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Indian Institute of Science Education and Research (IISER) Kolkata
LS-1101 (Introductory Biology-I) End Semester Examination
(Total Marks-50) Duration: 3 Hours

Section A

Make the correct selection of the multiple-choice answers by writing ONLY the corresponding letter in your answer script (25)

1. The correct order for formation of molecules on primitive earth is likely to be 1
(a) NH₃, nucleic acid, protein and carbohydrate
(b) protein, carbohydrate, water and nucleic acid
(c) NH₃, protein, carbohydrate and nucleic acid
(d) NH₃, water, nucleic acid and protein.
2. The earliest self-replicating units are believed to be 1
a) double stranded RNA c) double stranded DNA
b) single stranded RNA d) single stranded DNA
3. Which of the following are not part of Darwin's theory to explain origin and evolution of species? 1
a) competition c) selection through survival of the fittest
b) variation d) genetic recombination
4. The following organelles in eukaryotic cells are devoid of DNA 1
a) mitochondria c) golgi apparatus
b) nucleus d) nucleus
5. The _____ checks, makes necessary modifications, packages, and secretes proteins. 1
a) mitochondria c) golgi apparatus/bodies
b) cell membrane d) endoplasmic reticulum
6. You are given the sequence of a double strand of DNA below. Answer the following questions using the information given in the sequence and the codon table 2
5'-ACTGTTACATGCTCGAAACGCTTTGACCCACC-3'
3'-TGACAATGTACGAGCTTTGCGAAACTGGGTGG-5'
A. What will be the correct sequence of the mRNA produced from this DNA?
a. 5'- UGACAAUGUACGAGCUUUGCGAAACUGGGUGG-3'
b. 5'-UCTGTTUCUTGCTCGUUUCGCUUUGUCCCUCC-3'
c. 5'-TGUCUUTGTUCGUGCTTTGCGUUUCTGGGTGG-3'
d. 5'-ACUGUUACAUGCUCGAAACGCUUUGACCCACC-3'

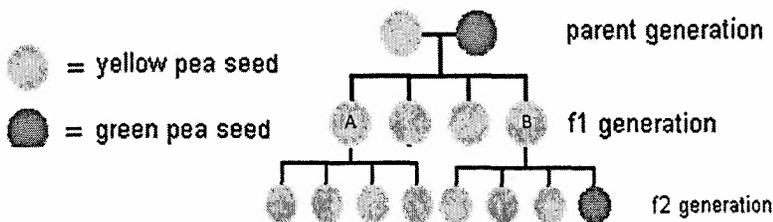
B. What will be the correct sequence of the polypeptide synthesized from this sequence?

- a. Thr-Val-Thr-Cys-Ser-Lys-Arg-Phe-Asp-Pro
- b. Met-Leu-His-Ala-Arg-Asn-Leu-Thr-His
- c. Met-Leu-Glu-Thr-Leu
- c. Cys-Tyr-Met-Leu-Glu-Thr-Leu

GCA	AGA									
GCC	AGG									
GCG	CGA									
GCU	CGC	GAC	AAC	UGC	GAA	CAA	GGA	CAC	AUA	
	CGU	GAU	AAU	UGU	GAG	CAG	GGC	CAU	AUC	
							GGU		AUU	
Ala	Arg	Asp	Asn	Cys	Glu	Gln	Gly	His	Ile	
A	R	D	N	C	E	Q	G	H	I	
UUA						AGC				
UUG						AGU				
CUA				CCA	UCA	ACA			GUA	
CUC				CCC	UCC	ACC			GUC	UAA
CUG	AAA		UUC	CCG	UCG	ACG		UAC	GUG	UAG
CUU	AAG	AUG	UUU	CCU	UCU	ACU	UGG	UAU	GUU	UGA
Leu	Lys	Met	Phe	Pro	Ser	Thr	Trp	Tyr	Val	stop
L	K	M	F	P	S	T	W	Y	V	

Figure 6-50. Molecular Biology of the Cell, 4th Edition.

7. If you keep DNA and RNA in a solution of pH 8, which will degrade faster and why? 1
- a. DNA, because of presence of 2' H
 - b. RNA, because of presence of 2'OH
 - c. DNA, because of presence of thymine
 - d. RNA, because of presence of uracil
8. You have analyzed a DNA molecule and it shows the presence of 10% A, 30% T, 20% G and 40% C. What is your opinion about the structure of the DNA molecule? 1
- a. It is single stranded
 - b. It is double stranded
 - c. It is degraded
 - d. It is not DNA but RNA
9. If you are starving for many days, what biomolecule will your body be using as the source of energy? 1
- a. Carbohydrate
 - b. Lipid
 - c. Protein
 - d. Nucleic acids
10. In the Mendelian cross between pea plants bearing yellow and green seeds, all plants in the f1 generation produced yellow seeds. However when two plants of the f1 generation were crossed with themselves, one (A) gave all yellow seeds, whereas the other (B) gave yellow and green seeds in 3:1 ratio. Why? 1



