UNIVERSITI KUALA LUMPUR
INSTITUTE OF MEDICAL SCIENCE TECHNOLOGY

FINAL EXAMINATION

OCTOBER 2025 SEMESTER

COURSE CODE	:	HDB30903
COURSE TITLE	:	MOLECULAR DIAGNOSTIC TECHNOLOGY
PROGRAMME NAME	:	BACHELOR OF BIOMEDICAL SCIENCE (HONOURS)
DATE	:	31 JANUARY 2026
TIME	:	9:00AM - 12:00PM
DURATION	:	3 HOURS

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. This question paper consist of TWO sections.
4. Answer ALL questions for Section A.
5. Section B consist of four questions. Answer THREE (3) questions only.
6. Please write your answer on the answer booklet provided.
7. Please answer all questions in English only.
8. Please answer MCQ/EMQ questions using OMR sheet. ☐ *Tick if applicable*
9. Refer to the attached Formula/ Appendies. ☐ *Tick if applicable*

THERE ARE 16 PAGES OF QUESTIONS INCLUDING THIS PAGE

SECTION A (Total: 40 marks)

Answer ALL questions.

Please use the answer booklet provided.

1. Northern blotting is used for separation of _____.

   A. cDNA

   B. protein

   C. DNA

   D. mRNA

2. Below is the practical application of cloning in agriculture except _____.

   A. creating diverse crop varieties

   B. controlling pests

   C. replicating superior livestock

   D. enhancing soil fertility

3. Gene cloning is a process where _____.

   A. DNA is cloned only in bacteria

   B. fragments of DNA are transferred from one organism to another using a vector

   C. fragments of DNA cloned into the same organism using a vector

   D. gene is cloned in an animal

4. Method that was used to clone Dolly the sheep is _____.

   A. gene editing

   B. embryo splitting

   C. somatic cell nuclear transfer

   D. controlling pests

5. Small circular DNA present in bacteria cells is called as _____.

   A. plasmid

   B. enzymes

   C. ribosomes

   D. vector

6. _____ method is used to manufacture human insulin in large quantities.

   A. Real-time PCR

   B. Gel-filtration chromatography

   C. Cloning

   D. Protein dialysis

7. PCR technique allows simultaneous amplification of several DNA targets in a single reaction is called _____.

   A. multiplex PCR

   B. long-range PCR

   C. digital PCR

   D. inverse PCR

8. The _____ is known as a codon.

   A. one of the three nucleotides that encode an amino acid

   B. three amino acids that encode a nucleotide

   C. three nucleotides that encode an amino acid

   D. one of the four bases in DNA

9. Which buffer is commonly used in agarose gel electrophoresis to maintain pH and ionic strength?

   A. Tris glycine

   B. Tris Acetate EDTA

   C. Distillled water

   D. Sodium chloride

10. The limitation of single stranded conformational SSCP is that it _____.

   A. may miss some mutations due to conformational similarity

   B. requires complex equipment

   C. only works on long DNA sequences

   D. cannot detect small insertions or deletions

11. When setting up a PCR reaction to amplify a gene from bacterial DNA, you would _____.

   A. add Taq polymerase to synthesize the DNA

   B. increase magnesium ions to denature the DNA

   C. use DNA ligase to link the DNA ends

   D. employ SDS-PAGE to visualize the DNA

12. Statement that distinguishes real-time PCR from conventional PCR is _____.

   A. conventional PCR does not involve a denaturation step

   B. real-time PCR does not require primers

   C. real-time PCR measures amplification as it occurs

   D. conventional PCR uses a different polymerase enzyme

13. The advantage of using polyarcrylamide gel electrophoresis (PAGE) over agarose for protein analysis is that it _____.

    A. increases DNA stability

    B. separates large molecules efficiently

    C. provides higher resolution for small molecules such as proteins

    D. reduces the time for sample loading

14. The commonly used method to assess RNA integrity based on the visualization of distinct bands representing 28s and 18s ribosomal RNA is _____.

