase or 4-phase bone scan and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities.
12. Describe the protocol for 3-phase or 4-phase bone imaging, including equipment, protocol, dose and administration technique, administration-to-acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, image formatting and potential pitfalls.

Single Photon Emission Computed Tomography (SPECT)
13. List the indications for a SPECT bone scan and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
14. Describe the procedures for SPECT bone imaging, including equipment, protocol, dose and administration technique, administration-to-acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, data processing, image formatting and potential pitfalls.

Interpretation of Images
15. Describe the normal distribution and normal variants seen on bone images and recognize them on bone studies.
16. Identify structures on bone images and SPECT slices.
17. Describe the appearance of various pathologies seen on bone images and identify them on bone studies.
18. Describe various artifacts that can occur during bone imaging and identify them on bone studies.
19. Discuss the diagnostic and prognostic value of bone imaging procedures.
20. Explain some common causes of false-negative and false-positive bone studies.

CARDIOVASCULAR IMAGING

Review of Anatomy and Physiology
1. Describe the gross anatomy and function of the cardiovascular system.
2. Discuss the anatomy and function of the cardiovascular system at the cellular level.
3. Outline the flow of blood through the coronary arteries and the systemic circulation.
4. Describe the various components of the heart’s conduction system.
5. Identify the wave deflections on an electrocardiogram, and describe the part of the cardiac cycle that each deflection represents.
6. Define the functional parameters of the cardiovascular system, including cardiac output, stroke volume, and ejection fraction, etc.

Pathology
7. Describe the characteristics and causes of common cardiac pathologies; identify the population most susceptible to the disease; and give a brief overview of potential treatments.
8. Trace the blood flow through the heart, given a vascular or chamber defect resulting in a shunt.
9. Discuss the relationship between abnormal cardiac output and respiratory function.
10. State whether a cardiac cycle is normal or abnormal, given an electrocardiogram (ECG) tracing obtained with a 3-lead ECG technique.

Cardiac Stress Testing Methods
11. List the indications, contraindications, and possible adverse reactions associated with exercise stress testing.
12. Describe the patient preparation necessary for the exercise stress test.
13. List the equipment utilized for exercise stress testing.
14. Describe the various exercise stress testing protocols and discuss the advantages and disadvantages of each.
15. Describe the skin preparation and electrode placement for a 12 lead electrocardiogram.
16. Discuss each of the pharmacologic interventions including the mechanisms of action, indications, contraindications, adverse effects, administration protocols, patient preparation, antidotes, and the operation of an infusion pump.
17. Discuss the addition of low-level exercise to a pharmacologic intervention study including indications, contraindications, adverse effects, positive effects, administration protocols, types of low-level exercise, and patient preparation.
18. Identify a normal electrocardiogram, and are able to locate and identify arrhythmias and other abnormalities on a 3-lead ECG tracing.

Myocardial Perfusion/Viability
19. List the indications for myocardial perfusion/viability imaging.
20. Compare the physical and chemical characteristics, kit and dose preparation, dose and route of administration, biorouting, and dosimetry of each radiopharmaceutical used for myocardial perfusion/viability imaging.
21. Discuss the possible adverse reactions and contraindications for myocardial perfusion/viability imaging.
22. Describe the patient preparation necessary for a high quality study.
23. Discuss the equipment and basic procedures and processing utilized in myocardial perfusion/viability imaging.
24. Identify a normal myocardial perfusion/viability scan, and discuss normal variants, abnormal findings, artifacts, and the diagnostic and prognostic value of the study.

**Equilibrium Radionuclide Angiography (ERNA)**
25. List the indications for an ERNA scan.
26. Describe the physical and chemical characteristics, kit and dose preparation, dose and route of administration, biorouting, and dosimetry for Tc-99m LABeled red blood cells.
27. Discuss contraindications and adverse reactions for an ERNA study.
28. Describe the patient preparation necessary for a high quality ERNA study.
29. Discuss the equipment and basic procedures and processing utilized in ERNA imaging.
30. Discuss the interventions and additional procedures that may be added to the basic ERNA study.
31. Identify a normal ERNA scan, and discuss normal variants, abnormal findings, artifacts, and the diagnostic and prognostic value of the study.

**First Pass Angiography**
32. List the indications for a first pass angiography procedure.
33. Compare the physical and chemical characteristics, kit and dose preparation, dose and route of administration, biorouting and dosimetry of each radiopharmaceutical used for first pass angiography imaging.
34. Discuss contraindications and adverse reactions for first pass angiography.
35. Describe the patient preparation necessary for a high quality first pass angiography study.
36. Discuss the equipment and basic procedures and processing utilized in first pass angiography.
37. Identify a normal first pass angiography procedure, and discuss normal variants, abnormal findings, artifacts, and the diagnostic and prognostic value of the study.

**Infarct Imaging**
38. List the indications for infarct imaging.
39. Compare the physical and chemical characteristics, kit and dose preparation, dose and route of administration, biorouting, and dosimetry of each radiopharmaceutical used for infarct imaging.
40. Discuss contraindications and adverse reactions for infarct imaging.
41. Describe the patient preparation necessary for high quality infarct imaging.
42. Discuss the equipment and basic procedures and processing utilized in infarct imaging.
43. Identify a normal infarct scan, and discuss normal variants, abnormal findings, artifacts, and the diagnostic and prognostic value of the study.

**Major Vessel Flow Study**
44. List the indications for a major vessel flow study.
45. Compare the physical and chemical characteristics, kit and dose preparation, dose and route of administration, biorouting, and dosimetry of each radiopharmaceutical used for a major vessel flow study.
46. Discuss contraindications and adverse reactions for a major vessel flow study.
47. Describe the patient preparation necessary for a high quality major vessel flow study.
48. Discuss the equipment and basic procedures and processing utilized during a major vessel flow study.
49. Identify a normal major vessel flow study, and discuss normal variants, abnormal findings, artifacts, and the diagnostic and prognostic value of the study.

**Deep Vein Thrombosis Detection**
50. List the indications for deep vein thrombosis imaging.
51. Compare the physical and chemical characteristics, kit and dose preparation, dose and route of administration, biorouting, and dosimetry of each radiopharmaceutical used for deep vein thrombosis detection.
52. Discuss contraindications and adverse reactions for deep vein thrombosis detection.
53. Describe the patient preparation necessary for high quality deep vein thrombosis detection.
54. Discuss the equipment and basic procedures and processing utilized in deep vein thrombosis imaging.
55. Identify a normal deep vein thrombosis scan, and discuss normal variants, abnormal findings, artifacts, and the diagnostic and prognostic value of the study.

**CENTRAL NERVOUS**

**Review of Anatomy and Physiology**
1. Describe the gross anatomy and function of the central nervous system.
2. Discuss the anatomy and function of the central nervous system at the cellular level.
3. Outline the flow of blood through the central nervous system.
4. Describe the production of cerebrospinal fluid (CSF), and trace the flow of CSF.

Pathology
5. Describe the characteristics and causes of common central nervous system pathologies; identify the population most susceptible to the disease; and give a brief overview of potential treatments.

Cerebral Vascular Flow

7. Compare the physical and chemical characteristics, kit and dose preparation, dose and route of administration, biorouting, and dosimetry of each radiopharmaceutical used for cerebral vascular flow imaging.

