The Royal Australian and New Zealand College of Radiologists®

The Faculty of Radiation Oncology

Candidate Number: _____

FRANZCR Examination

Phase 1 Radiation Oncology

Paper 1

9 September 2022

9:30am

Time Allowed: 2.5 Hours

INSTRUCTIONS

- There are a total of SIX questions numbered 1 – 6.
- Each question relates to one Oncology Science subject. The paper indicates which subject is being assessed in each question. The following abbreviations will be used:

  ANA = Anatomy
  PHY = Radiation Oncology Physics
  RCB = Radiation and Cancer Biology

- All questions are worth 15 marks each. **The marks allocated to each sub-part of the questions are indicated in brackets.**
- Write your answers in the answer book provided **only**.
- Start each subject question on a new page.
- Only use a black or blue pen.
- All questions are to be attempted.
- You may use diagrams, tables or lists in your answers.
- Write your candidate number, subject and question number on each page used in the answer booklet.
- Hand **all** papers to the invigilator. No papers are allowed to be taken from the exam room. THIS INCLUDES THE EXAMINATION QUESTION PAPERS.

Question 1

ANA

a.

i. List the superior, inferior, medial and lateral borders of the breast, based on relationship with adjacent anatomical landmarks. **(2)**

ii. List the posterior relations of the breast. **(1.5)**

iii. List three anatomical lymph node regions (not surgical levels) that the breast drains into. **(1.5)**

b.

i. Define the anatomical boundaries of the axilla. **(2)**

ii. List the contents of the axilla. **(2)**

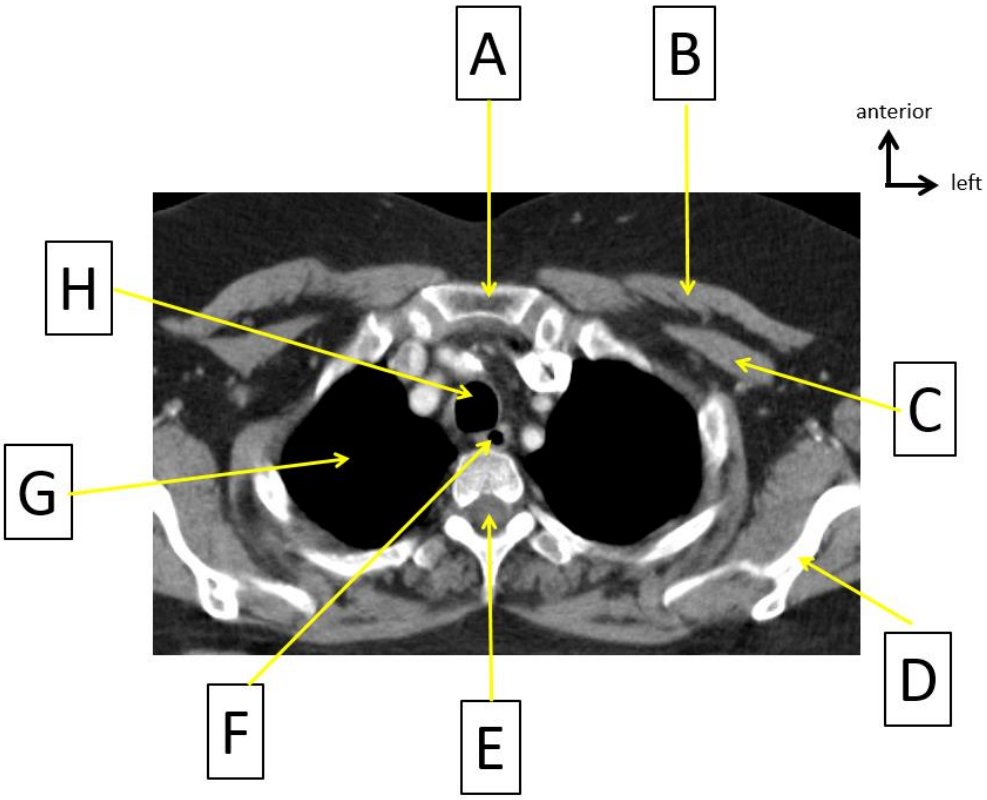
c. Define levels I-III of the axilla from a surgical perspective. **(3)**

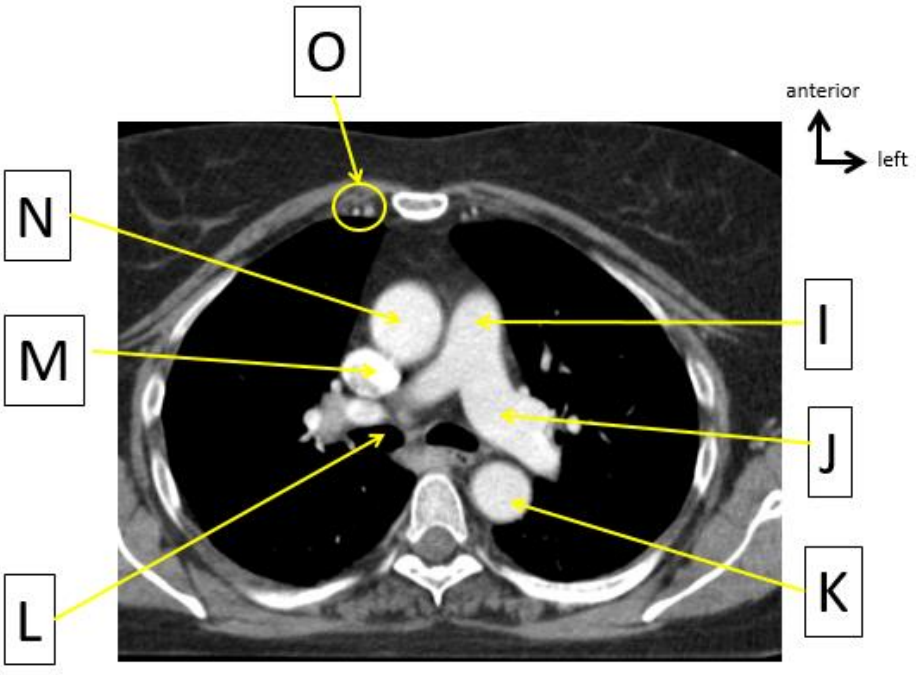
Question 1 (Continued)

