Exam Date & Time: 09-Sep-2019 (10:30 AM - 11:30 AM)

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

BIOLOGY FOR ENGINEERS

Biology for Engineers [BIO 1051 - 2018 -CHM]

Marks: 15 **Duration: 60 mins.**

MCQ

Answer all the questions.

Section Duration: 20 mins

1) Which of the following regarding Mendel cross are logical?

1. Mendel selected only those characters which are easily distinguishable
2. Mendel selected seven characters, because he was knowing that the factors responsible for them are located on seven different chromosomes
3. Pea plant is of a better experimental choice because they have many distinguishable characters which are easy to handle for experiments
4. Pea plants have separate male and female flowers
5. Pea plant do not have a male or female specific organs

(0.5)

1) All the above 2) Only 1 and 3 3) Only 2 and 4 4) 1, 2 and 3

Correct option is: 2

2) What is the reason that Gecko can climb the wall, but humans can't ? Select the best answer

1) Gecko's foot has several hair like structures called setae. This provide a sufficiently large surface area in close contact with the substratum enabling simultaneous occurrence of Van der Walls interaction. While humans don't have similar structures for maximum surface area contact

2) The weight of Gecko is very less compared to that of a human. Further Gecko's foot has suction cup like structures which produces a strong suction force. This is sufficient to hold its weight.Our hand do not have a suction cup mechanism or glands for producing the gum

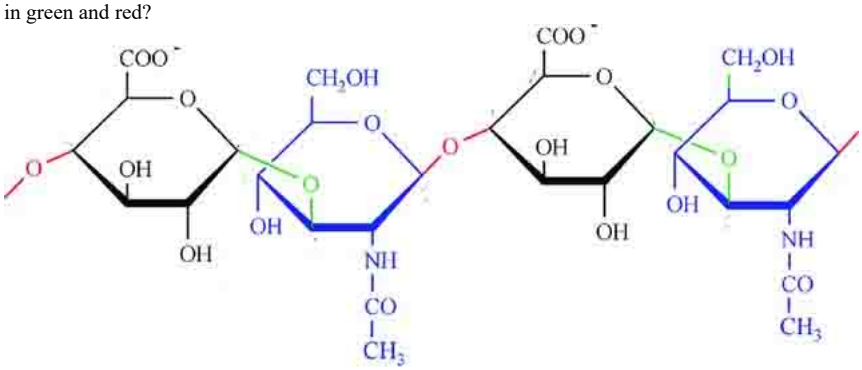
3) Weight to Volume ratio of human is less than that of Gecko. Further centre of gravity of Gecko is close to the ground unlike humans.

4) Polar sticky secretions from the Gecko foot creates hydrogen bonding at multiple positions. This enables Gecko to hold. Further Gecko is having a flat body compared to us making it easier to climb walls.

(0.5)

Correct option is: 1

3) Given below is the structure of hyaluronan. Analyze the structure and identify the linkages highlighted in green and red?



(0.5)

1) Green: **B**eta 1,3 peptide linkage Red :Alpha 1,6 peptide linkage

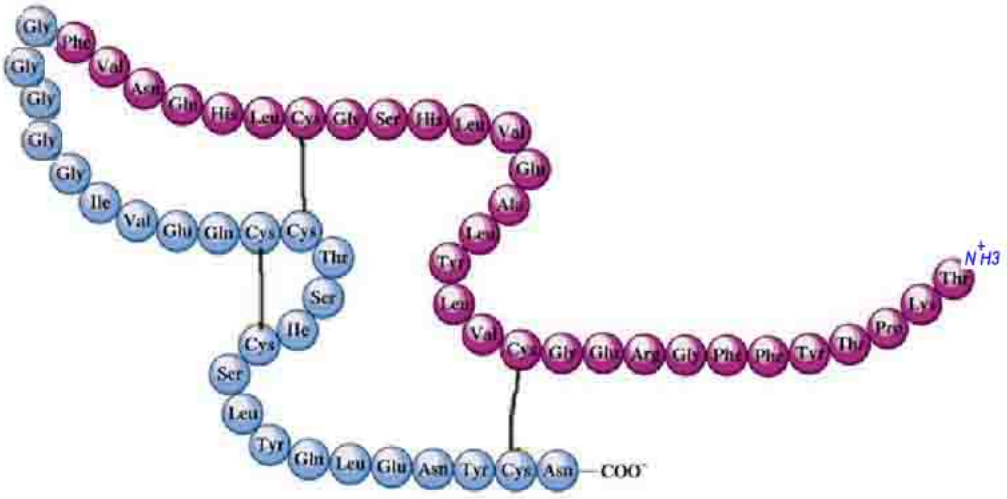
2) Green: Alpha 1,3 glycoidic linkage Red :Beta 1,4 glycosidic linkage