8. Discuss the possible adverse reactions and contraindications for cerebral vascular flow imaging.

9. Describe the patient preparation necessary for a high quality study.

10. Discuss the equipment and basic procedures and processing utilized in cerebral vascular flow imaging.

11. Identify a normal cerebral vascular flow scan, and discuss normal variants, abnormal findings, artifacts, and the diagnostic and prognostic value of the study.

Planar Brain Imaging
12. List the indications for planar brain imaging.

13. Compare the physical and chemical characteristics, kit and dose preparation, dose and route of administration, biorouting, and dosimetry of each radiopharmaceutical used for planar brain imaging.

14. Discuss the possible adverse reactions and contraindications for planar brain imaging.

15. Describe the patient preparation necessary for a high quality study.

16. Discuss the equipment and basic procedures and processing utilized in planar brain imaging.

17. Identify a normal planar brain scan, and discuss normal variants, abnormal findings, artifacts, and the diagnostic and prognostic value of the study.

Functional Brain SPECT
18. List the indications for functional brain SPECT.

19. List and compare the physical and chemical characteristics, kit and dose preparation, dose and route of administration, biorouting, and dosimetry of each radiopharmaceutical used for functional brain SPECT imaging.

20. Discuss the possible adverse reactions and contraindications for functional brain SPECT.

21. Describe the patient preparation necessary for a high quality study.

22. Discuss the equipment and basic procedures and processing utilized in functional brain SPECT imaging.

23. Discuss the interventions and additional procedures that may be added to the basic brain SPECT imaging study.

24. Identify a normal functional brain SPECT scan, and discuss normal variants, abnormal findings, artifacts, and the diagnostic and prognostic value of the study.

Positron Imaging
25. List the indications for positron brain imaging.

26. Compare the physical and chemical characteristics, kit and dose preparation, dose and route of administration, biorouting, and dosimetry of each radiopharmaceutical used for positron brain imaging.

27. Discuss the possible adverse reactions and contraindications for positron brain imaging.

28. Describe the patient preparation necessary for a high quality study.

29. Discuss the equipment and basic procedures and processing utilized in positron brain imaging.

30. Discuss the interventions and additional procedures that may be added to the basic positron brain imaging study.

31. Identify a normal positron brain scan, and discuss normal variants, abnormal findings, artifacts, and the diagnostic and prognostic value of the study.

Brain Tumor Imaging
32. List the indications for brain tumor imaging.

33. Compare the physical and chemical characteristics, kit and dose preparation, dose and route of administration, biorouting, and dosimetry of each radiopharmaceutical used for brain tumor imaging.

34. Discuss the possible adverse reactions and contraindications for brain tumor imaging.

35. Describe the patient preparation necessary for a high quality study.

36. Discuss the equipment and basic procedures and processing utilized in brain tumor imaging.

37. Identify a normal brain tumor scan, and discuss normal variants, abnormal findings, artifacts, and the diagnostic and prognostic value of the study.

Cisternography
38. List the indications for cisternography.

39. Compare the physical and chemical characteristics, kit and dose preparation, dose and route of administration, biorouting, and dosimetry of each radiopharmaceutical used for cisternography.

40. Discuss the possible adverse reactions and contraindications for cisternography.
41. Describe the patient preparation necessary for a high quality study.
42. Discuss the equipment and basic procedures and processing utilized in cisternography.
43. Identify a normal cisternogram, and discuss normal variants, abnormal findings, artifacts, and the diagnostic and prognostic value of the study.

**Cerebrospinal Fluid (CSF) Leak Study**
44. List the indications for a CSF leak study.
45. Compare the physical and chemical characteristics, kit and dose preparation, dose and route of administration, biorouting, and dosimetry of each radiopharmaceutical used for a CSF leak study.
46. Discuss the possible adverse reactions and contraindications for a CSF leak study.
47. Describe the patient preparation necessary for a high quality study.
48. Discuss the equipment and basic procedures and processing utilized for a CSF leak study.
49. Identify a normal CSF leak study, and discuss normal variants, abnormal findings, artifacts, and the diagnostic and prognostic value of the study.

**Cerebrospinal Fluid (CSF) Shunt Patency**
50. List the indications for a CSF shunt patency study.
51. Compare the physical and chemical characteristics, kit and dose preparation, dose and route of administration, biorouting, and dosimetry of each radiopharmaceutical used for CSF shunt patency imaging.
52. Discuss the possible adverse reactions and contraindications for CSF shunt patency imaging.
53. Describe the patient preparation necessary for a high quality study.
54. Discuss the equipment and basic procedures and processing utilized for a CSF shunt patency study.
55. Identify a normal CSF shunt patency scan, and discuss normal variants, abnormal findings, artifacts, and the diagnostic and prognostic value of the study.

**DIGESTIVE SYSTEM PROCEDURES**

**Review of Anatomy and Physiology**
1. Describe the gross anatomy and function of the digestive system and its individual organs.
2. Discuss the cellular structure and physiology of the organs of the digestive system.
3. Discuss blood flow to, from and through organs of the digestive system.
4. Describe bile production and flow.

**Pathology**
5. Describe the characteristics and causes of common pathologies of the digestive system as related to nuclear medicine procedures; identify the population most susceptible to the disease; and give a brief overview of potential treatments.

**Salivary Gland Imaging**
6. List the indications for salivary gland imaging and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
7. Describe the radiopharmaceutical used for salivary gland imaging including the physical and chemical properties, biorouting, dose preparation, and route & method of administration.
8. Specify the dose range for salivary gland imaging and discuss the resulting radiation dose to various organs and tissues.
9. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with salivary gland imaging, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.
10. Describe the preparation of the patient for salivary gland imaging.
11. Describe the procedures for salivary gland imaging, including equipment, protocol, dose and administration technique, administration-to-acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, data processing, image formatting and potential pitfalls.
12. Describe the interventional procedures that may be used for salivary gland imaging, including salivary discharge.
13. Describe the normal distribution and normal variants seen on salivary gland studies, and recognize them on printed images.
14. Describe the appearance of various pathologies seen on salivary gland studies and identify them on printed images.
15. Describe various artifacts that can occur during salivary gland studies and identify them on printed images.
16. Discuss the diagnostic and prognostic value of salivary gland studies.
17. Discuss some common causes of false-negative and false positive salivary gland studies.

**Esophageal Motility/Transit and Reflux**
18. List the indications for esophageal studies and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
19. Describe the radiopharmaceutical used for esophageal studies including the physical and chemical properties,
biorouting, dose preparation, and route & method of administration.

20. Specify the dose range for esophageal studies and discuss the resulting radiation dose to various organs and tissues.

21. Discuss kit and dose preparation and any special precautions that should be taken to assure the quality of esophageal study agents.

22. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with esophageal studies, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceuticals.

23. Describe the special radiation safety precautions that must be considered when performing esophageal studies.

24. Describe the preparation of the patient for esophageal studies.

25. Describe the procedures for esophageal studies, including equipment, protocol, dose and administration technique, acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, data processing, image formatting and potential pitfalls.

26. Describe any interventional procedures that may be used for esophageal studies.

27. Calculate esophageal transit time and percent esophageal reflux when given appropriate data.

28. Discuss the normal results and normal variants seen on esophageal studies, and recognize them in printed form.

29. Describe various artifacts that can occur during esophageal studies and recognize them in printed form.

30. Discuss the diagnostic and prognostic value of esophageal studies.

31. Discuss some common causes of false-negative and false positive esophageal studies.

**Gastric Emptying**

33. List the indications for a gastric emptying study and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.

34. Describe the radiopharmaceuticals used for gastric emptying studies including the physical and chemical properties, biorouting, dose preparation, and route & method of administration.