    A. western blotting

    B. spectrophotometry

    C. gel electrophoresis

    D. PCR amplification

15. The step in polymerase chain reaction responsible for creating a cDNA copy from RNA is called _____.

    A. replication

    B. transcription

    C. translation

    D. reverse transcription

16. The primary function of mass spectrometry in protein analysis is _____.

    A. immunodetection

    B. enzymatic digestion

    C. sequence determination

    D. size separation

17. Which technique is widely used for quantifying protein expression levels in serum?

    A. ELISA (Enzyme-Linked Immunosorbent Assay)

    B. PCR (Polymerase Chain Reaction)

    C. Southern blotting

    D. Northern blotting

18. In what ways do accreditation activities benefit a molecular diagnostics laboratory?

    A. Increasing costs of testing.

    B. Reducing the needs for proficiency testing.

    C. Decreasing the needs for quality control measures.

    D. Validating and ensures the quality of laboratory practices.

19. Which action demonstrates ethical behavior regarding patient confidentiality in molecular diagnostics?

    A. Using patient data for medical research with proper anonymization.

    B. Sharing genetic test results with unauthorized family members.

    C. Disclosing patient genetic information to law enforcement without consent.

    D. Selling patient genetic profiles to insurance companies for profit.

20. In the context of molecular diagnostics, which action demonstrates ethical behavior regarding informed consent?

    A. Providing detailed information about the risks and benefits of testing before obtaining patient consent.

    B. Sharing test results with healthcare providers but withholding information from the patient.

    C. Conducting genetic testing on minors without parental consent

    D. Performing diagnostic procedures without informing the patient about potential adverse outcomes.

21. The limitation of Sanger sequencing compared to next-generation sequencing techniques is _____.

A. slower throughput

B. higher error rates

C. lower cost per base

D. longer read lengths

22. Which of the following is NOT a second-generation (Next Generation Sequencing) technology?

A. Ion Torrent

B. Oxford Nanopore sequencing

C. Illumina sequencing by synthesis

D. Roche 454 pyrosequencing

23. Determine the amount of agarose powder required to prepare 50 mL of a 1.5% agarose gel solution.

A. 1.50 g

B. 0.50 g

C. 1.00 g

D. 0.75 g

24. Each lab group will prepare a primer mix. The forward and reverse beta actin primers are at a concentration of 50 µM each. You will prepare a primer mix by combining 8 µl of each two primers to give a total combined volume of 16 µl. Calculate the new concentration of each primer.

A. 25 µM

B. 5 µM

C. 20 µM

D. 10 µM

25. A polymorphism is _____.

A. a variation of gene or marker sequence present in <1% of the population

B. the most common variation of a gene or marker sequence

C. the least common variation of a gene or marker sequence

D. a variation of gene or marker sequence present in >1% of the population

26. In the Sanger method of DNA sequencing, DNA synthesis ____ when a dideoxy base is encountered.

A. commences

B. stops

C. increases

D. continues

27. Which ethical principle refers to the patient's right to make their own decisions about healthcare?

A. Beneficence

B. Non-maleficence

C. Autonomy

D. Justice

28. Which of the following organizations provides External Quality Assessment (EQA) programs for Malaysian laboratories?

A. Royal College of Pathologists of Australasia (RCPA)

B. Centers for Disease Control and Prevention (CDC)

C. International Organization for Standardization (ISO)

D. World Health Organization (WHO)

29. In order for gene probes to be useful, they must _____.

A. not be labeled to avoid unspecific binding

B. be long enough to contain gene-specific sequence

C. be made of short DNA fragments

D. bind to targets with a complementary sequence only

30. Manipulation or misrepresentation of results from molecular research violate which of the following ethical principle?

A. Beneficence

B. Non-maleficence

C. Justice

D. Integrity

31. The addition of sodium-dodecyl-sulfate (SDS) to protein samples before electrophoresis serves which function?

A. To increase protein molecular weight for smooth migration.

B. To bind to the protein and form a negatively charged micelle around it.

C. To stabilize the protein structure during electrophoresis.

D. To add positive charges to the negatively charged protein.

32. The Human Genome Project was completed in the year _____.

A. 2011

B. 2003

C. 2001

D. 2013

33. Prior to getting electrophoresed in the sequencing gel, DNA is _____.

A. denatured

B. fragmented

C. purified

D. synthesized

34. Which international standard should molecular diagnostic laboratories comply with to ensure quality assurance?

A. ISO 15189

B. ISO 17025

C. ISO 15190

D. ISO 9001

35. DNA extracted from an organism is cut into smaller gene fragments with _____.

A. okazaki enzyme

B. DNA polymerase

C. restriction enzyme

D. helicase

36. In RNA extraction using Guanidinium thiocyanate-phenol-chloroform, which layer contains RNA following the centrifugation step?

A. Upper aqueous phase.

B. Lower interphase.

C. Middle organic phase.

D. Sediment.

37. A 48-year-old woman presents with breast tenderness and nipple discharge for the past two months. An ultrasound examination reveals cystic degeneration in her right breast. A fine needle aspirate is performed in the mammography suite, and subsequent testing on the cytopathology slide reveals the presence of HER2 gene amplification on Chromosome 17. Which of the following techniques will be used to obtain this result?

    A. Polymerase Chain Reaction (PCR)

    B. Enzyme-Linked Immunosorbent Assay (ELISA)

    C. Agarose Gel Electrophoresis

    D. Fluorescent In-Situ Hybridization (FISH)

38. The purpose of incubation with skimmed milk steps in western blotting is to _____.

    A. block any interfering unspecific antibody binding

    B. separate the sample from other proteins

    C. ensure that the primary antibody binds properly to the sample

    D. allow detection of the protein sample

39. Which molecular diagnostic technique is commonly used for the detection of bacterial and viral DNA in clinical samples?