3) Green: Beta1,3 glycoidic linkage Red :Beta 1,4 glycosidic linkage

4) Green: Beta 1,4 glycoidic linkage Red Alpha 1,3 glycosidic linkage

Correct option is: 3

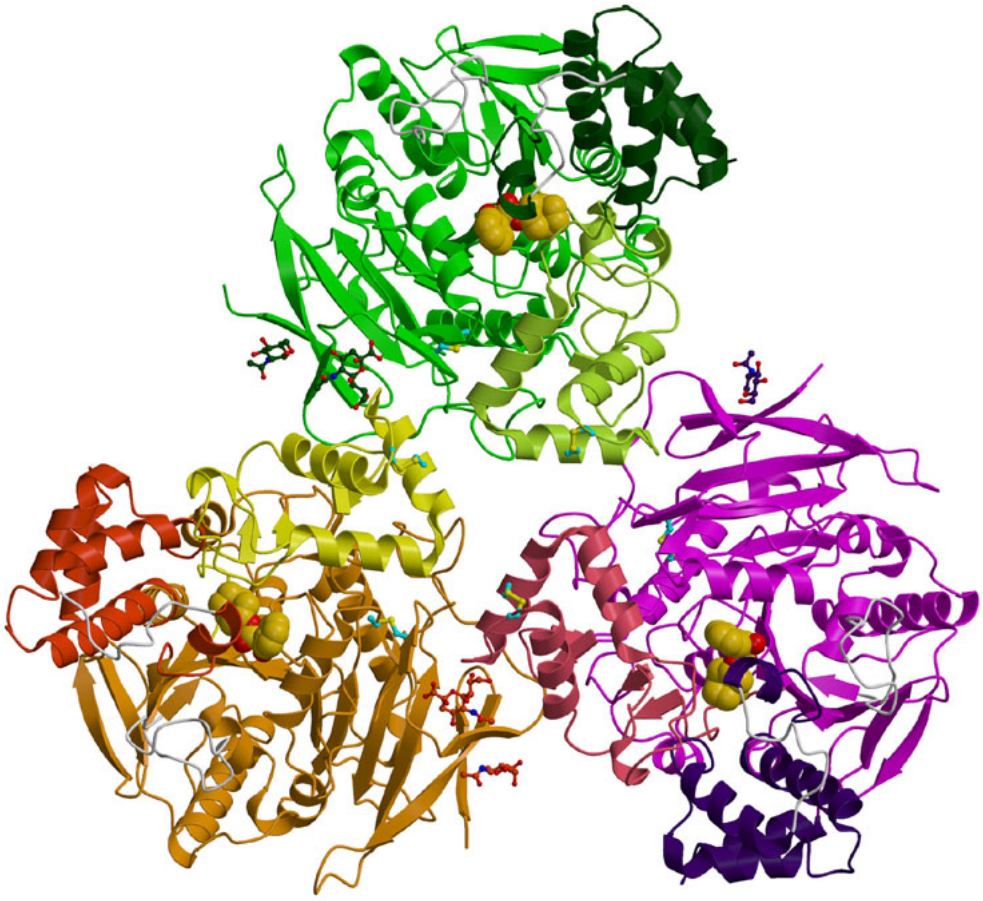
4) A project team from MIT, Manipal as discovered an enzyme that will break the linkages illustrated as black lines in the following protein. Which level of protein structure is mostly affected by this enzyme? (0.5)



1) Primary structure 2) Secondary structure 3) Tertiary structure 4) Quaternary structure

Correct option is: 3

5) Given below is the illustration explaining the structure of the protein. Here 55% of isolecuine molecules are replaced with methionine. Which of the following will be the logical outcome? (0.5)



1) The enzyme 2) The enzyme will still 3) The enzyme will work with 4) The enzyme will not

will not work as the primary structure changes	work, but with less efficiency as the position of the carbon atom changes	better efficiency as the carbon atoms are less in methioine and this will bring the substrate more closer	work as methionine is non-polar and is lighter while isolecuine is hydrophilic and heavier

Correct option is: 2

6) Most of the scientists predict silicon based alien life forms. Other than silicon based life forms, **among the following** which element can be the best potential candidate for life forms in a planet in whcih all elements are equally abundant?