35. Specify the dose range for gastric emptying studies and discuss the resulting radiation dose to various organs and tissues.

36. Discuss kit and dose preparation and any special precautions that should be taken to assure the quality of gastric emptying study agents.

37. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with gastric emptying studies, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceuticals.

38. Describe the special radiation safety precautions that must be considered when performing gastric emptying studies.

39. Describe the preparation of the patient for gastric emptying studies.

40. Describe the procedure for a gastric emptying study, including equipment, protocol, dose and administration technique (appropriate meal), acquisition parameters, standard positioning and views, special imaging adaptations, data processing, image formatting and potential pitfalls.

41. Describe any interventional procedures that may be used for gastric emptying studies.

42. Calculate gastric emptying times and percent gastric emptying when given appropriate data.

43. Discuss the normal results and normal variants seen on gastric emptying studies, and recognize them in printed form.

44. Describe the appearance of various pathologies seen on gastric emptying studies and identify them in printed form.

45. Describe various artifacts that can occur during gastric emptying studies and identify them in printed form.

46. Discuss the diagnostic and prognostic value of gastric emptying studies.

47. Discuss some common causes of false-negative and false positive gastric emptying studies.

**Helicobacter Pylori Detection**

48. List the indications for a helicobacter pylori (H. pylori) detection study and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.

49. Describe the radiopharmaceutical used for H. pylori detection including the physical and chemical properties, biorouting, dose preparation, and route & method of administration.

50. Specify the dose range for H. pylori detection and discuss the resulting radiation dose to various organs and tissues.

51. Discuss kit & dose preparation and any special precautions that should be taken to assure the quality of H. pylori detection agent.

52. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with H. pylori detection, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceuticals.

53. Describe the special radiation safety precautions and regulations that must be considered when performing H. pylori detection studies.
54. Describe the preparation of the patient for a H. pylori detection study.
55. Describe the procedure for H. pylori detection, including equipment, protocol, dose and administration technique, acquisition parameters, data processing and potential pitfalls.
56. Describe the normal results and normal variants seen in H. pylori detection studies, and recognize them in printed form.
57. Describe the appearance of various pathologies seen in H. pylori detection studies and identify them in printed form.
58. Describe various artifacts that can occur during H. pylori detection and identify them in printed form.
59. Discuss the diagnostic and prognostic value of H. pylori detection studies.
60. Discuss some common causes of false-negative and false-positive H. pylori detection studies.

Liver/Spleen Imaging
61. List the indications for liver/spleen imaging and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
62. Describe the radiopharmaceutical used for liver/spleen imaging including the physical and chemical properties, biorouting, dose preparation, and route and method of administration.
63. Specify the dose range for liver/spleen imaging and discuss the resulting radiation dose to various organs and tissues.
64. Discuss kit and dose preparation and any special precautions that should be taken to assure the quality of the liver/spleen imaging agent.
65. Discuss any physical or pathological conditions or prior procedures that could contraindicate or interfere with liver/spleen imaging, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.
66. Describe the preparation of the patient for liver/spleen imaging.
67. Describe the procedures for liver/spleen imaging, including equipment, protocol, dose and administration technique, administration-to-acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, image formatting and potential pitfalls.
68. Describe the normal distribution and normal variants seen on liver/spleen studies, and recognize them on printed images.
69. Describe the appearance of various pathologies seen on liver/spleen studies and identify them on printed images.
70. Describe various artifacts that can occur during liver/spleen studies and identify them on printed images.
71. Discuss the diagnostic and prognostic value of liver/spleen studies.
72. Discuss some common causes of false-negative and false-positive liver/spleen studies.

Hemangioma Detection
73. List the indications for a hemangioma detection study and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
74. Describe the radiopharmaceuticals used for hemangioma detection including the physical and chemical properties, biorouting, dose preparation, and route & method of administration.
75. Specify the dose range for hemangioma detection studies and discuss the resulting radiation dose to various organs and tissues.
76. Discuss kit and dose preparation and any special precautions that should be taken to assure the quality of the hemangioma detection agents.
77. Describe the process for tagged red blood cells for hemangioma detection.
78. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with hemangioma detection, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceuticals.
79. Describe the preparation of the patient for a hemangioma detection study.
80. Describe the procedures for a hemangioma detection study, including equipment, protocol, dose and administration technique, administration-to-acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, data processing, image formatting and potential pitfalls.
81. Describe the normal distribution and normal variants seen on a hemangioma detection study, and recognize them on printed images.
82. Identify structures on hemangioma detection SPECT slices.
83. Describe the appearance of various pathologies seen on hemangioma detection studies and identify them on printed images.
84. Describe various artifacts that can occur during hemangioma detection studies and identify them on printed images.
85. Discuss the diagnostic and prognostic value of hemangioma detection studies.
86. Discuss some common causes of false-negative and false-positive hemangioma detection studies.

Hepatobiliary Studies
87. List the indications for hepatobiliary studies and discuss why a nuclear medicine study would be preferable to or
complement other diagnostic modalities in various cases.
88. Describe the radiopharmaceuticals used for hepatobiliary studies including the physical and chemical properties, biorouting, dose preparation, and route and method of administration.
89. Specify the dose range for hepatobiliary studies and discuss the resulting radiation dose to various organs and tissues.
90. Discuss kit and dose preparation and any special precautions that should be taken to assure the quality of the hepatobiliary study agents.
91. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with hepatobiliary study, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceuticals.
92. Describe the preparation of the patient for hepatobiliary study.
93. Describe the procedures for hepatobiliary study, including equipment, protocol, dose and administration technique, acquisition parameters, standard positioning and views, special imaging adaptations, data processing, image formatting and potential pitfalls.
94. Describe the interventional procedures that may be used with hepatobiliary studies, including morphine enhancement, cholecystokinin intervention, and gall bladder ejection fraction calculation.
95. Calculate the gall bladder ejection fraction when given appropriate data.
96. Describe the normal distribution and normal variants seen on hepatobiliary studies, and recognize them on printed images and forms.
97. Describe the appearance of various pathologies seen on hepatobiliary studies and identify them on printed images and forms.
98. Describe various artifacts that can occur during hepatobiliary studies and identify them on printed images and forms.
99. Discuss the diagnostic and prognostic value of salivary gland studies.
100. Discuss some common causes of false-negative and false-positive salivary gland studies.

Gastrointestinal (GI) Bleeding Scan
101. List the indications for a GI bleeding scan and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
102. Describe the radiopharmaceuticals used for GI bleeding scan including the physical and chemical properties, biorouting, dose preparation, and route and method of administration.
103. Specify the dose range for a GI bleeding scan and discuss the resulting radiation dose to various organs and tissues.
104. Discuss kit and dose preparation and any special precautions that should be taken to assure the quality of the GI bleeding scan agents.
105. Describe the process for tagged red blood cells for a GI bleeding scan.
106. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with a GI bleeding scan, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceuticals.
107. Describe the preparation of the patient for a GI bleeding scan.
108. Describe the procedures for a GI bleeding scan, including equipment, protocol, dose and administration technique, acquisition parameters, standard positioning and views, special imaging adaptations, image formatting and potential pitfalls.
109. Describe the normal distribution and normal variants seen on a GI bleeding scan, and recognize them on printed images.
110. Describe the appearance of various pathologies seen on GI bleeding scan and identify them on printed images.
111. Describe various artifacts that can occur during a GI bleeding scan and identify them on printed images.
112. Discuss the diagnostic and prognostic value of GI bleeding scans.
113. Discuss some common causes of false-negative and false-positive GI bleeding scan.