    A. PCR

    B. Flow Cytometry

    C. Western Blot

    D. ELISA

40. Identify the importance of single nucleotide polymorphism (SNP).
    I. Act as biological markers.
    II. Predict response to certain drug.
    III. Predict susceptibility towards toxin.
    IV. Track the inheritance of disease genes within families.

    A. I, II, III and IV.

    B. II and III only.

    C. I and II only.

    D. I, II and III only.

SECTION B (Total: 60 marks)

Answer THREE (3) questions only.

Please use the answer booklet provided.

Question 1

Answer all of the following questions.

(a) Fred is married to Helen, who was previously married to George, now deceased. George and Helen conceived one child together and adopted one child. Fred and Helen have also conceived one child. All members of Helen's current family have had DNA fingerprinting done at a single VNTR locus. Unfortunately, the sheet that identified each child has been misplaced. Based on the following VNTR results, help them to identify which fingerprint in each lane (in lanes 5, 6, and 7) corresponds to each child.

I. Fred and Helen's conceive child.
II. George and Helen's conceive child
III. George and Helen's adopted child

Refer Below - Figure1 : VNTR results .

(3 marks)

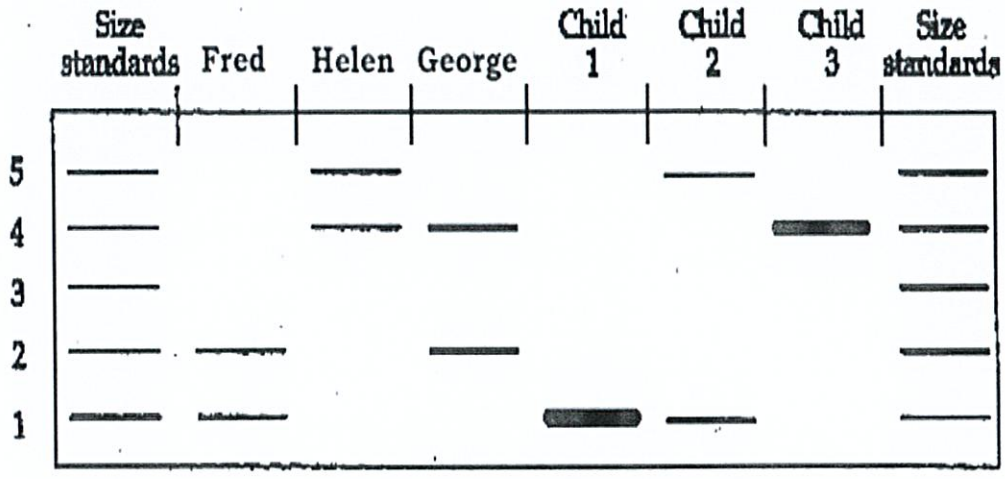

Figure 1: VNTR results

(b) Consider the following STR analysis in Table X.

I. List down all the child's allele numbers that are inherited from the father.
II. Which alleged father (AF) is the biological parent?

Refer Below - Figure2 : Table X .

(5 marks)

Locus	Child	Mother	AF1	AF2
D3S1358	15/15	15	15	15/16
vWA	17/18	17	17/18	18
FGA	23/24	22/23	20	24
TH01	6/10	6/7	6/7	9/10
TPOX	11/11	9/11	9/11	10/11
CSF1PO	12/12	11/12	11/13	11/12
D5S818	10/12	10	11/12	12
D13S317	9/10	10/11	10/11	9/11

Figure 2: Table X

(c) One of the applications of molecular diagnostic technology is parentage testing. Describe the step-by-step process of DNA-based parentage testing using the restriction fragment length polymorphism (RFLP) method.

(12 marks)

Question 2

Answer all of the following questions.

(a) Distinguish between mutation and polymorphism.

(10 marks)

(b) Outline the essential steps in PCR-based methods for detecting DNA mutations, using Single-Stranded Conformational Polymorphism (SSCP) analysis as an example.

(10 marks)

Question 3

Answer all of the following questions.

(a) BLAST, Clustal Omega, and Primer3 are commonly used bioinformatics sequence analysis tools. Explain the function of each tool.

(5 marks)

(b) Elaborate on the systematic workflow for variant interpretation in clinical diagnostics using bioinformatics, covering the three main steps from variant identification to clinical correlation. Your answer should include specific technical parameters and guidelines used at each step.

(15 marks)

Question 4

Answer all of the following questions.

(a) Differentiate between selectable marker and reporter gene techniques.

(6 marks)

(b) Describe how the Blue-White Screening method works in selecting transformed bacterial colonies.

(4 marks)

(c) Explain the process of molecular cloning, detailing the essential steps, key components, and its significance in biotechnology and research.

(10 marks)

END OF EXAMINATION PAPER