ANA

d. Name the structures labelled A to O on the axial CT slices below through the thorax. Indicate laterality where applicable. **(3)**

(Answers are to be written in your answer booklet, not on the question paper)





Question 2

PHY

a. Photons interact with matter through four major types of processes. **(4)**

Describe the process of interaction for coherent scattering, photoelectric effect, Compton scattering and pair production. A diagram may be used to aid description.

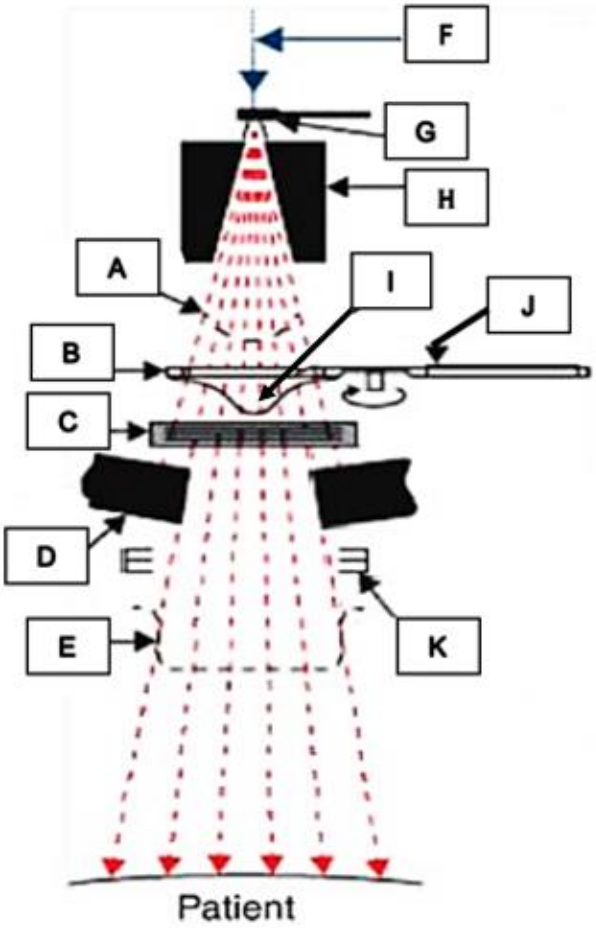
b.

i. Define the term Half-value layer. **(0.5)**

ii. Describe what happens when a beam is hardened. **(0.5)**

c. Name the parts of the linear accelerator head labelled A to K. **(2)**

(Answers are to be written in your answer booklet, not on the question paper)



Question 2 (Continued)

PHY

d.

i. Outline the structure and function of Multi-leaf collimators (MLCs). **(1)**

ii. List the advantages and disadvantages of MLCs. **(3)**

iii. Describe the purpose and physical principals of the flattening filter in a linear accelerator head. **(1)**

e. From the generated pencil beam, list and discuss the steps of how a clinical electron beam is produced from a linear accelerator. **(3)**

Question 3

RCB

a. A 68-year-old female presents with metastatic breast cancer with symptomatic bone metastasis at T1. She receives palliative radiation therapy to a dose of 30Gy in 10 fractions.

i. Describe the concept of EQD2, including the equation for its calculation. **(2)**

ii. Define Biologically Effective Dose (BED) of a given schedule, including the formula for its calculation. **(1)**

b. She re-presents 2 years later with further progression at T1 with impending cord compression.

i. Outline the concept of forgotten dose and its clinical relevance in this scenario. **(1)**

ii. List the factors that need to be taken into account when considering re-treatment in general. **(5)**

c. Briefly discuss the re-treatment tolerance for late effects for spinal cord. Include in your answer any relevant clinical and laboratory data where appropriate. **(1.5)**

d. Outline the proposed mechanisms of late radiation injury to the spinal cord. **(2)**

e. Define and discuss the concept of a serial functional subunit. Include in your answer a brief description of ‘threshold dose’. **(2.5)**