Meckel’s Diverticulum Imaging
114. List the indications for Meckel’s diverticulum imaging and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
115. Describe the radiopharmaceutical used for Meckel’s diverticulum imaging including the physical and chemical properties, biorouting, dose preparation, and route & method of administration.
116. Specify the dose range for Meckel’s diverticulum imaging and discuss the resulting radiation dose to various organs and tissues.
117. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with Meckel’s diverticulum imaging, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceuticals.
118. Describe the preparation of the patient for Meckel’s diverticulum imaging.
119. Describe the procedures for Meckel’s diverticulum imaging, including equipment, protocol, dose and administration technique, acquisition parameters, standard positioning and views, special imaging adaptations, image formatting and potential pitfalls.

120. Describe the interventional procedures that may be used for Meckel’s diverticulum imaging, including administration of glucagon, cimetidine and pentagastrin.

121. Describe the normal distribution and normal variants seen on Meckel’s diverticulum studies, and recognize them on printed images.

122. Describe the appearance of various pathologies seen on Meckel’s diverticulum studies and identify them on printed images.

123. Describe various artifacts that can occur during Meckel’s diverticulum studies and identify them on printed images.

124. Discuss the diagnostic and prognostic value of Meckel’s diverticulum studies.

125. Discuss some common causes of false-negative and false-positive Meckel’s diverticulum studies.

LeVeen Shunt Studies

126. List the indications for a LeVeen shunt study and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.

127. Describe the radiopharmaceuticals used for LeVeen shunt studies including the physical and chemical properties, biorouting, dose preparation, and route & method of administration.

128. Specify the dose range for a LeVeen shunt study and discuss the resulting radiation dose to various organs and tissues.

129. Discuss any procedures that could contraindicate or interfere with a LeVeen shunt study, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceuticals.

130. Describe the preparation of the patient for a LeVeen shunt study.

131. Describe the procedures for a LeVeen shunt study, including equipment, protocol, dose and administration technique, acquisition parameters, standard positioning and views, special imaging adaptations, image formatting and potential pitfalls.

132. Describe the normal distribution and normal variants seen on a LeVeen shunt study, and recognize them on printed images.

133. Describe the appearance of various pathologies seen on a LeVeen shunt study and identify them on printed images.

134. Describe various artifacts that can occur during LeVeen shunt studies and identify them on printed images.

135. Discuss the diagnostic and prognostic value of LeVeen shunt studies.

136. Discuss some common causes of false-negative and false-positive LeVeen shunt studies.

Intrahepatic Pump Study

137. List the indications for an intrahepatic pump study and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.

138. Describe the radiopharmaceuticals used for intrahepatic pump studies including the physical and chemical properties, biorouting, dose preparation, and route & method of administration.

139. Specify the dose range for an intrahepatic pump study and discuss the resulting radiation dose to various organs and tissues.

140. Discuss any procedures that could contraindicate or interfere with an intrahepatic pump study, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceuticals.

141. Describe the preparation of the patient for an intrahepatic pump study.

142. Describe the procedures for an intrahepatic pump study, including equipment, protocol, dose and administration technique, acquisition parameters, standard positioning and views, special imaging adaptations, image formatting and potential pitfalls.

143. Describe the normal distribution and normal variants seen on an intrahepatic pump study, and recognize them on printed images.

144. Describe the appearance of various pathologies seen on an intrahepatic pump study and identify them on printed images.

145. Describe various artifacts that can occur during intrahepatic pump studies and identify them on printed images.

146. Discuss the diagnostic and prognostic value of intrahepatic pump studies.

147. Discuss some common causes of false-negative and false-positive intrahepatic pump studies.

ENDOCRINE/EXOCRINE

Review of anatomy and physiology

1. Describe the gross anatomy and function of both the endocrine and exocrine system and its individual organs.

2. Discuss the cellular structure and physiology of each of the organs of the endocrine/exocrine system.

3. Discuss blood flow to, from, and through organs of the endocrine/exocrine system.
4. Describe the production and secretion of substances from each organ in the endocrine/exocrine system.
5. Describe the various feedback mechanisms associated with endocrine/exocrine system.

**Pathology**
6. Describe the characteristics and causes of common pathologies of the endocrine/exocrine system as related to nuclear medicine procedures; identify the population most susceptible to the disease; and give a brief overview of potential treatments.

**Thyroid Uptake study**
7. List the indications for performing a thyroid uptake study and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
8. Describe the radiopharmaceuticals used for thyroid uptakes including the physical and chemical properties, biorouting, dose preparation, and route and method of administration.
9. Specify the dose range for thyroid uptake studies and discuss the resulting radiation does to various organs and tissues.
10. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with a thyroid uptake study, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.
11. Describe the preparation of the patient for a thyroid uptake study.
12. Describe the procedures for a thyroid uptake study, including equipment, protocol, dose, and administration technique, administration–to-acquisition times, acquisition parameters, standard positioning, special imaging adaptations, data processing, data processing, and potential pitfalls.
13. Describe the normal range and normal variants with regard to acquired data.
15. Discuss the diagnostic and prognostic value of renal perfusion imaging.
16. Discuss some common causes of false-negative and false-positive thyroid uptake results.

**Thyroid Scan**
17. List the indications for thyroid imaging and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
18. Describe the radiopharmaceuticals used for thyroid imaging including the physical and chemical properties, biorouting, dose preparation, and route and method of administration.
19. Specify the dose range for thyroid imaging and discuss the resulting radiation dose to various organs and tissues.
20. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with thyroid imaging, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.
21. Describe the preparation of the patient for thyroid imaging.
22. Describe the procedures for thyroid imaging, including equipment, protocol, dose, and administration technique, administration–to-acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, data processing, data processing, image formatting and potential pitfalls.
23. Describe the normal distribution and normal variants seen on thyroid imaging studies and recognize them on printed images.
24. Describe various artifacts that can occur during thyroid imaging and identify them on printed images.
25. Discuss the diagnostic and prognostic value of thyroid imaging.
26. Discuss some common causes of false-negative and false-positive thyroid imaging studies.

**Parathyroid Imaging**
27. List the indications for parathyroid imaging and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
28. Describe the radiopharmaceuticals used for parathyroid imaging including the physical and chemical properties, biorouting, dose preparation, and route and method of administration.
29. Specify the dose range for parathyroid imaging and discuss the resulting radiation does to various organs and tissues.
30. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with parathyroid imaging, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.
31. Describe the preparation of the patient for parathyroid imaging.
32. Describe the procedures for parathyroid imaging, including equipment, protocol, dose, and administration technique, administration–to-acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, data processing, data processing, image formatting and potential pitfalls.
33. Describe the normal distribution and normal variants seen on parathyroid imaging studies and recognize them on printed images.
34. Describe various artifacts that can occur during parathyroid imaging and identify them on printed images.
35. Discuss the diagnostic and prognostic value of parathyroid imaging.
36. Discuss some common causes of false-negative and false-positive parathyroid imaging studies.

