POSTGRADUATE INSTITUTE OF MEDICINE
UNIVERSITY OF COLOMBO

MD (CLINICAL ONCOLOGY) PART I EXAMINATION – AUGUST 2020

Date:- 24th August 2020 **Time:-** 2.00 pm – 4.15 pm

PAPER I

If the examiners cannot read your writing, they will be unable to give you full credit for your knowledge.

PHYSICS

Each question carries 100 marks.
Each question to be answered in a separate book.
Question one (01) is compulsory.
Answer five (05) questions of the six (06) questions from 2 to 7.

1.

1.1. (a) What is the workload of a Teletherapy machine and give SI unit? (10 marks)

(b) For any kind of tele-therapy machine which emits X-rays or gamma rays, three types of radiation are considered for calculating room shielding. State the three (03) types of radiation which determine shielding of different areas of a teletherapy bunker and give the important information required for calculation of shielding for a teletherapy bunker. (25 marks)

1.2 Exposure to ionizing radiation causes both Stochastic and Deterministic effects.

(a) Give two (02) examples for each effect. (10 marks)

(b) What are the main differences between these two effects? (10 marks)

(c) State sensitive period and most sensitive period of human fetus to ionizing radiation. (10 marks)

1.3. (a) What is meant by internal radiation hazards? (15 marks)

(b) In order to implement a good radiation protection programme, in a radiation therapy department, local rules shall be prepared.
State five (05) examples of procedures which should be covered in local working rules to protect from internal radiation hazards. (20 marks)

Contd...../2-

2.

2.1. Define the following terms related to ionizing radiation and **state their units.**

(a) Kerma (15 marks)

(b) Absorbed dose (15 marks)

(c) Linear energy transfer (15 marks)

2.2. Briefly describe the relation between Kerma and absorbed dose for low energy photons and high energy photons. (20 marks)

2.3. Define the half value layer (HVL) of X ray photon spectrum. (10 marks)

2.4. Explain, why the second half value layer is larger than first half value layer for an X ray energy spectrum. (10 marks)

2.5. If 1 mCi gamma source is adequately shielded by 4 HVLs of Lead, how many HVLs would be needed to have equal shielding for a source containing 4 mCi of the radionuclide? (15 marks)

3.

3.1. Define the following terms in relation to ICRU (Internal Commission on Radiological Units and Measurements) 50 and 62 reports.

(a) Clinical Target Volume (CTV) (15 marks)

(b) Organ at Risk (OAR) (15 marks)

3.2. Why are the margins added to define the Planning Organ at risk Volume (PRV)? (20 marks)

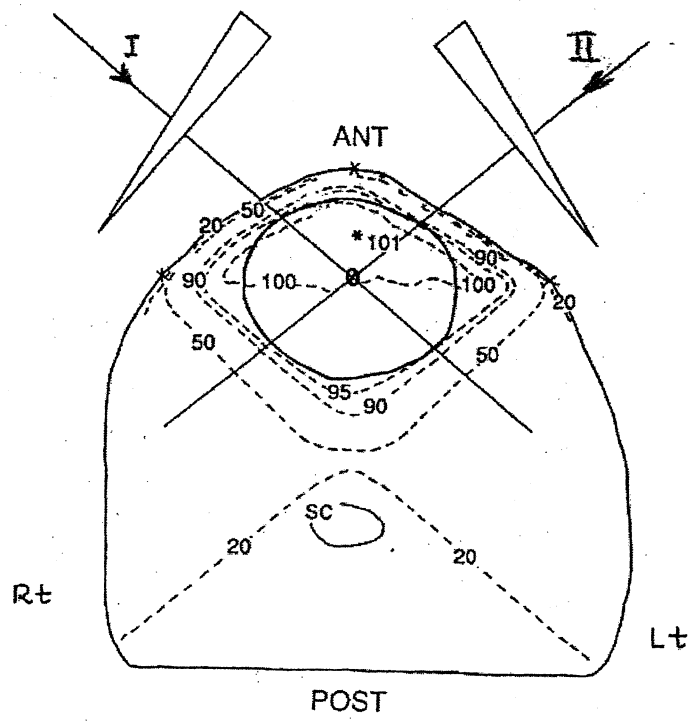
3.3. Compare the differences between direct DVH (Dose Volume Histogram) and cumulative DVH. (20 marks)