Question 4

ANA

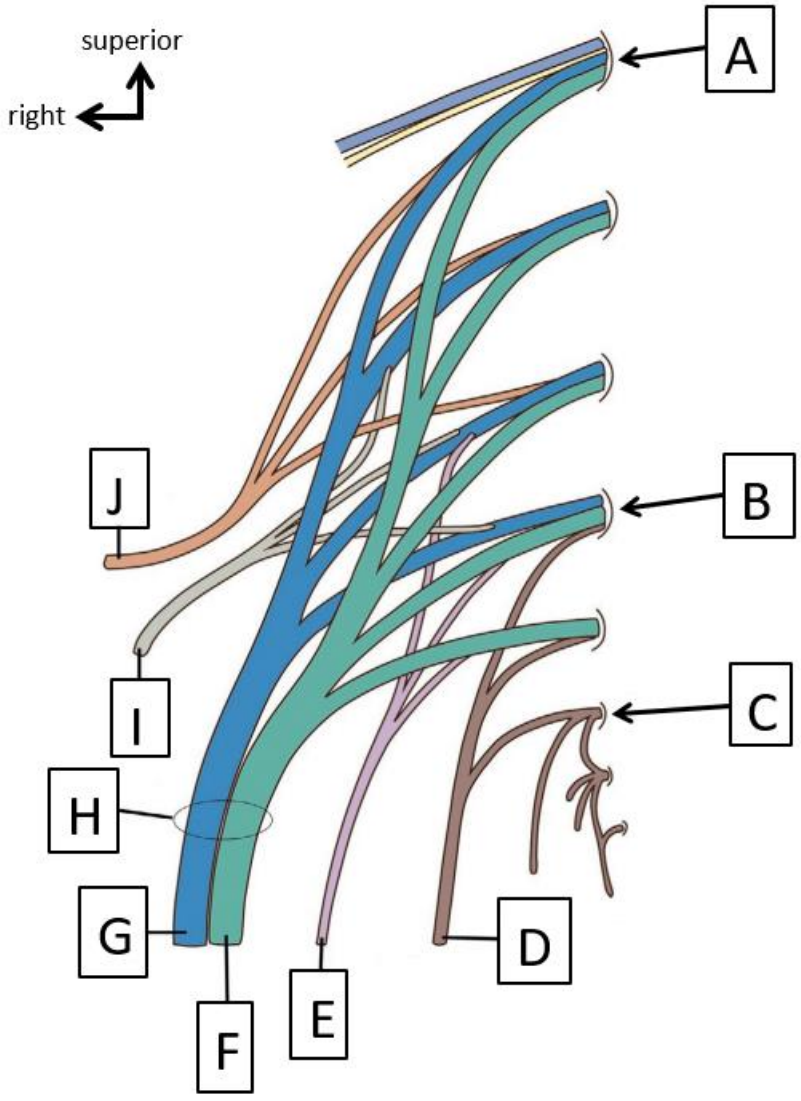
a.

i. List the relations of the femoral canal. **(2)**

ii. Name the contents of the female inguinal canal. **(1)**

b. Name the nerves labelled A to J on this schematic of the RIGHT sacral plexus. Laterally is not required. **(3)**

(Answers are to be written in your answer booklet, not on the question paper)



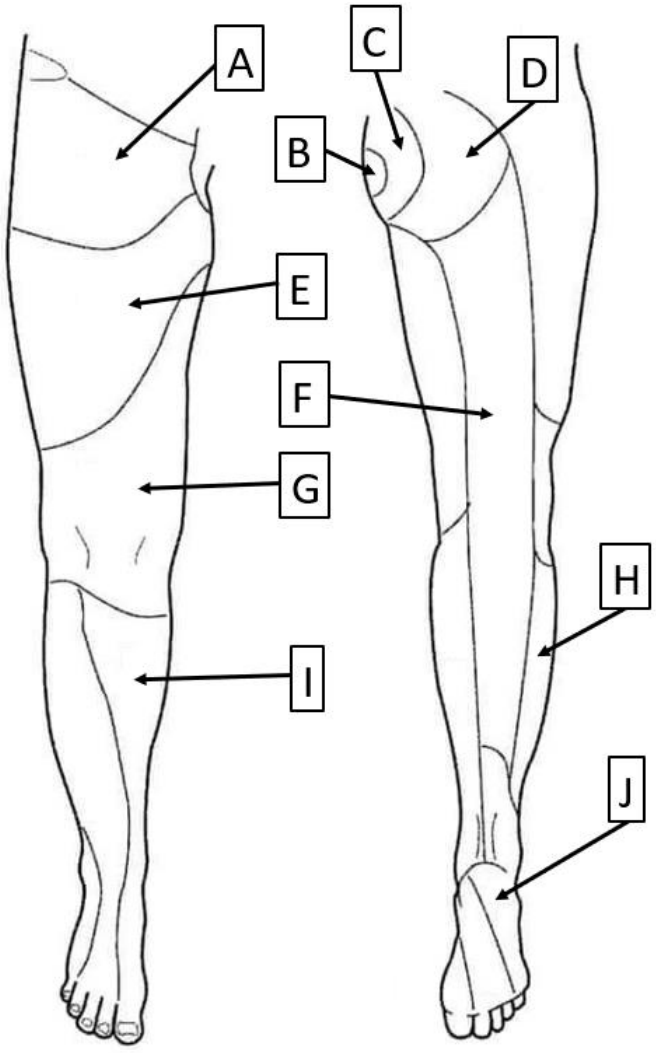
Question 4 (Continued)

ANA

c.

i. Name the dermatomes labelled A to J on the following diagram. **(3)**

(Answers are to be written in your answer booklet, not on the question paper)



ii. Name one major muscle and one spinal nerve root responsible for hip flexion and plantar flexion **(2)**

d. Using a table, compare and contrast the appearance of the thoracic and lumbar vertebrae. **(4)**

In your answer, address the differences in the body, spinous process, transverse process and articulations.