**Adrenal Imaging**
37. List the indications for adrenal imaging and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
38. Describe the radiopharmaceuticals used for adrenal imaging including the physical and chemical properties, biorouting, dose preparation, and route and method of administration.
39. Specify the dose range for adrenal imaging and discuss the resulting radiation dose to various organs and tissues.
40. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with adrenal imaging, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.
41. Describe the preparation of the patient for adrenal imaging.
42. Describe the procedures for adrenal imaging, including equipment, protocol, dose, and administration technique, administration-to-acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, data processing, data processing, image formatting and potential pitfalls.
43. Describe the normal distribution and normal variants seen on adrenal imaging studies and recognize them on printed images.
44. Describe various artifacts that can occur during adrenal imaging and identify them on printed images.
45. Discuss the diagnostic and prognostic value of adrenal imaging.
46. Discuss some common causes of false-negative and false-positive adrenal imaging studies.

**Lacrimal Duct Imaging (Dacryoscintigraphy)**
47. List the indications for lacrimal duct imaging and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
48. Describe the radiopharmaceuticals used for lacrimal duct imaging including the physical and chemical properties, biorouting, dose preparation, and route and method of administration.
49. Specify the dose range for lacrimal duct imaging and discuss the resulting radiation does to various organs and tissues.
50. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with lacrimal duct imaging, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.
51. Describe the preparation of the patient for lacrimal duct imaging.
52. Describe the procedures for lacrimal duct imaging, including equipment, protocol, dose, and administration technique, administration-to-acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, data processing, data processing, image formatting and potential pitfalls.
53. Describe the normal distribution and normal variants seen on lacrimal duct imaging studies and recognize them on printed images.
54. Describe various artifacts that can occur during lacrimal duct imaging and identify them on printed images.
55. Discuss the diagnostic and prognostic value of lacrimal duct imaging.
56. Discuss some common causes of false-negative and false-positive lacrimal duct imaging studies.

**GENITOURINARY**

**Review anatomy and physiology**
1. Describe the gross anatomy and function of the major components of the genitourinary system.
2. Discuss the cellular structure and physiology of the organs of the genitourinary system.
3. Discuss the relationship between renal activity and aldosterone, renin-angiotension and antidiuretic hormone (ADH).
4. Describe the effects of diuretics on renal function.
5. Discuss factors that contribute to success or failure of transplanted kidneys.

**Pathophysiology**
6. Describe the characteristics and causes of common pathologies of the genitourinary system as related to nuclear medicine procedures; identify population most susceptible to the disease; and give a brief overview of potential treatments.

**Renal Perfusion Study**
7. List the indications for renal perfusion imaging and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
8. Describe the radiopharmaceuticals used for renal perfusion imaging including the physical and chemical properties, biorouting, dose preparation, and route and method of administration.
9. Specify the dose range for renal perfusion imaging and discuss the resulting radiation does to various organs and tissues.
10. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with renal perfusion imaging, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.

11. Describe the preparation of the patient for renal perfusion imaging.

12. Describe the procedures for renal perfusion imaging, including equipment, protocol, dose, and administration technique, administration-to-acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, data processing, data processing, image formatting and potential pitfalls.

13. Describe the normal distribution and normal variants seen on renal perfusion imaging studies and recognize them on printed images.

14. Discuss various artifacts that can occur during renal perfusion imaging and identify them on printed images.

15. Discuss the diagnostic and prognostic value of renal perfusion imaging.

16. Discuss some common causes of false-negative and false-positive renal perfusion imaging studies.

**Renogram**

17. List the indications for performing a renogram and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.

18. Describe the radiopharmaceuticals used for renograms including the physical and chemical properties, biorouting, dose preparation, and route and method of administration.

19. Specify the dose range for renograms and discuss the resulting radiation dose to various organs and tissues.

20. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with performing a renogram, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.

21. Describe the preparation of the patient to have a renogram.

22. Describe the procedures for performing renograms, including equipment, protocol, dose, and administration technique, administration-to-acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, data processing, data processing, image formatting and potential pitfalls.

23. Describe the interventional procedures that may be used for performing renograms.

24. Describe the normal distribution and normal variants seen on a renogram and recognize them on printed images.

25. Describe various artifacts that can occur when performing a renogram and identify them on printed images.

26. Discuss the diagnostic and prognostic value of performing a renogram.

27. Discuss some common causes of false-negative and false-positive renograms.

**Glomerular Filtration Rate (GFR) and Effective Renal Plasma Flow (ERPF)**

28. List the indications for performing a GFR and ERPF and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.

29. Describe the radiopharmaceuticals used for a GFR and ERPF including the physical and chemical properties, biorouting, dose preparation, and route and method of administration.

30. Specify the dose range for a GFR and ERPF and discuss the resulting radiation dose to various organs and tissues.

31. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with performing a GFR and ERPF, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.

32. Describe the preparation of the patient to have a GFR and ERPF.

33. Describe the procedures for performing a GFR and ERPF, including equipment, protocol, dose, and administration technique, administration-to-acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, data processing, data processing, image formatting and potential pitfalls.

34. Describe the normal distribution and normal variants seen on a GFR and ERPF and recognize them on printed images.

35. Describe various artifacts that can occur when performing a GFR and ERPF and identify them on printed images.

36. Discuss the diagnostic and prognostic value of performing a GFR and ERPF.

37. Discuss some common causes of false-negative and false-positive GFR and ERPF.

**Renal Scan for Morphology**

40. List the indications for performing a renal scan for morphology and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.

41. Describe the radiopharmaceuticals used for a renal scan for morphology including the physical and chemical properties, biorouting, dose preparation, and route and method of administration.

42. Specify the dose range for a renal scan for morphology and discuss the resulting radiation dose to various organs and tissues.

43. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with performing a renal scan for morphology, and describe any precautions that should be taken and any potential adverse
reactions to the radiopharmaceutical.
44. Describe the preparation of the patient to have a renal scan for morphology.
45. Describe the procedures for performing renal scan for morphology, including equipment, protocol, dose, and administration technique, administration–to–acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, data processing, data processing, image formatting and potential pitfalls.
46. Describe the normal distribution and normal variants seen on a renal scan for morphology, and recognize them on printed images.
47. Describe various artifacts that can occur when performing a renal scan for morphology and identify them on printed images.
48. Discuss the diagnostic and prognostic value of performing a renal scan for morphology.
49. Discuss some common causes of false-negative and false-positive renal scan for morphology.

Voiding Cystograms
50. List the indications for performing a voiding cystogram and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
51. Describe the radiopharmaceuticals used for a voiding cystogram including the physical and chemical properties, biorouting, dose preparation, and route and method of administration.
52. Specify the dose range for a voiding cystogram and discuss the resulting radiation dose to various organs and tissues.
53. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with performing a voiding cystogram, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.
54. Describe the preparation of the patient to have a voiding cystogram.
55. Describe the procedures for performing a voiding cystogram, including equipment, protocol, dose, and administration technique, administration–to–acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, data processing, data processing, image formatting and potential pitfalls.
56. Describe the normal distribution and normal variants seen on a voiding cystogram, and recognize them on printed images.
57. Describe various artifacts that can occur when performing a voiding cystogram and identify them on printed images.
58. Discuss the diagnostic and prognostic value of performing a voiding cystogram.
59. Discuss some common causes of false-negative and false-positive results of voiding cystograms.

