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POSTGRADUATE INSTITUTE OF MEDICINE
UNIVERSITY OF COLOMBO

POSTGRADUATE DIPLOMA IN MOLECULAR MEDICINE
EXAMINATION – I MODULE I – JANUARY, 2014

Date: 22nd January, 2014

Time: 9.00 p.m. – 12.00 noon

SEQ PAPER
(Molecular Cell Biology and Cytogenetics)

Answer all six (06) questions.

Answer each question in a separate answer book.

1.

1.1 Describe the components of a chromosome (25 marks)

1.2 Name two (02) diseases that occur due to structural chromosomal abnormalities and outline the basis of the chromosome abnormality in each of these diseases (25 marks)

1.3 Write the karyotype of a child with Klinefelter syndrome (15 marks)

1.4 Compare spermatogenesis with oogenesis (35 marks)

2. Answer any two (02) of the following (2.1, 2.2, 2.3)

2.1 Describe the sodium potassium ATPase pump and its role in maintaining the resting membrane potential (50 marks)

2.2 Outline the receptor mechanisms of the signal transduction pathway (50 marks)

2.3 Explain the functions of the following in eukaryotic DNA replication

i. Topoisomerase (25 marks)

ii. Telomerase (25 marks)

Contd.....2/-

3. Answer any **two** (02) of the following (3.1, 3.2, 3.3)

3.1 Discuss the following

- i. Non coding DNA in eukaryotes (25 marks)
- ii. Single nucleotide polymorphism (25 marks)

3.2

- i. Name three (03) mechanisms of gene silencing in eukaryotes (15 marks)
- ii. Explain giving example/s one mechanism that you named above (35 marks)

3.3

- i. Name two (02) DNA repair mechanisms found in eukaryotes (10 marks)
- ii. What type of DNA damage is repaired by each repair mechanism stated above? (20 marks)
- iii. State the consequences of a point mutation that occurs as a result of unrepaired DNA damage (20 marks)

4.

4.1 Briefly describe how transcription termination occurs during prokaryotic gene expression (25 marks)

4.2 List the post transcriptional modifications in eukaryotic pre-mRNA and state the significance of these modifications (25 marks)

4.3 Briefly explain the following in relation to protein synthesis

- i. Polysomes in prokaryotic protein synthesis (25 marks)
- ii. Scanning in the initiation of eukaryotic protein synthesis (25 marks)

5. Answer any **two** (02) of the following (5.1, 5.2, 5.3)

5.1 Explain how you would quantify pathogen load by Real Time PCR
(Quantitative PCR) (50 marks)

5.2 Explain Sanger's dideoxy DNA sequencing method (50 marks)

5.3 Write briefly on microarray technology and its applications (50 marks)

6. Answer any **two** (02) of the following (6.1, 6.2, 6.3)

6.1 Humulin is a recombinant insulin expressed in *Escherichia coli* using synthetic cDNA. Explain the experimental procedure for manufacturing humulin (50 marks)

6.2 Explain the process of producing alpha-1- antitrypsin (AAT), a protease inhibitor, in milk of transgenic sheep (50 marks)

6.3 Discuss the following

i. Prokaryotic expression systems against eukaryotic expression systems (25 marks)

ii. Selectable markers and reporter genes in gene expression (25 marks)

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POSTGRADUATE DIPLOMA IN MOLECULAR MEDICINE
EXAMINATION I MODULE I – JANUARY, 2014

Date: 22nd January, 2014

Time: 1.00 p.m. – 3.00 p.m.

PRACTICAL PAPER
(Molecular Cell Biology and Cytogenetics)

Answer all six (06) questions.
Answer each question in a separate answer book.

1.
Outline the activity of the following enzymes and explain how they are utilized in DNA cloning experiments. (4 x 25 marks)

- 1.1 Alkaline phosphatase
- 1.2 Sau3AI
- 1.3 Klenow fragment of DNA polymerase I
- 1.4 DNA ligase

2.
2.1 State the advantages of phage lambda vectors over plasmid vectors (30 marks)

2.2 Complete digestion of genomic DNA with restriction enzymes is **not** a satisfactory method in constructing a genomic DNA library. Explain (50 marks)

2.3 State two methods that are **suitable** for obtaining DNA fragments for construction of genomic libraries (20 marks)

3.

3.1 You plan to digest 2 μg of a recombinant plasmid DNA using restriction enzyme EcoR I to release the cloned insert. The enzyme activity is 10U/ μL . A colleague gives you the following suggestions.

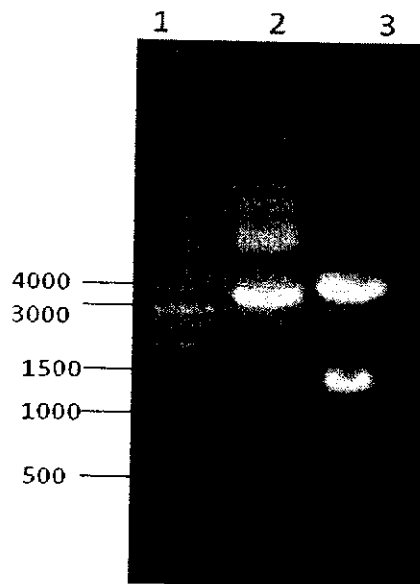
- a. Use 5U of enzyme for 1 μg of DNA
- b. The maximum enzyme volume should be 1/10th of the reaction volume
- c. Add EDTA at the end of the incubation

i. Give reasons for each of the above (45 marks)

ii. What is the minimum total reaction volume you would use for the digestion? (15 marks)

3.2 You carry out agarose gel electrophoresis to analyze the digested DNA and the following gel picture was obtained.

Comment on the results obtained (40 marks)



Lane 1: DNA ladder marker (bp), Lane 2: undigested plasmid, Lane 3: EcoR I digested plasmid.

Contd...../3-

4.
4.1 Using the matrix given below, work out the concentrations of each PCR component in the 25 μ l PCR reaction. (45 marks)

Stock concentration of PCR component	Volume(μ l) to be taken for 1 reaction	Concentration in the final 25 μ l volume
10X PCR mix	2.5	?
25 mM MgCl ₂	1.5	?
10 mM dNTPs	0.5	?
Forward Primer (5 μ M)	1.0	?
Reverse Primer (5 μ M)	1.0	?
Taq (5U/ μ l)	0.5	?
H ₂ O	13.0	
DNA	5.0	
TOTAL	25.0	

- 4.2 You are provided with the following solutions: 100 mM dATP, 100 mM dTTP, 100 mM dCTP, 100 mM dGTP, distilled de-ionized water.

State briefly how you would prepare a 200 μ l solution of 10 mM dNTP mix using the above solutions for PCR work (35 marks)

- 4.3 State 4 factors that are important in designing primers for PCR (20 marks)

5.

5.1 State the rationale of performing the MTT assay to detect cell Proliferation (25 marks)

5.2 Design an experiment to detect cytotoxicity induced by a heavy metal (25 marks)

5.3. How would you calculate the effective dose (EC_{50})? (50 marks)

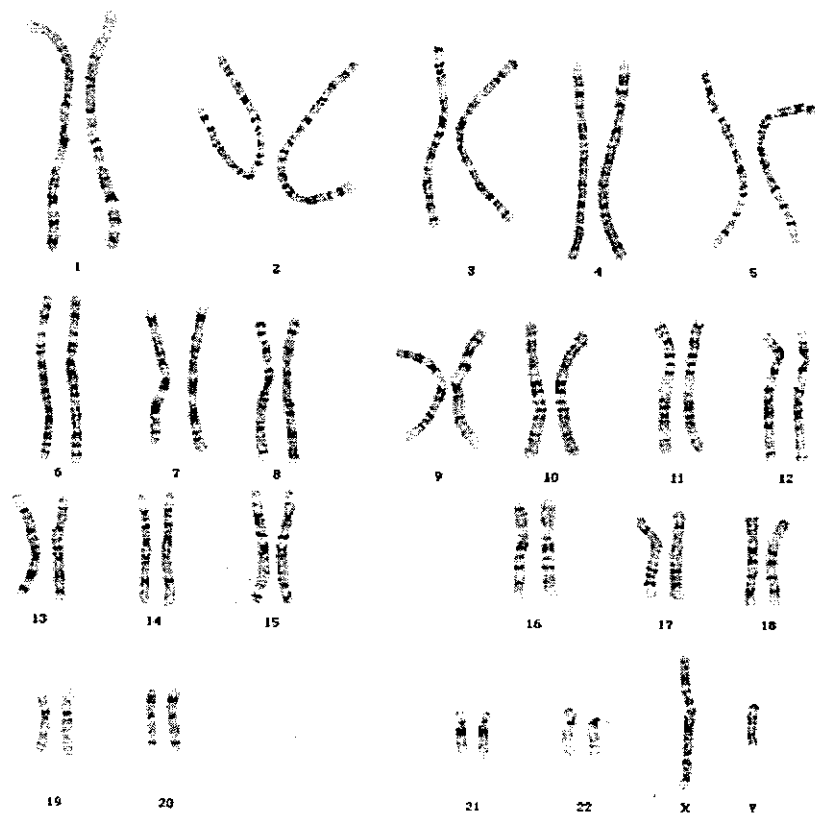
6.

6.1 Outline using a flow chart, the procedure involving karyotyping (40 marks)

6.2 State the chemical that should be present in the blood collection tube for karyotyping and outline why it is used (15 marks)

6.3 State two chemicals used during karyotyping and outline their roles in this process (30 marks)

6.4 State the karyotype of the karyogram depicted below (15 marks)



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POSTGRADUATE DIPLOMA IN MOLECULAR MEDICINE
EXAMINATION I – MODULE II – JANUARY, 2014

Date: 23rd January, 2014

Time: 9.00 a.m. – 12.00 noon

SEQ PAPER

(Human Biology, Medical Microbiology and Parasitology)

1.

A 30 year old woman complains of having a swelling of her neck associated with weight loss, excessive sweating, palpitations (sensation of pounding of the heart) and prominence of her eyes in the past six months.

The following are the results of her thyroid function tests

Total thyroxine (T ₄) and triiodothyronine (T ₃)	-	Elevated
Free thyroxine and triiodothyronine	-	Elevated
Thyroid stimulating hormone (TSH)	-	Reduced

- 1.1 State the likely diagnosis in this patient (10 marks)
- 1.2 List five functions of thyroxine (25 marks)
- 1.3 Outline the normal regulation of T₄ and T₃ secretion and the reason for the reduced TSH in this patient (20 marks)
- 1.4 State another hormone secreted by the thyroid gland and its main action (10 marks)
- 1.5 Describe the microscopic structure of the thyroid gland (35 marks)

Contd...../2-

2.

A 45 year old obese, smoker has a blood pressure of 190/95mmHg. Following treatment with a drug that blocks the beta 1 receptor (beta blocker), his blood pressure falls to 170/85mmHg and his pulse rate is recorded to be 50/ minute

- 2.1 State the equation for calculating the blood pressure (10 marks)
- 2.2 Outline the mechanism by which the blood pressure increases in the following situations
- 2.2.1 Generalised arteriolar narrowing (15 marks)
- 2.2.2 Increased heart rate (15 marks)
- 2.3 State the normal blood pressure and pulse rate in an adult male and comment on this man's blood pressure before treatment (10 marks)
- 2.4 Outline the mechanism of blood pressure and heart rate reduction following beta blocker therapy (30 marks)
- 2.5 Draw a labeled diagram showing the microscopic structure of an artery (20 marks)

3.

Write short notes on **four** (04) of the following (4x 25 marks)

- 3.1 The role of the kidney in acid base balance
- 3.2 Microscopic structure of the renal corpuscle
- 3.3 Microscopic structure of the alveolar capillary membrane
- 3.4 Role of bile salts in digestion and absorption of lipids
- 3.5 Describe the microscopic structure of the liver lobule

Contd...../3-

4.

Answer any **two** (02) of the following

(2x50 marks)

4.1 Explain the metabolic fate of pyruvate

4.2 A 45-year-old man who was diagnosed with “gouty arthritis” was advised to reduce his alcohol and meat intake. Outline the biochemical basis of this lifestyle advice

4.3 Outline the metabolic interrelationships between chylomicrons, VLDL, IDL and LDL

5

5.1 Name **three** (03) parasitic infections that are transmitted through insect vectors in Sri Lanka (15 marks)

5.2 Taking one parasitic infection mentioned under 1.1 above as an example

5.2.1 Name the infective stage to man introduced by the vector (05 marks)

5.2.2 Write an account on the diagnostic methods used for confirmation of diagnosis giving the advantages and disadvantages (40 marks)

5.2.3 Discuss the control methods used in the local setting (40 marks)

Contd...../4-

6.

A 25- year- old male presented with fever, chills and productive cough for one week duration. As part of the investigations for this, blood was collected for culture and antibiotic sensitivity testing.

- 6.1 Briefly outline how you would process the blood sample in the laboratory (40 marks)
- 6.2 What are the tests you would perform to identify the causative organism if gram positive cocci were isolated from the specimen (10 marks)
- 6.3 State the important factors you should consider when collecting and processing of a sample of blood for culture (20 marks)
- 6.4 Briefly describe the cell membrane (cytoplasmic membrane) of a bacterium (30 marks)