3.4. What is the role of cumulative DVH in treatment plan assessment? (15 marks)

3.5. Sketch the cumulative DVH for a typical 3D CRT treatment plan indicating the CTV, PTV, a serial organ and a parallel organ. (15 marks)

Contd...../3-

4. A patient with carcinoma of the larynx is planned to be treated in the supine position at 100 cm SAD technique with two oblique fields using a 6 MV photon beam from a Linear accelerator machine as shown in the figure below. The prescribed dose to the center of Planning Target Volume (PTV) is 55 Gy in 20 fractions.



Machine calibration conditions

Source chamber distance = 100 cm
Reference depth of calibration = 1.5 cm in water
Reference field size = 10 x 10 cm^2
Dose rate = 1 cGy/MU

Description	Beam I	Beam II
Tissue depth to beam isocenter (cm)	3.5	3.0
Gantry angle	310°	50°
Treatment field size (cm^2) *	5W x 6	4.5W x 6
Tissue maximum ratio	0.954	0.970
Wedge transmission factor (30°)	0.760	0.760
Collimator scatter factor	0.972	0.970
Phantom scatter factor	0.948	0.932

*W indicates wedged beam width

Contd...../4-

4.1. Calculate the dose rate at d_{max} in water for above wedge beams. (20 marks)

4.2. Assuming equal dose to the center of PTV from each beam, calculate the number of monitor units (MUs) per field per fraction. (20 marks)

4.3. Estimate the radiation dose to the spinal cord (SC) from this treatment. (10 marks)

4.4. Illustrate another field arrangement which could be considered for the above treatment. (10 marks)

4.5. List three (03) measures used to ensure reproducibility of patient positioning in external beam radiotherapy. (15 marks)

4.6. State the target dose uniformity, recommended in the ICRU report No: 50 for external photon beam radiotherapy. (10 marks)

4.7. List three (03) factors that contribute to increase the radiation dose to skin from high energy photons in external beam radiotherapy. (15 marks)

5.

5.1. Define the wedge angle for MV photon beams. (15 marks)

5.2. With the aid of diagrams, briefly describe two (02) methods that use wedge filtration in megavoltage photon treatments in clinical practice. (20 marks)

5.3. Discuss four (04) differences between physical wedges and enhanced dynamic wedges in radiotherapy. (20 marks)

5.4. Define the following beam parameters for a 6 MV photon beam.

(a) Flatness (15 marks)

(b) Symmetry (15 marks)

5.5. How do you verify the light and radiation field congruency for a 6 MV photon beam? (15 marks)

Contd...../5-

6.

6.1. Draw on a diagram the 90%, 50% and 10% typical isodose curves in the principal plane in water for a 10 x 10 cm^2 for a 6 MeV electron beam at 100 cm SSD. (20 marks)

6.2. A lateral neck tumour is to be treated with a single direct electron field. The maximum depth of the treatment volume is 1.5 cm, and the depth to the spinal cord is 5.0 cm. The following two techniques are considered:

(a) 6 MeV electrons

(b) 8 MeV electrons with 0.5 cm bolus

Compare the absorbed radiation doses to the skin, distal part of tumour and spinal cord in each case. (30 marks)

6.3. Briefly explain three (03) different indications for applying bolus materials in electron beam therapy. (30 marks)

6.4. Explain why electron beams are contaminated with x ray photons. Mention the percentage of photon contamination for 6 MeV electrons. (20 marks)

7.

7.1. What are the approximate dose rates for LDR, MDR and HDR afterloading brachytherapy systems? (15 marks)

7.2. List one (01) radionuclide and its typical activity that used in each of the above brachytherapy systems in 7.1. (15 marks)

7.3. Give two (02) advantages and two (02) disadvantages of HDR brachytherapy over LDR brachytherapy. (20 marks)

7.4. Briefly explain pulsed dose rate brachytherapy. (15 marks)

7.5. What is meant by apparent activity of a sealed radioactive source? Give its units. (15 marks)

7.6 The exposure rate in air at 1 m distance from a ^{60}Co brachytherapy source is 1.3 R/h. Calculate the exposure for 10 minutes at 25 cm from the source. (20 marks)

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MD (CLINICAL ONCOLOGY) PART I EXAMINATION – AUGUST 2020

Date:- 24th August 2020 **Time:-** 4.30 p.m. – 5.15 p.m.

