(*University of Choice*)

UNIVERSITY EXAMINATIONS (MAIN PAPER)
2023/2024 ACADEMIC YEAR

FOURTH YEAR FIRST SEMESTER EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE IN MEDICAL LABORATORY SCIENCES & BACHELOR OF MEDICAL BIOTECHNOLOGY

COURSE CODE: BMB 414

COURSE TITLE: NUCLEAR MEDICINE

DATE: 7TH DECEMBER 2023 TIME: 8.00-10.00AM

INSTRUCTIONS TO CANDIDATES

This paper is divided into three sections, **A B** and **C,** carrying respectively: Multiple Choice Questions (**MCQs**), Short Answer Questions (**SAQs**) and Long Answer Questions (**LAQs**). Answer all questions. **DO NOT WRITE ON THE QUESTION PAPER**

TIME: 2 Hours

This Paper Consists of 4 Printed Pages. Please Turn Over

SECTION A: Multiple Choice Questions (20 Marks)

1. The truth concerning radiations encountered in nuclear medicine is that ----------
   A. Particulate types are non-charged radiations
   B. Alpha (Ɑ)-radiation consists of tritium atoms
   C. Positrons are a type of beta (ß)-radiation
   D. Gamma (ɤ)-rays are a form of particulate radiation
2. The usefulness of ɤ-rays and x-rays in medicine is because ----------
   A. They carry sufficient energy and mass to penetrate dense matter
   B. Of their ability to enable detection of tumors
   C. They are bounced back by osseous body structures
   D. Being particulate in character they help visualize molecular processes
3. High-speed radiations can be exemplified by types such as ----------
   A. Protons
   B. Beta-radiations
   C. Alpha (Ɑ)-radiation
   D. Helium particles
4. Naturally occurring radioactive isotopes in the earth ----------
   A. Emit x-ray radiations
   B. Include uranium and radon
   C. Are the common source for alpha radiation
   D. Can be best represented by tritium (H_3)
5. Neutrons, can travel deep through matter and this is because,uniquely, they--------
   A. Don't have any electric charge
   B. Have large masses
   C. Possess a rocket-like head
   D. Have a strong electric charge
6. *Radiopharmaceutical* is a key concept in nuclear medicine and it refers to --------
   A. Radiation emitters like luciferin of fire-flies
   B. Radioisotope labeled biomolecules
   C. Bio-luminescent organic substances
   D. Molecular probes used to produce radioisotope conjugates
7. The truth about a carbon isotope ^{14}C with an atomic number of 6 is that ----------
   A. Its decay produces gamma radiation
   B. It yields neutrinos upon disintegration
   C. It is incapable of spontaneous fission
   D. Its decay can yield a new element
8. In SPECT imaging technology in nuclear medicine and molecular imaging----------
   A. The "PE" in the name "SPECT" stands for "Positron Emission"
   B. "PE" indicates "*Photon Emission*"
   C. A scintilator is the source of radiation detected
   D. Bioflourescence is the radiation signal forming object image
9. Truth about use of gamma (ɤ)- counting in regard to biomedical science is that------
   A. Gamma (ɤ) radiation serves as a molecular probe
   B. ɤ radiation can be from ^{125}I radioactive decay
   C. ^{32}P can be the ɤ radiotracer coupled to a molecular probe
   D. Gamma (ɤ) radiation can serve as a mitogen
10. Radiation-emitting radioisotopes can be used in biomedical science in ----------
   A. Detection of bone fractures
   B. Drug pharmacodynamics studies
   C. Lymphocyte immunostimulation studies

D. Gene detection by Southern blotting

11. Bioluminescence in molecular imaging uses spectrophotometers in photodetection and analysis because the----------
    A. Analyte are scintillation emitters
    B. Radioactive isotopes serve as the tracer substances
    C. Radiation from analytes or coupled indicators falls in visible spectrum
    D. Photon signal measured is of ultraviolet type
12. In SPECT imaging radiation photodetection cameras are designed to work with---
    A. ɤ- radiation
    B. Negatrons ($ß^-$ particles
    C. Positrons ($ß^+$ particles)
    D. Alpha (α- particles)
13. In nuclear imaging technologies the truth concerning *Micro-CAT* is that----------
    A. Very small-size cats provide the *in vivo* experimental environment
    B. Studies happen in *ex vivo* environments of isolated cat organs
    C. It is actually a type of X-ray technology
    D. Pathobiochemical processes in diseases are the study objects
14. Radiopharmaceuticals being materials used in nuclear medicine include -------
    A. NaI
    B. Antibody-coupled luciferase
    C. Enzyme-linked phosphate
    D. Tritium (^3H)
15. What is true about radioisotope in petri-dish study of antibacterial drug receptors?
    A. Exemplifies *ex vivo* nuclear imaging
    B. Is an *in vitro* nuclear imaging study
    C. Represents MRI molecular imaging
    D. Represents imaging in *in vivo* environments
16. Why are *scintillators* as substances that emit radiation used in nuclear imaging?
    A. They produce neutrinos
    B. Trigger emission of radiation by radioactive isotopes
    C. Initiate radiation detection in radioactivity-based studies
    D. Can be organic molecules
17. What rationale in promoting adoption SPECT against PET for small-animal imaging, sales marketing for SPECT pharmaceuticals?
    A. Higher spatial resolution
    B. Suitability for clinical diagnostic studies
    C. Utilisation of alpha (α)-particles
    D. Ability to readily detect beta (ß)-radiations
18. Truth about pharmaceuticals used in molecular imaging is that they ----------
    A. Can be contrast agents
    B. Are therapeutic drugs for lab animals
    C. Are actually molecular probe-indicator enzymes conjugates
    D. Are actually synonymous with radionuclides
19. What is the truth about bioluminescence as biomedical imaging technology?
    A. Image acquisition starts with scintillation production
    B. It employs spectrophotometry
    C. Radionuclides provide the radiation used
    D. *In vitro* investigations where it is common

19. In development of pharmaceutical for CT imaging medical biotechnologists
    A. Should use for example zinc macroparticles
    B. Can conjugate 2-depxy-D-glucose to gold nanoparticles
    C. Attach organic scintillators to molecular probes
    D. Radionuclides generate the luminescence

SECTION B: Short Answer Questions (40 Marks)

1. Contrast between positrons and alpha radiations (5marks)
2. Explain how the modes of production of *gamma (ɤ)-rays* and x-rays one hand and beta (ß)-radiation differ (5marks)
3. Explain the inability of some radiations to penetrate matter (5marks)
4. Distinguish between *nuclear fission* and *radioactive decay* (5marks)
5. In molecular imaging, distinguish between *bioluminescence* and *radiation* (5marks)
6. Explaining your answer in each case state which of following atoms radioactive or non-radioactive: $^{12}_{6}C$ and $^{14}_{6}C$ (5marks)
7. State the significance of scintillation in nuclear medicine (5marks)
8. Differentiate between *ex vivo* and i*n vitro* as experimental environments (5marks)

SECTION C: Long Answer Questions (60 Marks)

1. Illustrate the use *positron emission tomography* by means of one example of a small-animal as an ***in vivo*** experimental environment for molecular imaging. Highlight the experimental set-up; types of radiation employed and their sources and how they are used to generate images of the study objects. (20marks)
2. Explain the bio-hazards associated with biomedical use of radiopharmaceuticals highlighting radiations emitted and toxicity mechanisms of the radiations; and the necessary biosafety measures. (20marks)
3. Describe scintillators and radiopharmaceuticals, focusing on the physical nature, examples, principle underlying their use to generate images of study objects and imaging technologies and examples of their applications (20 marks)