

Department of Biosciences and Bioengineering

Indian Institute of Technology Guwahati

Modern Biology – BT 101

MID SEMESTER EXAMINATION

Time: 1400 to 1600 hrs

Date: 1st March 2016

Maximum Marks: 40

Write your answers **ONLY** in the space provided. You can use the supplements for the rough work.

Answers with incorrect or missing units will attract penalty.

Section A

(2 × 10 = 20 marks)

1. Identify the transmembrane protein in the purple membrane of *Halobacterium Salinarum*. and specify its function. **BACTERIORHODOPSIN which is a LIGHT-ACTIVATED PROTON PUMP**

2. Identify two common secondary structures adopted by proteins while traversing the lipid bilayer. **α-helix and β-barrel or β-sheet**

3. Identify one or more statements from below that is/are FALSE.

(A) The lipid bilayer is a two-dimensional fluid.

(B) The fluidity of a lipid bilayer depends on its composition.

(C) ***E. Coli* cell membrane contains cholestrol.**

(D) The distribution of phospholipids and glycolipids in lipid bilayer of human RBC is asymmetric.

4. Highlight two types of DYNAMICS (motions) observed among lipid molecules in a lipid bilayer. **lateral diffusion; flip-flop; flexion; rotation**

5. Identify one or more statements from below which is/are TRUE. **ALL are TRUE**

(A) Human brain has approximately 10¹¹ neurons.

(B) Human brain consumes less power than a computer.

(C) Information processing in the brain relies on massively parallel processing in the nervous system.

(D) Signalling mode in the brain is both analog and digital.

6. Put the following statements in the correct order.

(A)*Ca*²⁺ entry into the presynaptic terminal

(B)Opening of voltage-gated *Ca*²⁺ channels

(C)Neurotransmitter release

(D)Fusion of synaptic vesicle with the presynaptic PM

(E)Axonal action potential

(F)Depolarization of the presynaptic terminal

(E)→(F)→(B)→(A)→(D)→(C)

7. Arrange the following compounds by the standard free energy change (Δ*G*^o) for hydrolysis of the phosphate bond starting from the least negative value and moving on to the most negative value:

[A]Creatine phosphate

[B]Adenosine triphosphate

[C]Glucose-6-Phosphate

[D]1,3-bisphosphoglycerate

[E]Phosphoenolpyruvate

(C)→(B)→(A)→(D)→(E)

8. When the squid giant axon, suspended in a bath of seawater is stimulated to conduct a nerve impulse, the membrane potential changes transiently from -70 mV to +40 mV. Calculate the potential across the resting membrane of squid giant axon assuming it is solely due to A) *K*⁺ and B) *Na*⁺. *Na*⁺ concentration in the cytoplasm and seawater are 65 mM and 420 mM, respectively, while for *K*⁺ its is 340 mM and 10 mM respectively. [Given R = 8.314 J/K.mole; T = 310 K; F = 96500 J/V]
V*_{*Na*⁺} = 49.84*mV*; *V*_{*K*⁺} = −94.2*mV

9. Muscles contain creatine phosphate (CP) as an energy buffer to maintain the levels of ATP during initial stages of exercise. Creatine phosphate can transfer its phosphate to ADP to generate creatine (C) and ATP with a Δ*G*^o of -13.8 kJ/mole. *CP + ADP → C + ATP* Δ*G*^o = −13.8*kJ/mole*

A In a resting muscle, [ATP] = 4 mM, [ADP] = 0.013 mM, [CP] = 25 mM and [C] = 13 mM. What is the Δ*G* for this reaction in resting muscle? Ans = **−0.7172** kJ/mole

B Consider an initial stage in vigorous exercise, when 25% of ATP has been converted to ADP. Assuming no other concentrations have changed, what is the Δ*G* for this reaction at this stage in exercising muscle? Ans = **−12.69** kJ/mole

10. Identify two intermediates each of glycolysis and TCA cycle from the list below:
glyceraldehyde-3-phosphate; aspartate; succinyl CoA; oxaloacetate; glutamate; 3-phosphoglycerate

Glycolysis
glyceraldehyde-3-phosphate
3-phosphoglycerate

TCA cycle
oxaloacetate
succinyl CoA

Section B

(1 × 10 = 10 marks)

11. The Thompson seedless grape is triploid, with three copies of each chromosome. Which phase of the cell division would you expect triploid cells to be unable to complete.