Testicular (Scrotal) Imaging
60. List the indications for performing testicular imaging and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
61. Describe the radiopharmaceuticals used for a voiding testicular imaging including the physical and chemical properties, biorouting, dose preparation, and route and method of administration.
62. Specify the dose range for testicular imaging and discuss the resulting radiation dose to various organs and tissues.
63. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with performing testicular imaging, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.
64. Describe the preparation of the patient to have testicular imaging.
65. Describe the procedures for performing testicular imaging, including equipment, protocol, dose, and administration technique, administration–to–acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, data processing, data processing, image formatting and potential pitfalls.
66. Describe the normal distribution and normal variants seen on a testicular imaging, and recognize them on printed images.
67. Describe various artifacts that can occur when performing testicular imaging and identify them on printed images.
68. Discuss the diagnostic and prognostic value of performing testicular imaging.
69. Discuss some common causes of false-negative and false-positive results of testicular imaging.

HEMATOLOGY AND LYMPHATIC
1. Describe the gross anatomy and function of the hematopoietic and lymphatic systems.
2. Discuss the cellular structure and physiology of the organs and tissues of the hematopoietic and lymphatic systems.
3. Describe the life cycle of red blood cells and white blood cells.
4. Explain the role of intrinsic factor in vitamin B12 absorption; describe the bioroute of B12 after absorption.
5. Trace the movement of lymph through the body.

Pathology
6. Describe the characteristics and causes of common pathologies of the hematopoietic and lymphatic systems as related to nuclear medicine procedures; identify the population most susceptible to the disease; and give a brief overview of
potential treatments.

**Bone Marrow Imaging**
7. List the indications for bone marrow imaging and discuss why a nuclear medicine study would complement or be preferable to other diagnostic modalities in various cases.
8. Describe the radiopharmaceutical used for bone marrow imaging including the physical and chemical properties, biorouting and route & method of administration.
9. Specify the dose range for bone marrow imaging and discuss the resulting radiation dose to various organs and tissues.
10. Discuss kit and dose preparation and any special precautions that should be taken to assure the quality of the bone marrow imaging agent.
11. Discuss any physical or pathological conditions or prior procedures that could contraindicate or interfere with bone marrow imaging, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.
12. Describe the preparation of the patient for bone marrow imaging.
13. Describe the procedures for bone marrow imaging, including equipment, protocol, dose, administration technique, administration-to-acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, image formatting and potential pitfalls.
14. Describe the normal distribution and normal variants seen on bone marrow studies and recognize them on printed images.
15. Describe the appearance of various pathologies seen on bone marrow studies and identify them on printed images.
16. Discuss the diagnostic and prognostic value of bone marrow studies.

**Schilling Test**
19. List the indications for a Schilling test and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
20. Describe the radiopharmaceuticals used for Schilling test including the physical and chemical properties, biorouting, and route and method of administration.
21. Specify the dose range for Schilling test and discuss the resulting radiation dose to various organs and tissues.
22. Describe dose and standard preparation for a Schilling test.
23. Discuss any physical or pathological conditions or prior procedures that could contraindicate or interfere with a Schilling test, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceuticals.
24. Describe the preparation of the patient for a Schilling test.
25. Describe the procedures for Schilling test, including equipment, protocol, dose, administration technique, sample collection and processing, data processing and potential pitfalls.
26. Calculate Schilling test results when given appropriate data.
27. Specify the normal range of values and normal variants seen on a Schilling test.
28. Describe the effects of various pathologies on a Schilling test.
29. Discuss the diagnostic and prognostic value of a Schilling test.

**Plasma Volume Determination**
32. Calculate and prepare solutions from bulk standards.
33. State the dilution principle and demonstrate the ability to apply it to specific problems.
34. List the indications for a plasma volume study and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
35. Describe the radiopharmaceutical used for plasma volume study including the physical and chemical properties, biorouting and route and method of administration.
36. Specify the dose range for plasma volume study and discuss the resulting radiation dose to various organs and tissues.
37. Describe the preparation of the standard used to calculate a plasma volume.
38. Discuss any physical or pathological conditions or prior procedures that could contraindicate or interfere with a plasma volume study, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.
39. Describe the preparation of the patient for a plasma volume study.
40. Describe the procedures for plasma volume study, including equipment, protocol, dose, administration technique, sample collection and processing, data processing and potential pitfalls.
41. Describe the procedure for correcting for vascular leakage when performing a plasma volume determination.
42. Calculate the plasma volume when given appropriate data.
43. Determine the normal range of plasma volume values for a patient given appropriate data.
44. Discuss normal variants seen on a plasma volume study, and recognize them in printed form.
45. Describe the effects of various pathologies on a plasma volume study and recognize them in printed form.
46. Describe various artifacts that can occur during a plasma volume study and recognize them in printed form.
47. Discuss the sources of error that can affect the results of a plasma volume study and discuss methods to prevent such occurrences.

Red Cell Mass Determination

49. List the indications for a red cell mass study and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
50. Describe the radiopharmaceutical used for red cell mass study including the physical and chemical properties, biorouting and route and method of administration.
51. Specify the dose range for red cell mass study and discuss the resulting radiation dose to various organs and tissues.
52. Describe standard preparation and the method for tagging red blood cells for red cell mass determination, including the function of component used in the process.
53. Discuss any physical or pathological conditions or prior procedures that could contraindicate or interfere with a red cell mass study, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.
54. Describe the preparation of the patient for a red cell mass study.
55. Describe the procedures for red cell mass study, including equipment, protocol, dose, administration technique, sample collection and processing, data processing and potential pitfalls.
56. State the rationale for using the hematocrit correction factor when calculating the red cell mass.
57. Calculate the red cell mass when given appropriate data.
58. Determine the normal range of red cell mass values for a patient given appropriate data.
59. Discuss normal variants seen on a red cell mass study and recognize them in printed form.
60. Describe various artifacts that can occur during a red cell mass study and recognize them in printed form.
61. Discuss the sources of error that can affect the results of a red cell mass study, and discuss methods to prevent such occurrences.
62. Discuss the diagnostic and prognostic value of a red cell mass study.

Total Blood Volume Determination

64. Describe and perform calculation of total blood volume from plasma volume and red cell mass volume data.
65. Determine the normal range of total blood volume values for a patient given appropriate data.
66. Discuss normal variants seen on a total blood volume study.
67. Describe the effects of various pathologies on a total blood volume study.
68. Describe various artifacts that can occur during a total blood volume study.
69. Discuss some of the sources of error that can affect the results of a total blood volume study, and discuss methods to prevent such occurrences.
70. Discuss the diagnostic and prognostic value of a total blood volume study.

Red Cell Survival and Sequestration Studies

72. List the indications for red cell survival and sequestration studies and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
73. Describe the radiopharmaceutical used for red cell survival and sequestration studies including the physical and chemical properties, biorouting and route and method of administration.
74. Calculate the degree of red cell sequestration.
75. Specify the dose range for red cell survival and sequestration studies and discuss the resulting radiation dose to various organs and tissues.
76. Describe standard preparation and the method for tagging red blood cells for red cell sequestration determination, including the function of the components used in the process.
77. Discuss any physical or pathological conditions or prior procedures that could contraindicate or interfere with red cell survival and sequestration studies, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.
78. Describe the preparation of the patient for red cell survival and sequestration studies.
79. Describe the procedures for red cell survival and sequestration studies, including equipment protocol, dose,
administration technique, sample collection and processing, data processing and potential pitfalls.