Question 5

PHY

a.

i. Describe the principles of a 4-dimensional computed tomography (4D CT) scan and a positron emission tomography (PET) scan. **(2)**

ii. List two advantages of a 4D CT scan and two advantages of a PET scan. **(2)**

b. A patient with nasopharyngeal carcinoma is planned for intensity modulated radiotherapy (IMRT). Prior to contouring volumes for this patient, the radiation oncologist requests for image registration and fusion of the pre-treatment MRI scan with the CT simulation scan.

i. Define image registration and image fusion. **(2)**

ii. What are the uses of image registration and fusion in radiation therapy? **(1.5)**

c. List five imaging techniques used to verify treatment accuracy. **(2.5)**

d. Briefly describe each of the five imaging techniques. **(5)**

Question 6

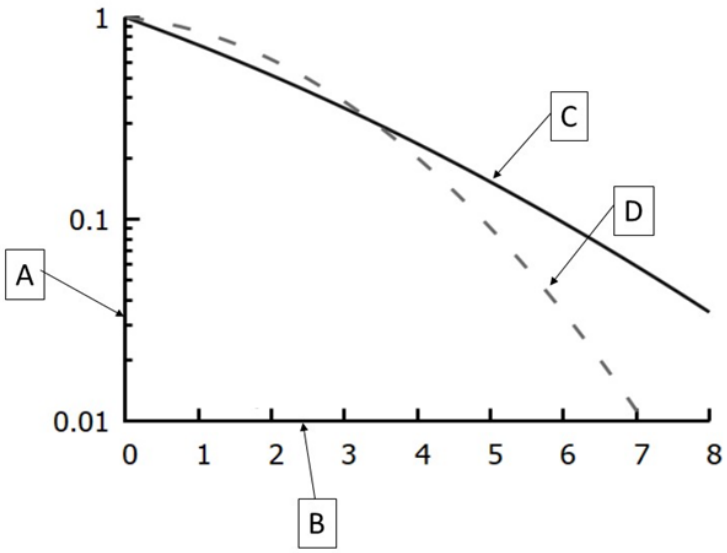
RCB

a.

i. State the formula for the linear quadratic model of cell kill and individually define each of the components of the equation. **(3)**

ii. Below are two cell survival curves for low and high α/β cell lines. **(1)**

Identify the axes and curves labelled A-D.



iii Define the term α/β value and describe how it can be found from a cell survival curve. **(1)**

iv. List four potential limitations of the Linear Quadratic model in clinical practice. **(2)**

b.

i. What is sublethal damage repair? **(1)**

ii. Using a labelled diagram, outline the key differences in cell survival curves for a single fraction vs. multiple fraction course of radiation therapy. **(2)**

Question 6 (Continued)

RCB

c.

i Describe the mechanism of acute skin reaction including how moist desquamation develops. **(3)**

ii. Briefly describe consequential late effects and how they differ from late toxicities of radiation therapy. Give a clinical example. **(2)**

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Candidate Number: _____

FRANZCR Examination

Phase 1 Radiation Oncology

Paper 2

9 September 2022

2:00pm

Time Allowed: 2.5 Hours

INSTRUCTIONS

- There are a total of SIX questions numbered 7 – 12.
- Each question relates to one Oncology Science subject. The paper indicates which subject is being assessed in each question. The following abbreviations will be used:

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Question 7

ANA

a.

i. Describe the course of the internal carotid artery. **(3)**

ii. List the branches of the external carotid artery. **(2)**

b.

i. Describe the structure and boundaries of the bony orbit. **(3)**

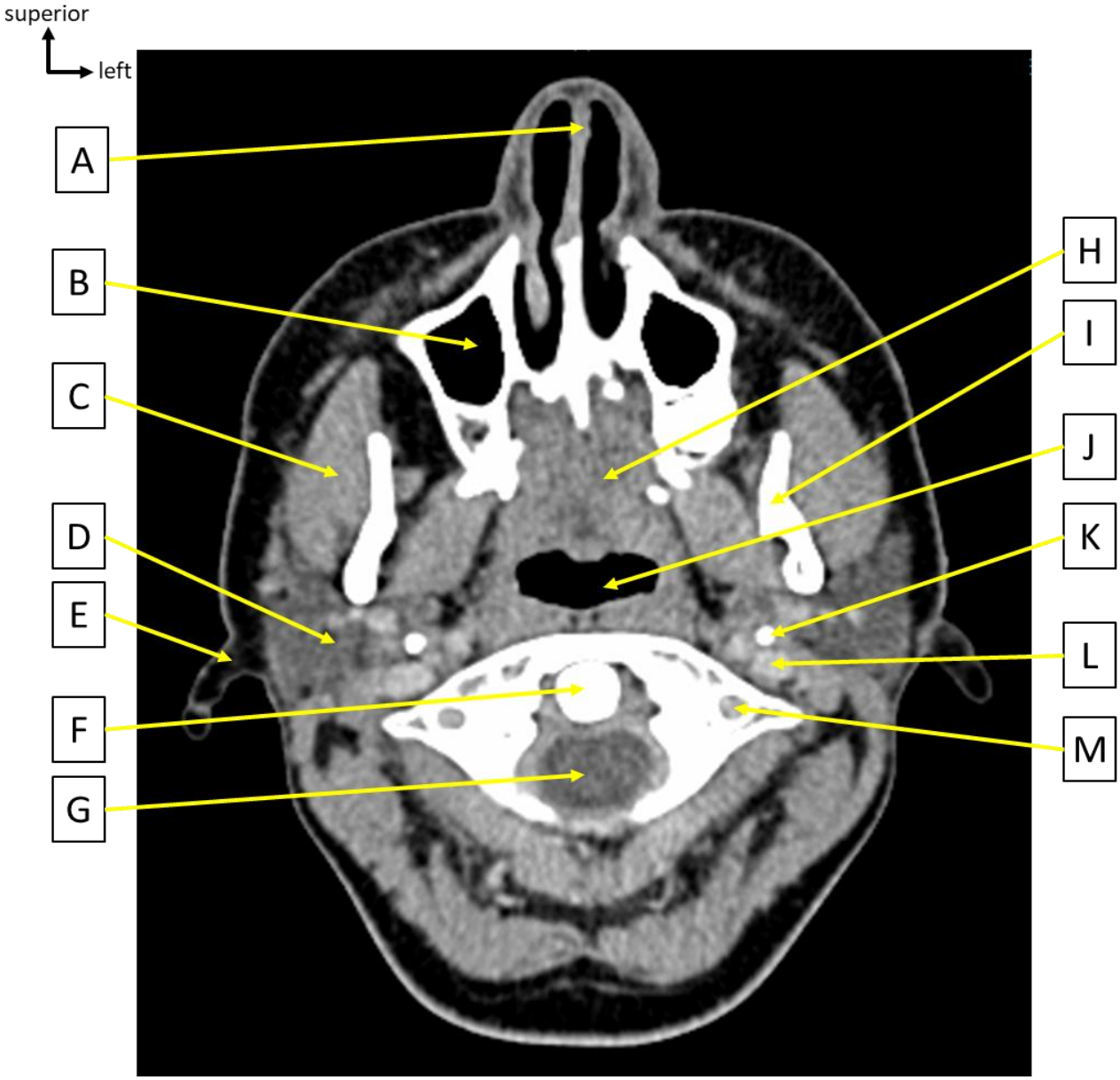
ii. List the nerves and muscles within the bony orbit. **(2)**

