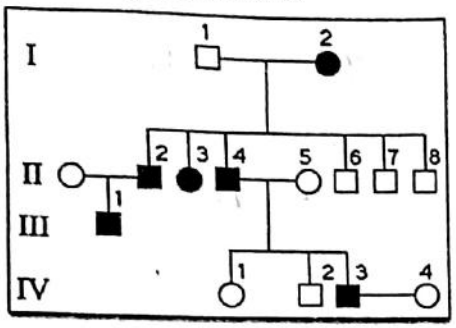
BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI (RAJ.)
First Semester 2017-2018

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

There are eight questions (with sub-parts) printed on both sides of this sheet. Answer all parts of the same question together; if you jumble the order, your answers may not be evaluated.

1. For each of the following three kingdoms, (i) list three unique features that are typical characteristics of it, and (ii) name one specific organism that belongs to it. You don't have to elaborate on any feature. **a.** Eubacteria **b.** Plantae **c.** Fungi **[3]**

2. The following questions are in connection with the pedigree chart shown below for a family, some of whose members exhibit the dominant trait, *D*. Affected individuals are indicated by a dark square or circle.



a. What is the genotype of individual II-4? Explain briefly. **[1]**

b. What is the likelihood that the progeny of IV-3 and IV-4 will have the trait? Show how you arrived at the answer. **[2]**

3. A patient with classic galactosemia (a rare recessive disorder) carries deleterious mutations in both copies of their gene (alleles represented as **G** and ***g***) for producing the enzyme GALT so that their blood shows essentially no detectable residual GALT activity. This leads to accumulation of galactose sugar in their cells and tissues, a situation that is potentially lethal, if left untreated.

a. What do you think is the function of GALT? **[1]**

b. Consider a couple that are carriers for this trait.

i. If they have four children, what is the probability that the first two will have galactosemia, and the second two will not? Show your calculations. **[1]**

ii. The woman is pregnant with twins. If she has fraternal (non-identical) twins, what is the probability that both of the twins will be girls who have galactosemia? Show how you arrived at the answer. **[2]**

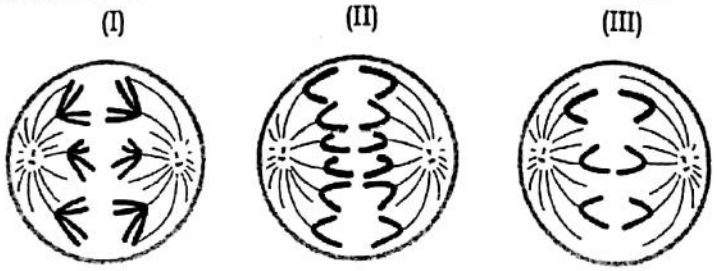
4. Albert Szent-Györgi, a pioneer in early photosynthesis research, stated, "What drives life is a little electric current kept up by the sunshine".

a. (i) In which compartment of the chloroplast, and (ii) how is electric current produced by sunshine? **[1]**

b. What products of photosynthesis are required to sustain life, and which reactions of photosynthesis are they produced in? **[1]**

c. How do living organisms use these products of photosynthesis to make ATPs that are essential for the cell? Represent your answer as a flow diagram, clearly stating the major steps, and where each step occurs, output at each step. Also incorporate the two distinct mechanisms of ATP production. *Please do not write an essay!* **[2]**

5. All of the following cells, shown in various stages of mitosis and meiosis, come from the same rare species of plant.



   a. What is the diploid chromosome number of this plant species? Explain. [1½]

   b. Which stage of mitosis/meiosis is represented by panel I, II and III? Explain briefly. [1½]

6. A cell has two pairs of chromosomes, which we shall designate as 1_M, 1_P, 2_M, and 2_P (the subscripts $_M$ and $_P$ indicate maternal and paternal). Chromosome 1 contains two loci – genes ***G*** and ***H*** located on either side of the centromere, whereas chromosome 2 has gene ***I*** located near one end of the chromosome. All paternal chromosomes carry the dominant alleles at these three loci, whereas the maternal homologs carry the recessive counterparts.

   a. Draw a diagram to show <u>any one arrangement</u> of these chromosomes in metaphase-I of meiosis, making an assumption that <u>no crossing over</u> had taken place. You should clearly label the alleles, centromere and the maternal and paternal homologs. [2]

   b. What can you say about the assortment of these three loci with respect to each other? State the rationale too. [1]

   c. How many double-stranded DNA molecules were present when this cell was in G2 phase? Justify. [1]

7. *Provide brief answers to the next <u>three</u> questions:* [9]

   a. Errors can occur during both types of cell division – mitosis and meiosis.

      i. What kind of errors can occur during each of these cell division types?

      ii. What are the ways in which the cell can respond to errors?

      iii. What would be the possible consequences of these errors?

   b. State three ways in which the liver contributes to body homeostasis. (Don't elaborate.)

   c. Identify and correct the mistakes in this statement, offering a brief justification where necessary: *"The fluid portion of the plasma that filters out from Bowman's capsule into the glomerulus is called the glomerular filtrate and contains urea, water, glucose, proteins, creatinine, platelets and salts."*

8. *Provide to-the-point answers to the next <u>five</u> questions:* [15]

   a. Why can the function of proteins be affected more than that of carbohydrates when conditions such as pH and temperature are even slightly varied?

   b. Cholesterol is ill reputed for its contribution to the development of cardiovascular disease. Can you state two reasons why it is necessary for us to consume cholesterol at all?

   c. Mention the membrane transport mechanisms that are protein-mediated. How are they different from each other?

   d. How is the working of the mitochondrion similar to that of an internal combustion (IC) engine? In what ways are the two different in terms of the output they produce?

   e. "An organism's phenotype is not determined by its genotype exclusively." Explain this statement giving two lines of evidence.