80. Describe the normal range of values and normal variants seen on red cell survival and sequestration studies and recognize them in printed form.

81. Describe the effects of various pathologies on red cell survival and sequestration studies and recognize them in printed form.

82. Describe various artifacts that can occur during red cell survival and sequestration studies and recognize them in printed form.

83. Discuss some of the sources of error that can affect the results of red cell survival and sequestration studies, and discuss methods to prevent such occurrences.

84. Discuss the diagnostic and prognostic value of red cell survival and sequestration studies.

**Selective Spleen Imaging**

85. List the indications for selective spleen imaging and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.

86. Describe the radiopharmaceutical used for selective spleen imaging including the physical and chemical properties, biorouting and route and method of administration.

87. Specify the dose range for spleen imaging and discuss the resulting radiation dose to various organs and tissues.

88. Describe standard preparation and the method for tagging and denaturing red blood cells for selective spleen imaging.

89. Discuss any physical or pathological conditions or prior procedures that could contraindicate or interfere with selective spleen imaging, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.

90. Describe the preparation of the patient for selective spleen imaging.

91. Describe the procedures for selective spleen imaging, including equipment, protocol, dose, administration technique, administration-to-acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, image formatting and potential pitfalls.

92. Describe the normal distribution and normal variants seen on selective spleen studies and recognize them on printed images.

93. Describe the appearance of various pathologies seen on selective spleen studies and identify them on printed images.

94. Describe various artifacts that can occur during selective spleen studies and identify them on printed images.

95. Discuss the diagnostic and prognostic value of selective spleen studies.

96. Discuss some common causes of false-negative and false-positive selective spleen studies.

**Radioassay**

97. Describe the characteristics of a good radioassay for detecting minute quantities of substances in the blood.

98. Describe how antigens and antibodies are produced.

99. Describe the basic process for competitive radioassay and explain the data reduction process.

100. Explain the law of mass action and how it applies to competitive radioassay.

101. Define equilibrium and state how it applies to competitive radioassay.

102. Describe the basic process for direct method radioassay and explain the data reduction process.

103. Describe quality control methods used to evaluate radioassays, curves, and various data, including control solutions, curve analysis, standard deviation, coefficient of variation, and Levy-Jennings plots.

**ONCOLOGY/INFLAMMATION IMAGING**

**Review anatomy and physiology**

1. Describe the components of the immune system and their physiology.

2. Describe the distribution of lymph nodes.

3. Describe the inflammatory processes and differentiate between acute and chronic.

4. Describe the characteristics of a malignancy and the natural processes by which malignancies are produced.

**Pathology**

5. Describe the characteristics and causes of common pathologies of the inflammatory and malignant diseases as related to nuclear medicine procedures; identify population most susceptible to the disease; and give a brief overview of potential treatments.

**RadioLABeled White Blood Cell Studies**

6. List the indications for radioLABeled white blood cell studies and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.

7. Describe the radiopharmaceuticals used for radioLABeled white blood cell studies including the physical and chemical properties, biorouting, dose preparation, and route and method of administration.

8. Specify the dose range for radioLABeled white blood cell studies and discuss the resulting radiation dose to various
9. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with radioLABeled white blood cell studies, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.

10. Describe the preparation of the patient for radioLABeled white blood cell studies.
11. Describe the procedures for radioLABeled white blood cell studies including equipment for both the study and the tagging process, protocol, dose and administration technique, administration–to-acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, data processing, image formatting and potential pitfalls.

12. Describe the normal distribution and normal variants seen on radioLABeled white blood cell studies and recognize them on printed images.
13. Describe various artifacts that can occur during radioLABeled white blood cell studies and identify them on printed images.
14. Discuss the diagnostic and prognostic value of radioLABeled white blood cell studies.
15. Discuss some common causes of false-negative and false-positive radioLABeled white blood cell studies.

Gallium Imaging
16. List the indications for gallium imaging and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
17. Describe the radiopharmaceuticals used for gallium imaging including the physical and chemical properties, biorouting, dose preparation, and route and method of administration.
18. Specify the dose range for gallium imaging and discuss the resulting radiation dose to various organs and tissues.
19. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with gallium imaging, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.

20. Describe the preparation of the patient for gallium imaging.
21. Describe the procedures for gallium imaging including equipment, protocol, dose and administration technique, administration–to-acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, data processing, image formatting and potential pitfalls.
22. Describe the normal distribution and normal variants seen in gallium imaging and recognize them on printed images.
23. Describe various artifacts that can occur during gallium imaging and identify them on printed images.
24. Discuss the diagnostic and prognostic value of gallium imaging.
25. Discuss some common causes of false-negative and false-positive gallium scans.

Receptor Imaging
26. List the indications for receptor imaging and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
27. Describe the radiopharmaceuticals used for receptor imaging including the physical and chemical properties, biorouting, dose preparation, and route and method of administration.
28. Specify the dose range for receptor imaging and discuss the resulting radiation dose to various organs and tissues.
29. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with receptor imaging, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.

30. Describe the preparation of the patient for receptor imaging.
31. Describe the procedures for receptor imaging including equipment, protocol, dose and administration technique, administration–to-acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, data processing, image formatting and potential pitfalls.
32. Describe the normal distribution and normal variants seen in receptor imaging and recognize them on printed images.
33. Describe various artifacts that can occur during receptor imaging and identify them on printed images.
34. Discuss the diagnostic and prognostic value of receptor imaging.
35. Discuss some common causes of false-negative and false-positive receptor imaging scans.

Breast Imaging (Scintimammography)
36. List the indications for scintimammography and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
37. Describe the radiopharmaceutical used for scintimammography including the physical and chemical properties, biorouting, dose preparation, and route and method of administration.
38. Specify the dose range for scintimammography and discuss the resulting radiation dose to various organs and tissues.
39. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere
with scintimammography, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.

40. Describe the preparation of the patient for scintimammography.
41. Describe the procedures for scintimammography including equipment, protocol, dose and administration technique, administration-to-acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, data processing, image formatting and potential pitfalls.
42. Describe the normal distribution and normal variants seen in scintimammography and recognize them on printed images.
43. Describe various artifacts that can occur during scintimammography and identify them on printed images.
44. Discuss the diagnostic and prognostic value of scintimammography.
45. Discuss some common causes of false-negative and false-positive scintimammography.

Sentinel Node Imaging
46. List the indications for sentinel node imaging and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
47. Describe the radiopharmaceuticals used for sentinel node imaging including the physical and chemical properties, biorouting, dose preparation, and route and method of administration.
48. Specify the dose range for sentinel node imaging and discuss the resulting radiation dose to various organs and tissues.
49. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with sentinel node imaging, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.
50. Describe the preparation of the patient for sentinel node imaging.
51. Describe the procedures for sentinel node imaging including equipment, protocol, dose and administration technique, administration-to-acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, data processing, data processing, image formatting and potential pitfalls.
52. Describe the normal distribution and normal variants seen in sentinel node imaging and recognize them on printed images.
53. Describe various artifacts that can occur during sentinel node imaging and identify them on printed images.
54. Discuss the diagnostic and prognostic value of sentinel node imaging.
55. Discuss some common causes of false-negative and false-positive sentinel node imaging.