(A) Meiosis I

(B) S phase

(C) **Meiosis II**

12. A molecular genetics lab is given a tooth from the skull of a man suspected to be the Czar of Russia and is asked to prepare a sample of a small portion of the Y chromosome from the DNA that is, hopefully preserved in the central tissue of the tooth. Which technique would the scientists use to produce millions of copies of this specific segment of DNA?

(A) Agarose Gel Electrophoresis

(B) **Polymerase Chain Reaction (PCR)**

(C) Recombinant DNA

(D) Mitosis

13. DNA replication is described as semi-conservative because:

(A) Half of the DNA is replicated in each cell cycle.

(B) Half of the DNA molecule is destroyed during replication.

(C) **Each new DNA molecule contains half of the original molecule.**

14. The diploid human genome comprises 6.4×10^9 base pairs and fits into a nucleus that is $6 \mu\text{m}$ in diameter. If base pairs occur at intervals of 0.34 nm along the DNA helix, what is the length of DNA in a human cell?

- (A) 6.4 m (B) **2.2 m** (C) $6 \mu\text{m}$

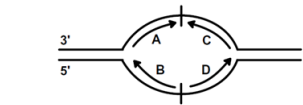
15. If the eukaryotic chromosome of 150 Mb in length had a single replication origin located in the middle of the chromosome which has no centromere and the replication proceeds at about 150 nucleotides per second:

- (A) DNA replication will stall (B) The cells will lose nucleotide during each round of replication
(C) **The newly replicated chromosome cannot separate properly during mitosis**

16. Choose the primer sequence which will allow you to amplify the following DNA sequence by PCR.
5'AGGTCTAGTAACGGTACTAGTACGCG.....CGTAGCTTGGACGTCGTAGTAGCTAA 3'

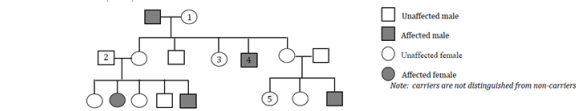
- (A) 5'-AGGTCTAGTAACGGTA-3' (B) 5'-AATCGATGATGCTGCA-3'
(C) **5'-TTAGCTACTACGACGT-3'**

17. Which of the arrows in the diagram best represent the direction of lagging strand DNA synthesis?



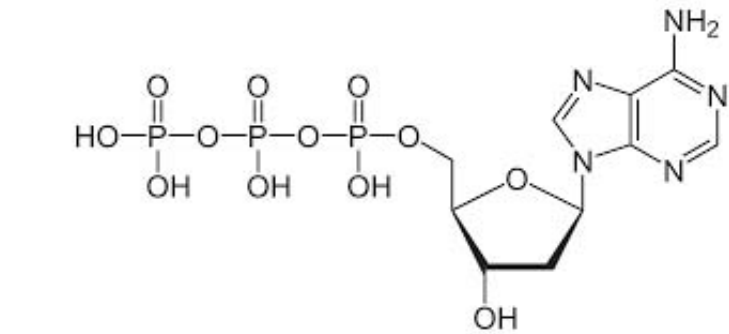
- (A) A and C (B) **C and D** (C) A and D

18. You are studying a genetically inherited trait. The family pedigree for this trait is shown below. This trait shows complete penetrance and expressivity and no new mutations were encountered.