Question 7 (Continued)

ANA

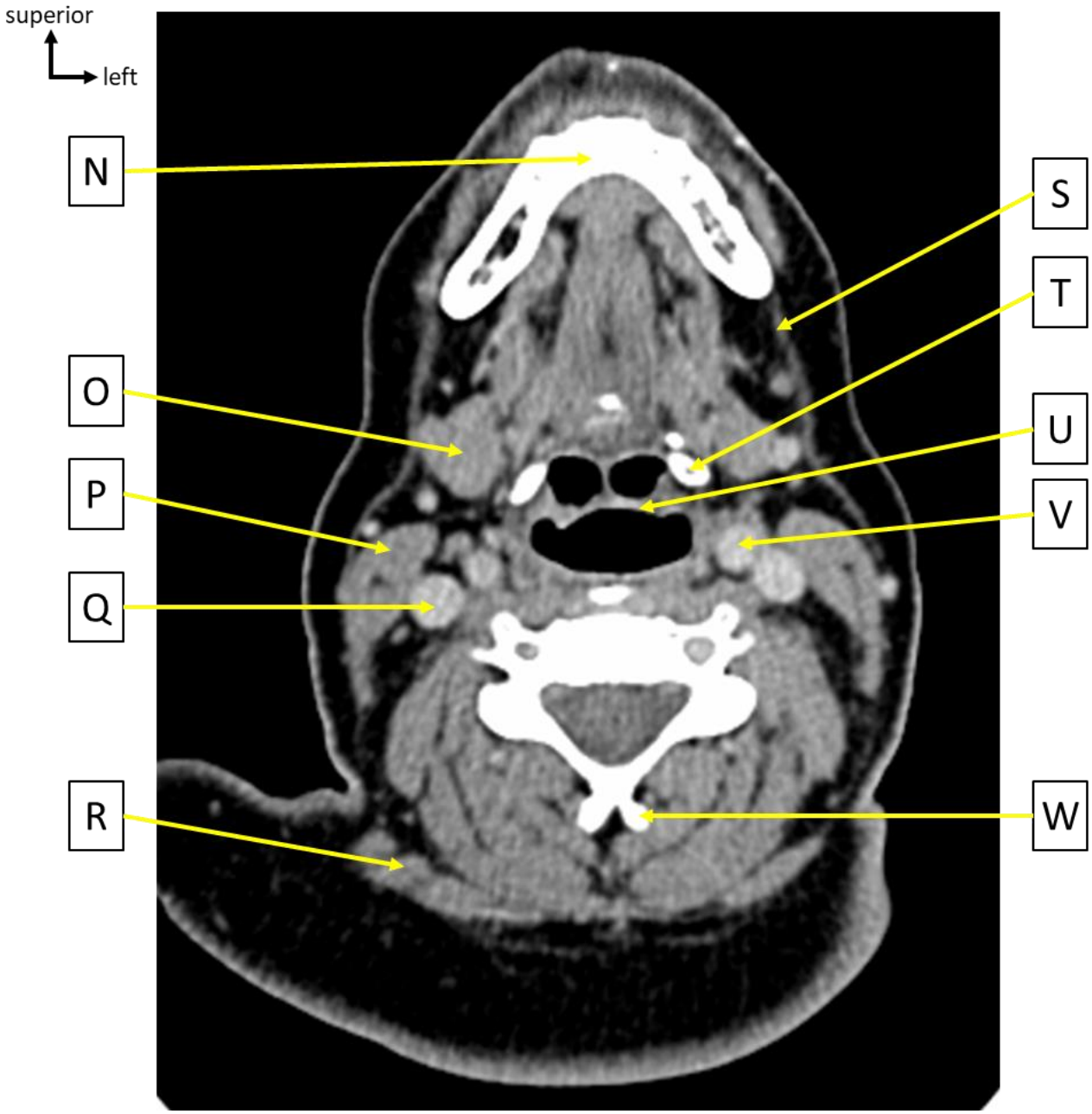
c. Name the structures labelled A to W in the two axial post-contrast CT slices from the head and neck region below. Indicate laterality where applicable. **(5)**