PAPER I

If the examiners cannot read your writing, they will be unable to give you full credit for your knowledge.

MEDICAL STATISTICS

Each question carries 100 marks.
Each question to be answered in a separate book.
Answer TWO (02) questions of the THREE (03) questions given below.

1. A study was carried out in the Radiology Department in a Teaching Hospital, with a sample size of 103. All patients with a clinical suspicion of breast cancer who gave informed consent were recruited and assessed clinically, underwent bilateral mammography and whole breast ultrasonography and then biopsy as the gold standard. Of 103 patients, 52 (50.5%) had malignant lesions. Sixty-two cases were detected as suspicious or highly suggestive of malignancy on ultrasound. The results are given below.

	Presence of mass in the breast	**Breast Ultrasound**	**Mammography**
Sensitivity % (95% CI*)	90 (79 to 97)	100 (93 to 100)	73 (60 to 83)
Specificity % (95%CI*)	41 (27 to 56)	80 (67 to 90)	80 (65 to 91)

*CI - Confidence interval

1.1. Briefly describe the appropriateness of the study population for the above study. (10 marks)

1.2. Briefly describe the methodology of the above study. (20 marks)

1.3. Briefly describe two (02) causes of bias that would affect the results. (20 marks)

1.4. Calculate and interpret the positive predictive value for breast ultrasound. (20 marks)

1.5. Briefly describe the relative advantages of the above three (03) screening methods for breast carcinoma. (30 marks)

Contd...../2-

A phase III, randomised, double-blind, placebo-controlled study was conducted to evaluate the efficacy of pegvorhyaluronidase alfa (PEGPH20) plus nab-paclitaxel/gemcitabine (AG) in patients with hyaluronan-high metastatic pancreatic ductal adenocarcinoma (PDA). 492 patients were randomly assigned (327 for PEGPH20 and 165 for placebo) and included in the intention-to-treat analyses. Baseline characteristics were balanced for PEGPH20 plus AG versus placebo plus AG. The primary end point was overall survival (OS). The results are reported with a median OS of 11.2 months for PEGPH20 plus AG versus 11.5 months for placebo plus AG (Hazard Ratio = 1.00; 95% Confidence Interval = 0.80 to 1.27).

2.1. Briefly explain the method of randomisation in the above study. (20 marks)

2.2. Briefly explain the use of 'double-blind' in the above study. (20 marks)

2.3. What is the purpose of reporting that "Baseline characteristics were balanced"? (10 marks)

2.4. Briefly explain the purpose of applying an intention to treat analysis. (20 marks)

2.5. Briefly explain the purpose of performing survival analysis. (20 marks)

2.6. What is the conclusion of the study? (10 marks)

3. A systematic review was conducted to assess the effectiveness of eradication of H. pylori in healthy asymptomatic individuals in the general population in reducing the incidence of gastric cancer. It revealed that H. pylori eradication therapy was superior to placebo or no treatment (Relative Risk=0.54, 95% Confidence Interval = 0.40 to 0.72), with moderate certainty evidence. The number needed to treat to benefit was 72.

3.1. Briefly describe the steps of conducting a systematic review. (20 marks)

3.2. State three (03) criteria for assessing validity of the primary studies. (30 marks)

3.3. Interpret relative risk and 95% Confidence Interval. (20 marks)

3.4. What is meant by 'moderate certainty evidence'? (10 marks)

3.5. Explain 'number needed to treat to benefit was 72'. (20 marks)

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MD (CLINICAL ONCOLOGY) PART I EXAMINATION – AUGUST 2020

Date:- 25th August 2020 **Time:-**9.00 a.m. – 9.45 a.m.

PAPER II

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PATHOLOGY

Each question carries 100 marks.
Each question to be answered in a separate book.
Answer TWO (02) questions of the THREE (03) questions given below.

1. A 60-year-old man presents with an enlarged left supraclavicular lymph node of 3 months duration.

1.1. State three (03) possible causes for the lymph node enlargement. (15 marks)

1.2. List three (03) laboratory tests that can be performed on the lymph node of this patient. (15 marks)

1.3. For each of the causes in question 1.1, describe briefly how these laboratory tests that you mentioned in question 1.2 will help to arrive at a definitive diagnosis. (70 marks)

2.

2.1. List four (04) precursor lesions/conditions of colorectal carcinoma. (20 marks)

2.2. State five (05) histopathological prognostic factors of colorectal carcinoma. (25 marks)

2.3. List three (03) genetic tumour syndromes associated with colorectal carcinoma. (15 marks)

2.4. Give the genetic abnormality in each of these conditions. (30 marks)

2.5. Give two (02) clinical features which alert you to the possibility of a colorectal cancer being part of a genetic syndrome. (10 marks)

Contd..../2-

3. The histopathology laboratory has received a left nephrectomy specimen from a 56-year-old male. Subsequently he was diagnosed to have a primary renal carcinoma.

3.1. List three (03) common presenting features of this tumour. (15 marks)

3.2. List four (04) risk factors associated with this disease. (20 marks)

3.3. List three (03) histopathological subtypes of primary renal carcinoma. (15 marks)

3.4. State two (02) special stains and three (03) important immuno-histochemical markers which are helpful in diagnosis of above tumour. (30 marks)

3.5. State four (04) important histopathological prognostic factors for primary renal carcinoma. (20 marks)

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MD (CLINICAL ONCOLOGY) PART I EXAMINATION – AUGUST 2020

Date:- 25th August 2020 **Time:-**10.00 a.m. – 10.45 a.m.

PAPER II

If the examiners cannot read your writing, they will be unable to give you full credit for your knowledge.

RADIOBIOLOGY

Each question carries 100 marks.
Each question to be answered in a separate book.
Answer TWO (02) questions of the THREE (03) questions given below.

1.

1.1. List the three (03) types of lesions that radiation induces in DNA and discuss the consequences of these events. (18 marks)

1.2. Name the two (02) damage response pathways that will operate for the most damaging lesions mentioned under 1.1. (20 marks)

1.3. Briefly describe the role of p53 protein in regulating tissue response to radiation. (12 marks)

1.4. Compare and contrast a single dose survival curve with that of a survival curve for a multifraction (equal fractions) regimen, using X rays. Illustrate your answer with a diagram. (35 marks)

1.5. A tumor consists of 10^{11} clonogenic cells. The effective dose-response curve given in daily dose fractions of 2 Gy has no shoulder and a D_0 of 3 Gy.

(a) What total dose is required to give a 90% chance of tumour cure? (10 marks)

(b) If these clonogenic cells underwent three cell doublings during treatment, what total dose would be required to achieve the same probability of tumour control? (05 marks)

Contd..../2-

2.

2.1. Define the therapeutic ratio in radiotherapy. (15 marks)

2.2. Differentiate between the following:

(a) Early normal tissue damage versus late normal tissue damage. (20 marks)

(b) Hypofractionation and hyperfractionation. (20 marks)

2.3. Define Relative Biologic Effectiveness (RBE). (10 marks)

2.4. Briefly discuss the relationship of RBE with linear energy transfer (LET). (15 marks)

2.5. Why does the RBE of high-LET radiation compared with that of low-LET radiation increase as the dose per fraction decrease? (20 marks)

3.

3.1. What is radiosensitivity? (05 marks)

3.2. List the physical, chemical and biological factors that affect radiosensitivity. (15 marks)

3.3. Name in sequential order the most to least radiosensitive phases of the cell cycle. (08 marks)

3.4. Write briefly on the following in relation to whole body radiation exposure:

(a) Treatment available for the haemopoietic syndrome. (10 marks)

(b) Symptoms of the gastro-intestinal syndrome. (12 marks)

(c) The pathophysiology of the above two syndromes in relation to the radiosensitivity of cells. (20 marks)

3.5. Provide brief definitions for the following:

(a) Reoxygenation (10 marks)

(b) Dose reduction factor (DRF) (10 marks)

(c) Theragnostics (10 marks)

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MD (CLINICAL ONCOLOGY) PART I EXAMINATION – AUGUST 2020

Date:- 25th August 2020 **Time:-**11.00 a.m. – 11.45 a.m.

