



Department of Biotechnology
Indian Institute of Technology (IIT) Guwahati, Guwahati 781039
Mid semester Examination
BT 101 Modern Biology

Date: Feb. 21, 2013, Time: 2.00-4.00 PM, Max. Marks: 40

Answer all questions. Please answer all parts of one question in continuity.

1. Fill in the blanks

0.5 Mark x 10 = 5 Marks

- i) The five kingdoms of life are prokaryotes, eukaryotes, fungi, plant and animal.
- ii) Spirogyra is a eukaryotic autotroph belonging to kingdom plantae.
- iii) 70s ribosomes are composed of 30S + 50S subunits whereas 80s ribosomes are composed of 60S + 20S.
- iv) Spores in bacteria are formed under unfavourable conditions.
- v) Growth curve of bacteria consists of lag phase, log phase, stationary and death phase.
- vi) Ribosomes are synthesized in the ribosome.
- vii) Endoplasmic reticulum is in continuation with the nucleus.
- viii) The inner membrane of mitochondria forms finger like projections called cristae.
- ix) Red blood cells lack nucleus.
- x) Chloroplasts are the photosynthetic units of a plant cell.

2. Match the following

1 Mark x 5 = 5 Marks

- | A | B |
|---------------------|--|
| I) Rough ER | - a. double membrane organelle ② |
| II) Smooth ER | - b. cellulose, hemicelluloses and pectin ④ |
| III) Lysosomes | - c. synthesis of fatty acids and phospholipids. ③ |
| IV) Plant cell wall | - d. single membrane organelle ① |
| V) Nucleus | - e. protein synthesis ⑤ |

3. I) A mannose 6 phosphate linked protein will have the following pathway
Ribosome, rough ER, golgi apparatus, secretory vesicle

1 Mark x 2 = 2 Marks

- II) Respiration in a eukaryotic cell takes the following path

Glycolysis in cytosol, TCA cycle in mitochondrial matrix, Electron Transport chain in inner mitochondrial membrane.

State True or False

0.5 Mark x 6 = 3 Marks

- a) Mushroom and bread mold are thallophytes. ✓
- b) Mushroom and bread mold have saprophytic mode of nutrition. ✓
- c) Sponges belong to Phylum porifera of the animal kingdom. ✓
- d) Arthropoda is the largest phylum of animal kingdom. ✓
- e) Octopus is an arthropod. ✗
- f) Banana plant is a monocot. ✗

4. I) A culture with 4000 cells in it is going through exponential decline at a rate of 50% die-off per minute. After three minutes, how many viable cells will be there? **1.5 Marks**
- II) A bacterial cell increases from one cell to 256 cells in 10 hours. What is the generation time- (doubling time) of this organism? **1.5 Marks**
- III) You have a culture in exponential phase with 190 cells in it. The culture goes through 3 generations. How many cells are now in the culture? **2.0 Marks**

5. A human erythrocyte has about 2×10^5 AQP-1 monomers. If water molecules flow through the plasma membrane at a rate of 5×10^8 per AQP-1 tetramer per second, and the volume of an erythrocyte is 5×10^{-11} ml, how rapidly could an erythrocyte halve its volume as it encountered the high osmolarity (1 M) in the interstitial fluid of the renal medulla? Assume that the erythrocyte consists entirely of water and $[H_2O] = 55 M$. **4 Marks**

6. Calculate the actual free energy of hydrolysis of ATP in human erythrocytes. The standard free energy of hydrolysis of ATP is -32.5 kJ/mol , and the concentrations (mM) of ATP, ADP, and P_i are 2.25, 0.25 and 1.65, respectively. Assume that the pH is 7.0 and temperature is 37°C (body temperature). **3 Marks**

7. Electron transfer in the mitochondrial respiratory chain may be represented by the net reaction equation. $\text{NADH} + \text{H}^+ + \frac{1}{2} \text{O}_2 \rightleftharpoons \text{H}_2\text{O} + \text{NAD}^+$. E° for $(\frac{1}{2}) \text{O}_2/\text{H}_2\text{O}$ is 0.816 V and E° for NAD^+/NADH is 0.320 V **3 Marks**

- a) Calculate ΔE° for the net reaction of mitochondrial electron transfer?
 b) Calculate ΔG° for this reaction.
 c) How many ATP molecules can *theoretically* be generated by this reaction if the free energy of ATP synthesis under cellular conditions is 52 kJ/mol ?

8. The enzymes listed below are involved in DNA replication. Match each with its function. **4 Marks**

- | | |
|-------------------|--|
| I) DNA polymerase | a. breaks hydrogen bonds between bases |
| II) ligase | b. breaks phosphodiester bonds between DNA nucleotides |
| III) primase | c. makes phosphodiester bonds between RNA nucleotides |
| IV) helicase | d. joins Okazaki fragments together |
| | e. creates a replication origin |
| | f. removes the RNA primers |
| | g. synthesizes most of the DNA strand |
| | h. twists two DNA strand into a helical form |

9. DNA polymerase moves a distance of about 272 nm per second on a DNA template during replication? Calculate how many nucleotides per second are added? **2 Marks**

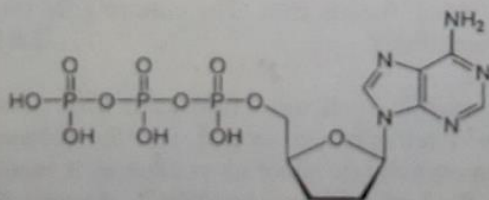
10. The base composition of one of the strands of a DNA (in molar fraction units) is $[\text{A}] = 0.25$ and $[\text{G}] = 0.31$. (a) What one can say about the composition of $[\text{T}]$ and $[\text{C}]$ for the same strand? (b) What one can say about the composition of $[\text{T}]$ and $[\text{C}]$ for the complementary strand? **2 Marks**

11. Shown below are two DNA molecules that are partially single-stranded and partially double-stranded. We put these two DNA molecules in a test tube with DNA polymerase and nucleotides and allow a little time for a reaction to happen. **2 Marks**

5' GGATCCTTAT
TAGGAATATTG

5' CTAGTACTGGTGC
GAAGATCATGACCA

- (a) If a reaction happens, add bases to the above molecule(s) to show the product(s)
 (b) Below is the structure of a dideoxy nucleotide, which as you can see resembles a normal DNA nucleotide except that it has no $-\text{OH}$ group on its $3'$ carbon.



If all the deoxy nucleotides are replaced by dideoxy nucleotides, how many nucleotides will be added to the DNA molecules shown above?