(Answers are to be written in your answer booklet, not on the question paper)



Question 7 (Continued)

ANA



Question 8

PHY

a. For a 6 MV photon beam, 10 x 10 cm^2 field size, and an SSD of 100 cm, draw two labelled curves on one diagram comparing the percentage depth dose as a function of depth as the beam passes through phantoms made of “water only” and “bone only”. **(4)**

b. For an 18 MV photon beam, 1 x 1 cm^2 field size, and an SSD of 100 cm, draw a labelled diagram showing the percentage depth dose as a function of depth: **(6)**

- as the beam passes through 5 cm of soft tissue
- followed by 4 cm of lung
- followed by 2 cm of solid tumour
- followed by 4 cm lung
- followed by 5 cm soft tissue.

c. List three types of beam modification and provide a brief explanation for each one. **(3)**

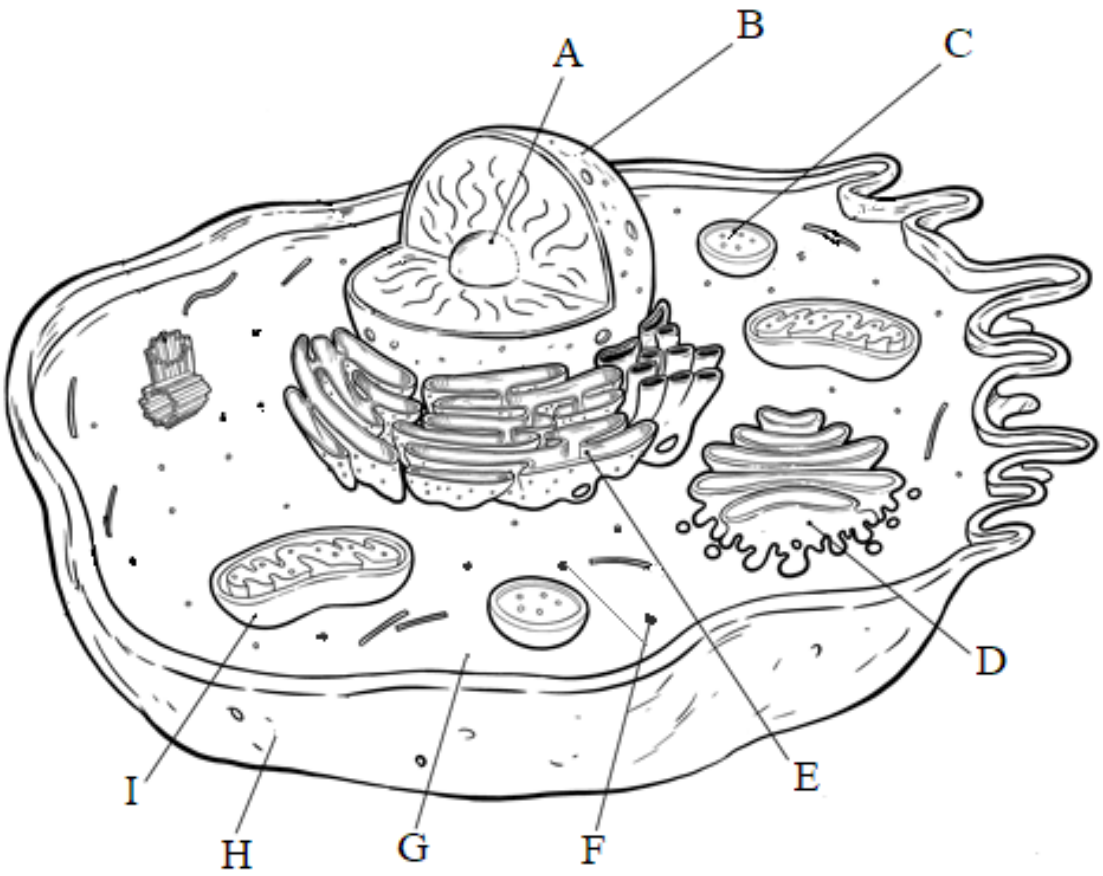
d List one advantage and one disadvantage of volumetric modulated arc therapy (VMAT) over intensity-modulated radiation therapy (IMRT). **(2)**

Question 9

RCB

a. Name the structures labelled A to I in the diagram of an animal cell below: **(3)**

(Answers are to be written in your answer booklet, not on the question paper)



b.

i. Name the DNA-repair pathway that is involved during / immediately after DNA replication pertaining to incorrectly paired nucleotides. **(1)**

ii. Microsatellite Instability (MSI) is caused by mutations in the genes responsible for the above pathway. Name at least one affected gene and name the associated syndrome. **(1)**

Question 9 (Continued)

RCB

c. Using a table, for each of the following stages of pregnancy: **(8)**

- Preimplantation
- Embryonic
- Early foetal stage
- Late foetal stage

discuss the potential effects of significant ionising radiation exposure on the human embryo and foetus.