- a. A is homozygous
- b. B is homozygous

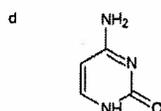
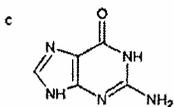
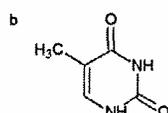
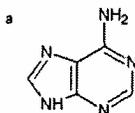
c. A is heterozygous

d. B is dominant over A

11. With which of the following organisms did Thomas Hunt Morgan do his pathbreaking experiments on chromosomal basis of inheritance? 1
- a. pea plants
 - b. bacteria
 - c. fruit flies
 - d. mice
12. When a scientist tried to repeat Mendel's experiments of crossing of two pea plants, one with yellow seeds and purple flowers, and the other with green seeds and white flowers, they found that in the progeny plants, there were many more of the plants with yellow seeds and purple flowers and green seeds and white flowers, than plants with yellow seeds and white flowers and green seeds and purple flowers. They already knew that yellow seeds were dominant over white, and purple flowers were dominant over white. The reason for their observation was later found out to be: 1
- a. The genes for yellow seeds and green seeds were present on the same chromosome
 - b. The genes for yellow seeds and purple flowers were present on the same chromosome
 - c. The genes for white flowers and purple flowers were present on the same chromosome
 - d. There was no dominant-recessive relationship between the genes
13. In the process of DNA replication which of the following chemical reactions occur? 1
- a. Nucleophilic attack by 3'-OH of the primer strand on the 5'-phosphate of incoming dNTP
 - b. Nucleophilic attack by 5'-phosphate of the primer strand on the 3'-OH of the incoming dNTP
 - c. Nucleophilic attack by the 5'-phosphate of the incoming dNTP on the 3'OH of the primer strand
 - d. Nucleophilic attack by the 3'-OH of the incoming dNTP on the 5'-phosphate of the primer strand
14. During Griffith's experiments with *Streptococcus pneumoniae* infection in mice, material from _____ bacteria transformed _____ bacteria, showing that a chemical substance from one cell can genetically transform another cell. 1
- a. living virulent, dead non-virulent
 - b. living non-virulent, dead virulent
 - c. dead virulent, living non-virulent
 - d. dead non-virulent, living virulent
15. Which technique was most useful for Watson and Crick to develop their double helical model of DNA? 1
- a. Density gradient ultracentrifugation
 - b. Random mutagenesis
 - c. Transgenic animals
 - d. X-ray crystallography

16. The backbone of a DNA strand is composed of: 1
- covalent bonds between carbon atoms in deoxyribose molecules
 - covalent bonds between nitrogen atoms in the nucleotide bases
 - carbon-phosphate bonds between deoxyribose molecules
 - carbon-phosphate bonds between nucleotide bases
17. Of the three major types of RNA in the cell, translation requires: 1
- messenger RNA
 - transfer RNA
 - ribosomal RNA
 - All of the above
18. In the Messelson-Stahl experiment, after growing *E. coli* for two rounds in presence of N^{14} after first growing them for several rounds in N^{15} , and density-gradient ultracentrifugation, two DNA bands were observed. One band was of low density (contained only N^{14}) whereas one was of intermediate density (contained both N^{14} and N^{15}). This suggested that: 1
- The low density band only contained parental DNA strands
 - The intermediate density band contained only parental DNA strands
 - The low density band contained only parental DNA strands but the intermediate density band contained both parental and daughter DNA strands
 - Both the bands contained parental and daughter DNA strands
19. Extracellular proteins like elastin and secreted proteins like insulin have disulphide bonds between Cys residues, but proteins present in the cell cytoplasm do not. Why do you think this happens? 1
- The cell cytoplasm is oxidizing
 - The cell cytoplasm is reducing
 - The extracellular fluid is oxidizing
 - The extracellular fluid is reducing
20. Which of the following processes show that RNA can function both as a molecule that contains genetic information and as an enzyme 1
- Replication
 - Transcription
 - Translation
 - Metabolism
21. In the four DNA bases shown in the adjacent picture, which two will form 3 hydrogen bonds? 1