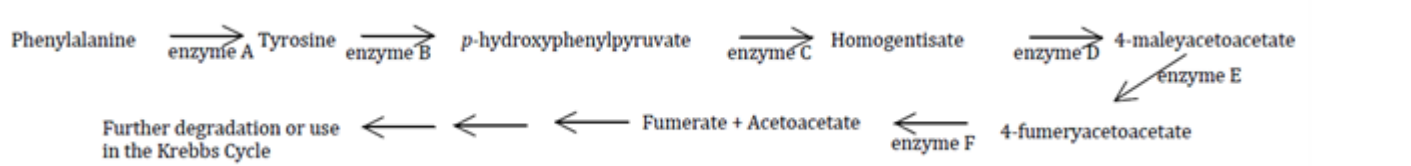
Is the trait inherited in an autosomal dominant fashion? Write Yes or NO
NO (*Autosomal recessive inheritance*)

19. Write the molecular structure of deoxyadenosine triphosphate.



20. Phenylketonuria (PKU) is an autosomal recessive disorder with a mutation in enzyme A (non functional enzyme A) and alkaptonuria (ALP) is also an autosomal recessive disorder with a mutation in enzyme D (non functional enzyme D). The pathway for breakdown of Phenylalanine is shown below. A woman

with PKU who is also a carrier for ALP marries a man with ALP who is also a carrier for PKU.



- (i) What are the chances that their child will appear phenotypically normal? Write the percentage.
25% (*Because both traits are recessive.*)
(ii) What are the chances that their child will show both the PKU and the ALP phenotype? Write the percentage.
0%. (*Although 25% will have the genotype, these children will show only the PKU phenotype because the PKU phenotype is epistatic to the ALP phenotype.*)

Section C ($1 \times 10 = 10 \text{ marks}$)

21. Arrange the following in the order of complexity (less to high): Pine tree; Mango tree; Green algae; Blue-green algae; Ferns; Mosses;

Ans: Blue-green algae, Green algae, Mosses, Ferns, Pine tree, Mango tree

22. Arrange the following phylum into vertebrates and invertebrates: Annelida; Cnidaria; Echinodermata; Nematoda; Platyhelminthes; Arthropoda; Chordata; Porifera; Mollusca;

Vertebrates

Echinodermata

Chordata

Invertebrates

Annelida, Cnidaria, Arthropoda

Nematoda, Platyhelminthes, Porifera, Mollusca

23. Lichen is the association between **Algae** and **Fungus**

24. Arrange the following phases of Prophase-1 of Meiosis-1 in sequence (from first to last): Zygotene; Leptotene; Diakinesis; Diplotene; Pachytene; **Ans: Leptotene, Zygotene, Pachytene, Diplotene and Diakinesis**

25. The anti-coagulant present in leech is **Hirudin**

26. Chromoplast, Chloroplast and Leukoplast are the different types of plastids present in plants. How they are different in color and function?

Chromoplast: Yellow, orange, or red; gives color to flowers and fruits which helps in pollination by attracting pollinating agents like insects and birds
Choloroplast: Green; Helps in photosynthesis

Leukoplast: Colourless; acts as storage for food in the form of carbohydrates, fats and proteins

27. What is the difference between constitutive chromatin and facultative chromatin?

Constitutive chromatin: always inactive and condensed: e.g. repetitive DNA, centromeric DNA
Facultative chromatin: Can be inactive and sometimes active

28. The histone protein that is absent in a nucleosome is **H1**

29. The check point of cell cycle which prevents the initiation of mitosis until DNA replication is completed is known as **G2 check point**

30. Which cell organelle is known as the power house of a cell? **Mitochondria**

Extra space for writing solutions. Please mention the question number

Q. No.	1	2	3	4	5	6	7	8	9	10					Sec A total
Marks															
Q. No.	11	12	13	14	15	16	17	18	19	20					Sec B total
Marks															
Q. No.	21	22	23	24	25	26	27	28	29	30					Sec C total
Marks															

Grand Total (out of 40 marks) =

Name of Student:

Signature of student:

Signature of Invigilator: