BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI (RAJ.)

First Semester 2017-2018

Date: 13-Oct-2017	**BIO F111 General Biology**	Max. Marks: 45 (22.5%)
Type: Closed book	**Mid-semester Test Answers**	Duration: 1½ hours

1. **a.** Eubacteria – prokaryotic; cell wall made of peptidoglycan; unicellular/single circular chromosome. Any common bacterial species can be named – e.g., *E. coli*, cyanobacteria, *M. tuberculosis*, *Lactobacillus* **[1]**

b. Plantae – autotrophic; cell wall made of cellulose; sessile; large central vacuole in cells/ absence of centrosomes/multicellular. Examples – rice, fern, cones, moss **[1]**

c. Fungi – all are heterotrophs (several are saprophytes); cell wall made of chitin; almost all are multicellular. Examples – bread mold, mushroom, yeast **[1]**

2.

a. Because II-4 shows the disease, he has to have at least one copy of the dominant allele *D*. Because the genotype of his father (I-1) is *dd* (healthy), II-4 would have inherited one healthy allele from him. Hence, the genotype of II-4 is ***Dd***. **[1]**

b. Genotypes of IV-3 and IV-4 are *Dd* and *dd* respectively. In a cross of *Dd* x *dd*, 50% of the progeny will be *Dd*, showing the trait. Hence, the probability is: **½**. **[2]**

3.

a. GALT enzyme metabolizes galactose. **[1]**

b.

i. P[obtaining *gg* from *Gg* x *Gg*] = ¼, and P[healthy child, i.e., *G_* from *Gg* x *Gg*] = ¾. Hence the P[first 2 children have galactosemia, and next 2 are healthy] = ¼ x ¼ x ¾ x ¾ = $\boxed{9/256}$. **[1]**

ii. P[girl child] = ½, and P[galactosemic child] = ¼. Hence, P[getting one galactosemic girl] = ½ x ¼ = 1/8. Non-identical twins result when two independent fertilization events occur at the same time. Hence, P[both of the twins will be girls who have galactosemia] = 1/8 x 1/8 = $\boxed{1/64}$. **[2]**

4.

a. (i) In the thylakoids (inner membrane of the chloroplast) **[½]**

(ii) Photons of sunlight excite electrons from the chlorophyll that <u>move</u> down an electron transport chain, thereby producing "current". **[½]**

b. Oxygen and sugar produced in photosynthesis are required to sustain life. **[½]** Oxygen is evolved during light-dependent reactions, while sugar is produced in the Calvin cycle. **[½]**

c. [*Students should draw a schematic encompassing these points.*] Glucose is broken down into 2 pyruvate molecules in glycolysis (that takes place in the cytoplasm), with the production of ATP (by substrate-level phosphorylation) and NADH.

Pyruvate gets converted into acetyl CoA, and enters into the citric acid cycle (within the stroma of the mitochondrion), giving out ATP (substrate-level phosphorylation), reduced electron carriers and CO_2.

The reduced electron carriers deposit their electrons in the mitochondrial ETS (located in the inner membrane). The energy of the electrons is used to produce several ATPs by chemiosmosis. Together, this is oxidative phosphorylation. **[2]**

5.

a. Since (I) has 6 chromosomes, and (II) also has 6, 2N=6. **[1½]**

b. (I) is anaphase-I (meiosis), since homologous chromosomes are getting separated. **[½]**

(II) is mitotic anaphase, since 6 sister chromatid pairs are being separated. **[½]**

(III) is anaphase-II (meiosis), since haploid number of chromosomes is moving toward opposite poles. **[½]**

6.

a. There are two arrangements possible, with homologous chromosomes shown paired up at the metaphase plate. **[2]**

b. Since loci *G* and *H* are linked (located on the same chromosome), they may not assort independently. However, locus *I* assorts independently of the other two loci. **[1]**

c. 2N=4 for this cell. Hence, in G2 phase the genetic content has doubled, and the cell will contain 8 dsDNA molecules (each one called a chromatid). **[1]**

7. **[9]**

a.

i. Mutations or improper attachment of spindle fibers during anaphase.

ii. In case of mutations – cell can fix the mutation, or kill the cell if the mutation is not fixed, or if the checkpoints have failed, allow the cell to proceed in the cell cycle. In case of non-attachment of spindle fibers, cell can correct it, or let it proceed with improper attachment of spindle fibers.

iii. Uncorrected mutations may lead to cancer; uncorrected spindle attachment may lead to non-disjunction (which may cause aneuplodies).

b. Liver contributes to body homeostasis by (<u>any three points</u> can be written):

(i) <u>Detoxifying toxic substances</u> that have entered the blood circulation

(ii) Playing a role in glucose metabolism by storing excess glucose as <u>glycogen</u>

(iii) Playing an important role in fat digestion by <u>secreting bile salts and bile juice</u> that aids in fat emulsification.

(iv) Manufacturing several lipids (such as cholesterol and triglycerides) and proteins (such as albumins) required for the body.

c. Mistakes have been underlined – "*The fluid portion of the plasma that filters out from <u>Bowman's capsule</u> into the <u>glomerulus</u> is called the glomerular filtrate and contains urea, water, glucose, <u>proteins</u>, creatinine, <u>platelets</u> and salts.*"

Explanation: Glomerular filtrate is the fluid portion of the plasma that filters out from the glomerulus into the Bowman's capsule. Proteins and platelets are not filtered into the nephron owing to their large size.

8. **[15]**

a. Both proteins and carbohydrates are biopolymers whose monomers are linked through covalent bonds that are not affected by slight variations in pH and temperature. However, while carbohydrates are functional in their polymeric state, proteins are

functional only when their polymeric chains acquire higher order folding (such are tertiary and quaternary), due to forces such as ionic bridges, hydrophobic interactions and hydrogen bonding. Such forces are affected by even slight changes in pH or temperature, and hence these tertiary and quaternary structures are destabilized. Hence, a protein may lose its functionality.

b. (i) Cholesterol is a precursor to the steroid hormones e.g., testosterone and estradiol.

(ii) It is an important constituent of cell membranes, playing a role in regulating membrane fluidity.

c. The two protein-mediated membrane transport mechanisms are facilitated diffusion and active transport. Difference between the two (any one can be written): (i) while the former is passive (not involving ATP expenditure), the latter involves energy expense. (ii) While facilitated diffusion moves substances down the concentration gradient, active transport moves molecules up the concentration gradient.

d. Both the mitochondrion and the IC engine are similar in the following ways: (i) both burn fuel in the presence of oxygen; (ii) both perform processes that yield energy (derived from the bond energy of the fuel molecule) which is used to perform work; (iii) both release CO_2 as the byproduct. *[Students can write any two points.]*

Working of the mitochondrion and the IC engine differ in terms of the output in the following ways: (a) while the energy from the burned fuel is released immediately as heat in the case of IC engine, in the case of the mitochondrion, bond energy of glucose is stored as ATP; (b) IC engine converts chemical energy (fuel) ultimately into mechanical work. In the mitochondrion, chemical energy (glucose) is converted into another form of usable chemical energy (ATP). (c) The IC engine produces carbon monoxide due to incomplete combustion of fuel, whereas no such product is released in the case of mitochondrial oxidation of glucose. *[Students can write any two points.]*

e. (i) The environment, and (ii) epigenetics are two factors that affect whether a gene's effect is manifested or not. Environmental triggers (e.g., temperature or presence of testosterone) will influence the gene's expression (e.g., gender of the offspring, baldness gene's effect). Though twins have identical genetic composition, they may differ in their epigenetic controls, thereby resulting in different set of genes being expressed in one individual versus another.