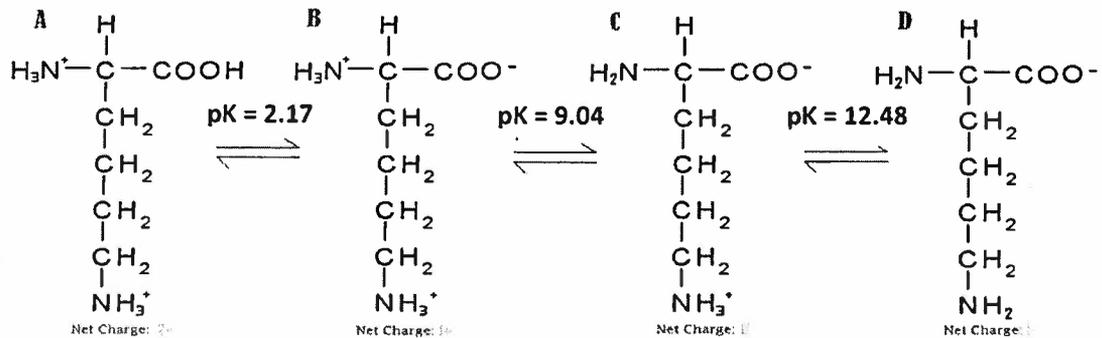
Four DNA Bases



- a and b
- b and c
- c and d
- d and a

22. What will be the pI of the amino acid lysine based on the following diagram?

1



- a. 9.04
- b. 5.61
- c. 7.33
- d. 10.76

23. Alpha helices in proteins are stabilized by bonds between side chains of amino acids. Which of the following amino acids would you NOT expect to find in alpha helices?

1

- a. Alanine
- b. Proline
- c. Leucine
- d. Lysine

24. What type of amino acids would be present on the outside surface of proteins which are embedded within a lipid bilayer?

1

- a. Basic
- b. Acidic
- c. Polar
- d. Non-polar

Section B

PART 1- Answer ANY THREE of the following questions briefly

(5 x 3 = 15)

1. The information for the correct folded structure of a protein is present in its amino acid sequence. However, according to the Levinthal paradox (Levinthal, 1968), the time it would take for an unfolded protein of 100 amino acids to fold into its correct conformation would be more than the age of the universe, if the protein had to test each possible conformation allowed by the primary sequence of amino acids. Yet, proteins fold correctly in the order of milliseconds. How do you suppose proteins manage to fold correctly so quickly?
2. Why is ATP the major "activated energy carrier molecule" in the cell? (Hint: think in term of energetics). Write the equation for the hydrolysis of ATP. It is seen that if ATP synthesis in cell is stopped, for

example in a person with cyanide poisoning, ATP hydrolysis stops very soon afterwards and the cell dies, even though there is ATP remaining in the cell. Why does this happen? (Hint: The free energy change on hydrolysis of a molecule is given by $\Delta G = -RT \ln [B][C]/[A]$ when the hydrolysis reaction is written as $A \rightarrow B + C$)

3. In cells, vesicles bound with lipid bilayers (often carrying proteins) bud off from the endoplasmic reticulum and Golgi complex and fuse finally with the cell membrane in an outward flow, whereas similar vesicles pinch off from the cell membrane and flow inward and fuse with the endoplasmic reticulum. In a non-dividing cell such as a liver cell, the outward flow of lipid bilayer vesicles is exactly balanced by the inward flow of vesicles. However, in a rapidly-dividing cells like epithelial cells, there is an imbalance in favour of the outward flow. Why?
4. You are a scientist who is trying to find out what is the nature of the molecule(s) that acts as the "translator", that connects the information encoded in DNA with that encoded in proteins. You have devised a reaction system where you can add DNA, and all the components of the cell, and make protein based on the sequence of the DNA. You can treat this reaction mixture with various enzymes to determine which molecules from the cellular components allows the conversion of the information encoded in the DNA to the protein. What will you use to treat this reaction mixture and what are your expected observations?

PART 2- Answer any two of the following questions, in brief.

(2 x 2 = 4)

1. During the voyage of the Beagle, Darwin observed that there were different, apparently related, species of finches on the different islands of the Galapagos chain. He developed his theory of speciation based on extensive observations on the variety of organisms existing in these islands. What, according to him, were the two broad ways by which speciation could have taken place?
2. After Aristotle's time, the theory of spontaneous generation was generally accepted for nearly 2 thousand years. This idea was questioned and disproved only in the last couple of centuries. What do you think were the major discoveries/inventions that helped scientists and thinkers to change their idea of how life originates?
3. Predation pressure is a major driving force for evolution of a variety of adaptive mechanisms among prey species, to avoid being eaten. What is Crypsis? How is it different from Mimicry? Explain with a few examples.

Answer any two questions given below.

(3 x 2 = 6)

4. Self-replication is considered as one of the basic prerequisites for life. What kind of self-replicating molecule/s do you think originated earliest on earth? What are its properties likely to have been in order to eventually evolve into the more complex genetic material carried by eukaryotes?
5. Outline briefly the main evidences for evolution of life that support our current understanding of how species evolved. Out of these, what kinds of evidences led Darwin to derive his theory of evolution?
6. The cytoskeleton constitutes a major part of the cytoplasm in all kinds of cells. What are the main kinds of cytoskeletal structures? What are the major roles of these structures within the cell?