Lymphoscintigraphy
56. List the indications for lymphoscintigraphy and discuss why a nuclear medicine study would be preferable to or complement other diagnostic modalities in various cases.
57. Describe the radiopharmaceuticals used for lymphoscintigraphy including the physical and chemical properties, biorouting, dose preparation, and route and method of administration.
58. Specify the dose range for lymphoscintigraphy and discuss the resulting radiation dose to various organs and tissues.
59. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with lymphoscintigraphy, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.
60. Describe the preparation of the patient for lymphoscintigraphy.
61. Describe the procedures for lymphoscintigraphy including equipment, protocol, dose and administration technique, administration-to-acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, data processing, data processing, image formatting and potential pitfalls.
62. Describe the normal distribution and normal variants seen in lymphoscintigraphy and recognize them on printed images.
63. Describe various artifacts that can occur during lymphoscintigraphy and identify them on printed images.
64. Discuss the diagnostic and prognostic value of lymphoscintigraphy.
65. Discuss some common causes of false-negative and false-positive lymphoscintigrams.

Positron Imaging
66. List the indications for positron imaging and discuss why this type of nuclear medicine study would be preferable to or complement other nuclear medicine procedures or diagnostic modalities in various cases.
67. Describe the radiopharmaceutical(s) used for positron imaging including the physical and chemical properties, biorouting, dose preparation, and route and method of administration.
68. Specify the dose range for positron imaging and discuss the resulting radiation dose to various organs and tissues.
69. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with positron imaging, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.
70. Describe the preparation of the patient for positron imaging.
71. Describe the procedures for positron imaging including equipment, protocol, dose and administration technique,
administration—to-acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, data processing, image formatting and potential pitfalls.

72. Describe the normal distribution and normal variants seen in positron imaging and recognize them on printed images.
73. Describe various artifacts that can occur during positron imaging and identify them on printed images.
74. Discuss the diagnostic and prognostic value of positron imaging.
75. Discuss some common causes of false-negative and false-positive positron imaging.

**Iodine-131 Whole Body Imaging**
76. List the indications for I-131 whole body imaging and discuss why this type of nuclear medicine study would be preferable to or complement other nuclear medicine procedures or diagnostic modalities in various cases.
77. Describe the radiopharmaceutical used for I-131 whole body imaging including the physical and chemical properties, biorouting, dose preparation, and route and method of administration.
78. Specify the dose range for I-131 whole body imaging and discuss the resulting radiation dose to various organs and tissues fusion imaging.
79. Discuss any physical or pathological conditions, prior procedures, or medications that could contraindicate or interfere with I-131 whole body imaging, and describe any precautions that should be taken and any potential adverse reactions to the radiopharmaceutical.
80. Describe special radiation safety considerations and associated procedures.
81. Describe the preparation of the patient for I-131 whole body imaging.
82. Describe the procedures for I-131 whole body imaging including equipment, protocol, dose and administration technique, administration—to-acquisition times, acquisition parameters, standard positioning and views, special imaging adaptations, data processing, image formatting and potential pitfalls.
83. Describe the normal distribution and normal variants seen in I-131 whole body imaging and recognize them on printed images.
84. Describe various artifacts that can occur during I-131 whole body imaging and identify them on printed images.
85. Discuss the diagnostic and prognostic value of I-131 whole body imaging.
86. Discuss some common causes of false-negative and false-positive I-131 whole body imaging.

**RESPIRATORY SYSTEM**
1. Describe the gross anatomy and function of the respiratory system.
2. Discuss the anatomy and function of the respiratory system at the cellular level.
3. Outline the flow of blood through the respiratory system.

**Pathology**
4. Describe the characteristics and causes of common respiratory pathologies; identify the population most susceptible to the disease; and give a brief overview of potential treatments.

**Perfusion**
5. List the indications for lung perfusion imaging.
6. List the physical and chemical characteristics, kit and dose preparation, dose and route of administration, biorouting, and dosimetry of the radiopharmaceutical used for lung perfusion.
7. Discuss the possible adverse reactions and contraindications for lung perfusion imaging.
8. Describe the patient preparation necessary for a high quality study.
9. Discuss the equipment and basic procedures and processing utilized in lung perfusion imaging.
10. Identify a normal lung perfusion scan, and discuss normal variants, abnormal findings, artifacts, and the diagnostic and prognostic value of the study.

**Gas Ventilation**
11. List the indications for gas ventilation imaging.
12. Compare the physical and chemical characteristics, dose preparation, dose and route of administration, biorouting, and dosimetry of each radiopharmaceutical used for gas ventilation imaging.
13. Discuss the possible adverse reactions and contraindications for gas ventilation imaging.
14. Discuss the special radiation safety considerations and regulations associated with gas ventilation imaging.
15. Describe the patient preparation necessary for a high quality study.
16. Discuss the equipment and basic procedures and processing utilized in gas ventilation imaging.
17. Identify a normal ventilation scan, and discuss normal variants, abnormal findings, artifacts, and the diagnostic and prognostic value of the study.

**Aerosol Ventilation**
18. List the indications for aerosol ventilation imaging.
19. List the physical and chemical characteristics, kit and dose preparation, dose and route of administration, biorouting, and
dosimetry of the radiopharmaceutical used for aerosol ventilation imaging.

20. Discuss the possible adverse reactions and contraindications for aerosol ventilation imaging.
21. Discuss the special radiation safety considerations associated with aerosol ventilation imaging.
22. Describe the patient preparation necessary for a high quality study.
23. Discuss the equipment and basic procedures and processing utilized in aerosol ventilation imaging.
24. Identify a normal aerosol ventilation scan, and discuss normal variants, abnormal findings, artifacts, and the diagnostic and prognostic value of the study.

**Combined Ventilation/Perfusion Study**

25. Discuss the advantages and disadvantages associated with the ventilation/perfusion and perfusion/ventilation sequences.
26. Describe the interpretative criteria for the ventilation/perfusion study, including the probability table for pulmonary embolism.
27. Discuss the diagnostic/prognostic value of the lung ventilation/perfusion study.

**Quantitative Lung Study**

28. List the indications for a quantitative lung study.
29. Discuss the equipment and basic procedures and processing utilized in quantitative lung imaging.
30. Identify a normal quantitative lung scan, and discuss normal variants, abnormal findings, artifacts, and the diagnostic and prognostic value of the study.


**Other resources**

www.auntminnie.com

**Teaching Strategies:**

Lecture
Large Group Discussions
Small Group Work
Observational Workshop
Guest lecturers
Case Studies

**Evaluation:**

<table>
<thead>
<tr>
<th>Component</th>
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<tr>
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<tr>
<td>Midterm Exam</td>
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<tr>
<td>Final Exam (cumulative)</td>
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<tr>
<td>Homework/Quizzes</td>
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<tr>
<td>Attendance</td>
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Attendance is mandatory. Two unexcused absences will result in the student’s grade being reduced by a half letter grade (e.g. B to B-). Each additional absence will result in the student’s grade being reduced by an additional ½ letter grade. Absences can only be excused by the Chairman of the Health Science Department (Prof. Zelizer).
<table>
<thead>
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<th>DATE</th>
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<td>LAB / CNS – Brain positioning, camera setup, patient prep.</td>
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**Americans with Disabilities Act:**

If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Disability Support Services, ECC (Educational Communications Center) Building, room128, (631) 632-6748. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential.

**Academic Integrity:**

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty are required to report and suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (Schools of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at http://www.stonybrook.edu/uaa/academicjudiciary/

**Critical Incident Management:**

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and School of Medicine are required to follow their school-specific procedures.