Include the gestational age in weeks at each stage and comment on reasons for the effects in your answer.

-

d.

i. Define the term “doubling dose”. **(1)**

ii. What is the estimated doubling dose for humans according to The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)? **(1)**

Question 10

ANA

a. The initial presentation of pancreatic cancer varies according to tumour location and type of cells involved.

i. Describe the microscopic features of the pancreas. In your answers include the names of the cell types and their secretory product. **(4)**

ii. List the relationships of the head of the pancreas. **(2)**

b. For oesophageal cancers, the extent of mural invasion dictates T stage and is therefore associated with prognosis. **(1)**

List the microscopic layers of the oesophagus from innermost to outermost.

c. Describe the lymphatic drainage of the oesophagus. In your answer include the following: **(3)**

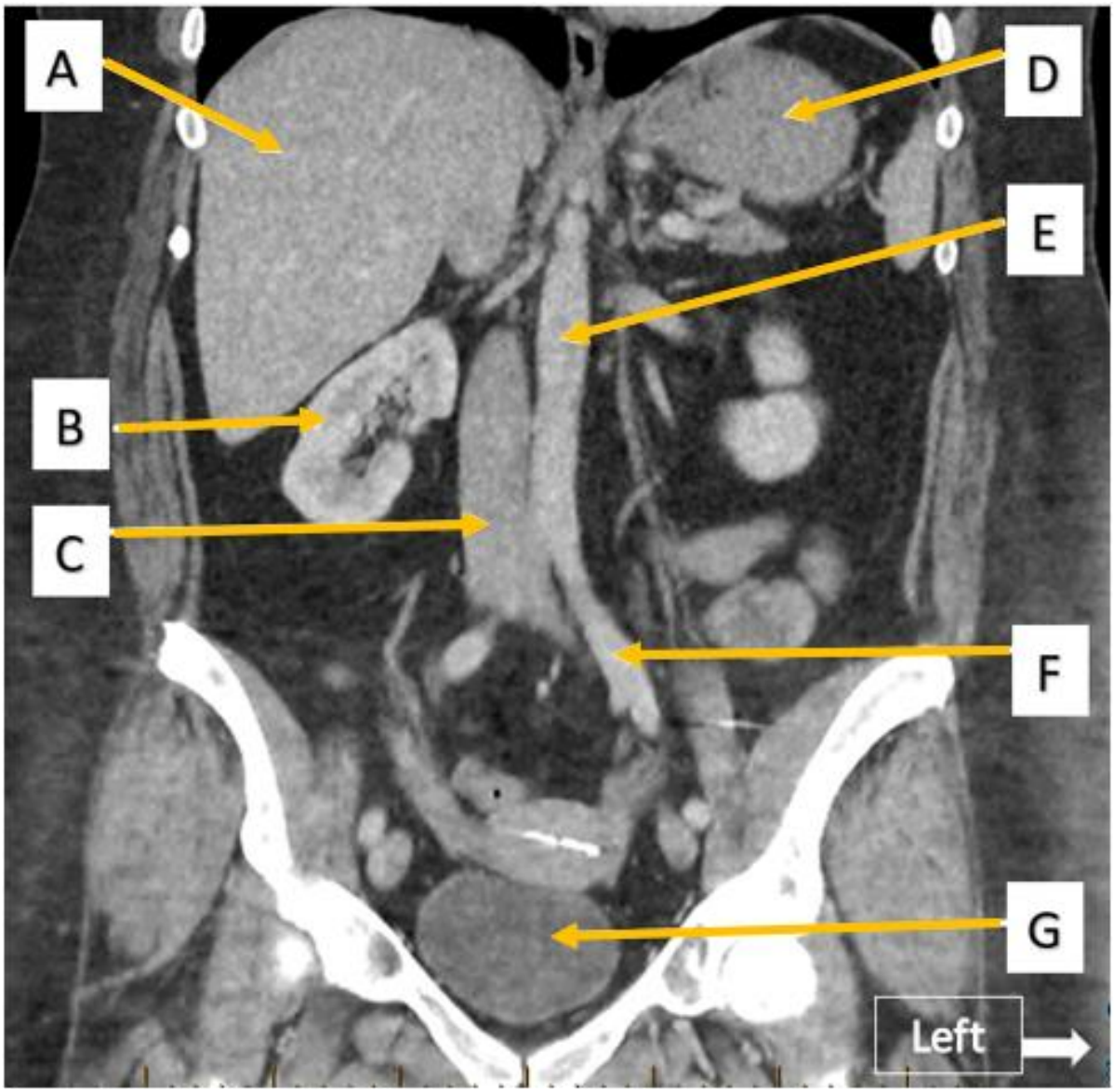
- lymphatic system within the organ
- regional lymph nodes for the upper, middle and lower third of the oesophagus

Question 10 (Continued)