PAPER II

If the examiners cannot read your writing, they will be unable to give you full credit for your knowledge.

PHARMACOLOGY

Each question carries 100 marks.
Each question to be answered in a separate book.
Answer TWO (02) questions of the THREE (03) questions given below.

1.

1.1. A 76-year-old patient is diagnosed to have advanced prostate cancer. The oncologist decides to start him on goserelin.

(a) Explain the mechanism of action of goserelin. (30 marks)

(b) Name an endocrine therapy administered with or prior to administration of goserelin and explain the rationale for doing so. (30 marks)

1.2. Explain the mechanism of action of the following anticancer drugs in the treatment of prostate cancer

(a) Docetaxel (20 marks)

(b) Abiraterone (20 marks)

Contd..../2-

2.

2.1. Define the following terms and briefly explain how they can influence a drug regimen in oncology practice

(a) Bioavailability (15 marks)

(b) Therapeutic index (15 marks)

(c) Plasma elimination half-life (15 marks)

2.2. Define the term pharmacokinetic drug interactions. (10 marks)

2.3. Write three (03) examples of pharmacokinetic drug interactions in oncology. (15 marks)

2.4. Describe five (05) measures that you can take to minimize the incidence of clinically significant drug interactions in oncology. (30 marks)

3.

3.1. List the four (04) main types of drug receptors and give an example for each receptor type. (20 marks)

3.2. For each of the receptors you mentioned in 3.1, name one (01) drug acting on that receptor and give one (01) indication for its use. (20 marks)

3.3. Explain the mechanism of action of two (02) **anticancer** drugs acting on different types of receptors you mentioned in question 3.2. (30 marks)

3.4. Name two (02) **anticancer** drugs acting on enzymes and briefly explain the mechanism of action of the two drugs mentioned. (30 marks)

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MD (CLINICAL ONCOLOGY) PART I EXAMINATION – AUGUST 2020

Date:- 25th August 2020 **Time:-**12.00 noon – 12.45 p.m.

PAPER II

If the examiners cannot read your writing, they will be unable to give you full credit for your knowledge.

CANCER BIOLOGY

Each question carries 100 marks.
Each question to be answered in a separate book.
Answer TWO (02) questions of the THREE (03) questions given below.

1.

1.1. List three (03) factors that activate **intrinsic** pathway of apoptosis. (15 marks)

1.2. Briefly describe the role of the following in apoptosis. (40 marks)

(a) Death receptor

(b) Cytochrome C

1.3. List three (03) features of epithelial mesenchymal transition. (15 marks)

1.4. Briefly outline the role of the RAS proteins in carcinogenesis. (30 marks)

Contd...../2-

2.

2.1. State the difference between a genetic change and an epigenetic change. (10 marks)

2.2. Name the cellular components detected by (10 marks)

(a) polymerase chain reaction (PCR)

(b) reverse transcriptase polymerase reaction (RT-PCR)

2.3. Explain the two hit hypothesis with respect to carcinogenesis by tumour suppressor genes. (20 marks)

2.4. Briefly describe the role of the following in carcinogenesis. (45 marks)

(a) *BRCA-1* mutations

(b) Translocation between chromosome 9 and 22

2.5. State the basis of using PARP (poly ADP ribose polymerase) inhibitors in the treatment of cancer due to *BRCA-1* mutations. (15 marks)

3.

3.1. Describe immune editing of tumours. (30 marks)

3.2. List four (04) types of cells of the immune system that act against tumours. (10 marks)

3.3. Briefly describe how two (02) of these cells act against tumours. (30 marks)

3.4. List two (02) cells that promote tumourigenesis. (10 marks)

3.5. Briefly describe how the cells listed in 3.4. promote tumourigenesis (20 marks)