ANA

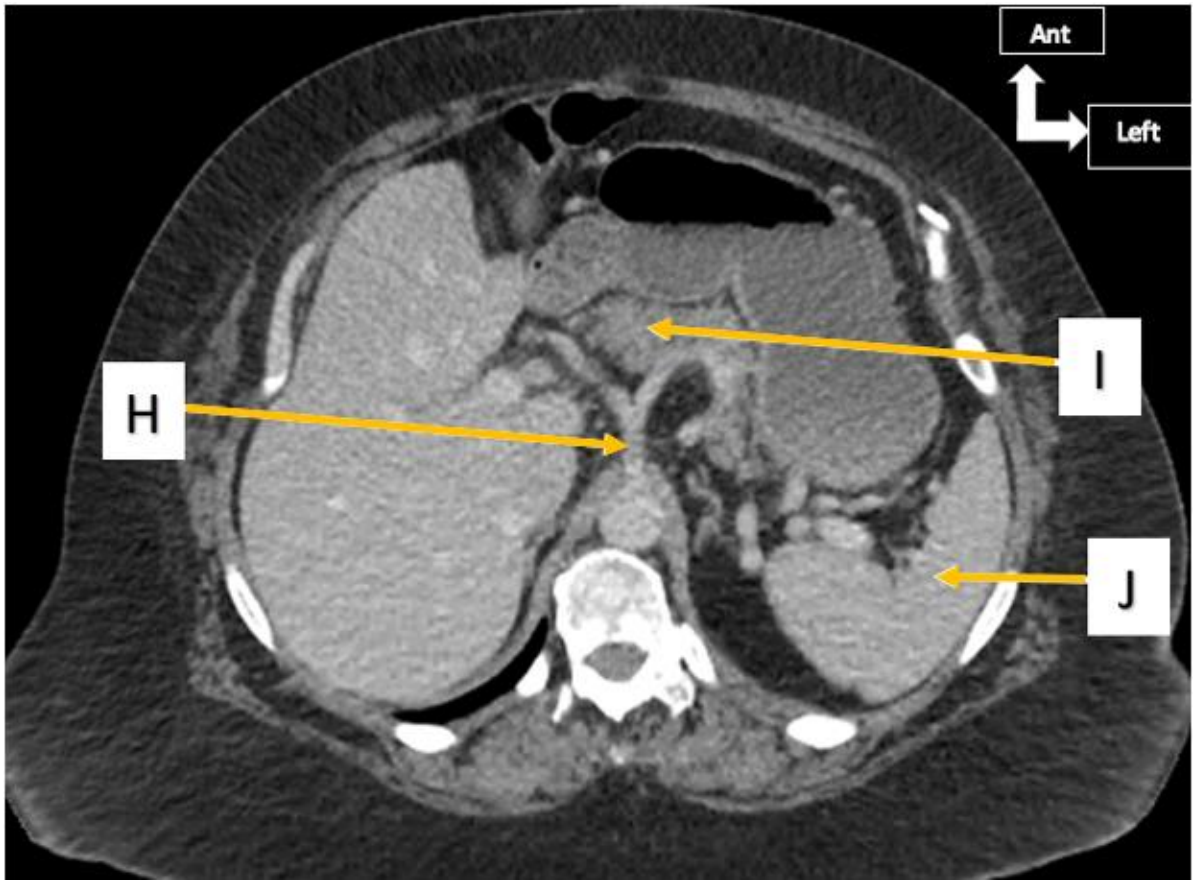
d. On the following coronal and axial CT scans, name the structures labelled A to J. **(2)**

(Answers are to be written in your answer booklet, not on the question paper)



Question 10 (Continued)

ANA



e. Liver segmentation can be described using Couinaud System. **(3)**

i. Briefly describe the Couinaud System.

ii. Draw a labelled diagram (from the anterior view of the liver) demonstrating the layout of the segments.

iii. Outline how these segments are grouped into the anatomical lobes of the liver.

Question 11

PHY

a.

i. Outline the purpose(s) of immobilization devices in radiation therapy planning and treatment. **(2)**

ii. List the key characteristics of immobilisation devices that can be used in radiation therapy planning and treatment. **(2)**

b.

i. Define and provide a brief description of each of the following ICRU abbreviations: **(2)**

- GTV
- CTV
- PTV
- ITV

ii. Describe in general terms the factors that are considered when determining setup margin (SM). **(2)**

c.

i. Outline three reasons why junctions are used in clinical practice. **(1.5)**

ii. Draw two separate labelled isodose diagrams to illustrate the key dosimetric features of two adjacent radiation therapy fields (with parallel central axis, size 15 cm x 15 cm) in a water phantom, for the following scenarios: **(4)**

- Two 6 MV photon fields junctioned at 2 cm depth
- 9 MeV electron and 6 MV photon fields junctioned on the phantom surface

Include any hot spots, cold spots, 100% and 80% isodoses lines.

iii. Outline three techniques that can be used to minimize the dosimetric inhomogeneity across a photon-photon junction. **(1.5)**

Question 12

RCB

a. Regarding combinations of radiation therapy and systemic therapies:

i. Define spatial co-operation. **(1)**

ii. Give one clinical example. **(1)**

b.

i. List four molecular mechanisms whereby radiation therapy and chemotherapy may interact. **(2)**

ii. In clinical practice, which is thought to be the main molecular mechanism responsible for beneficial radiation therapy-chemotherapy interactions? **(1)**

c. Cancer immunotherapy agents have been tested in preclinical and clinical studies in combination with irradiation.

i. List three classes of immunotherapy agents and give an example of an individual target in each class. **(3)**

ii. What is the rationale for combining radiation therapy and immune system blockade? **(3)**

What are two mechanisms by which radiation can cause immune modulation?

d. An irradiated tumour has been described as an ‘immunogenic hub’, leading to local antigen formation as well as distant ‘abscopal’ effects. **(4)**

Briefly describe the four main steps in the ‘abscopal’ effect. For each step, outline a key activity that take place.