1) Sodium 2) Aluminium 3) Boron 4) Polonium (0.5)

Correct option is: 3

7) In a typical Morgan experiment, when a white eyed female Drosophila was crossed with a red eyed male Drosophila, all the male offprings were white eyed, but all the female offsprings were red eyed. Select the possible reasons for this
(1) Factor for eye color is located on X chromosome
(2) Y chromosome contains the factor for eye color
(3) Red is dominant over white eye color
(4) Heterozygous female is white colored
(5) There are two factors for eye color, one sits on autosomes while other is on X chromosomes (0.5)

1) (1), (3) and (5) 2) (1) and (3) 3) (2) and (4) 4) All except 4

Correct option is: 2

8) Assume that in humans dimple is caused by a dominant sex-linked gene. A man with dimple marries a woman with dimple (Givent that the father of the man is dimple less) Therefore,

1) 50% probability for their daughter to have dimple	2) all of their daughters will have dimple	3) all of their children will have dimple	4) All of their sons will have dimple

(0.5)

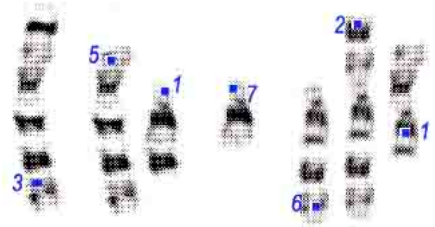
Correct option is: 2

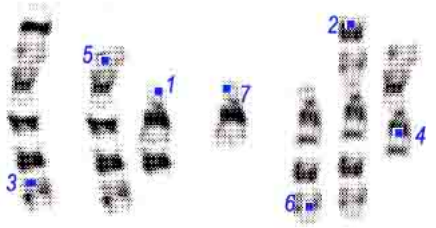
9) Which one of the following concepts can be concluded from the algorithm of Mendelian cross?
1. We can make plants pure breeding (true breeding) through the process of continuous selfing
2. For each character, there is a dominant factor and a recessive factor
3. A factor can be located either on an autosome or on a sex chromosome
4. The concept of the outcomes of a coin toss can be correlated with mendelian factors
5. There can be five modes of inheritance, ie autosomal dominant, autosomal recessive, X linked dominant and X linked recessive
6. It is possible to find the genotype of unknown by crossing it with a dominant parent (0.5)

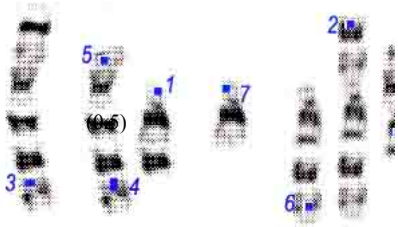
1) All except 6 2) 1,2 and 5 3) All except 3 4) 1,2 and 4

Correct option is: 4

10) Given below is an illustration of 7 chromosomes of pea plant and the possible location of 7 mendelian factors. Which of the following explain the correct logical location of these factors?

1) 

2) 

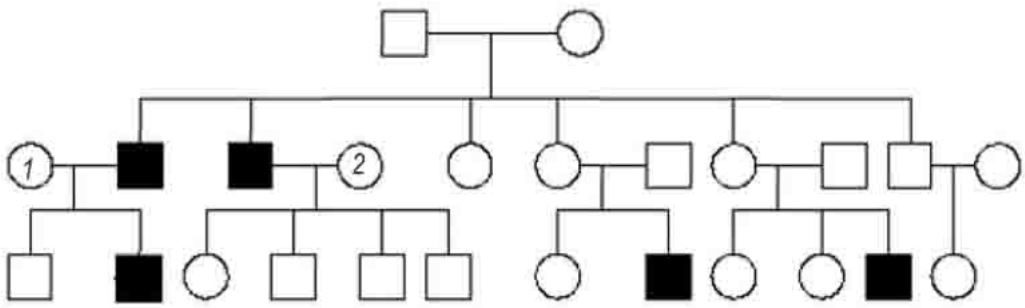
3) 

Correct option is: 2

DESCRIPTIVE

Answer all the questions. Section Duration: 40 mins

11) (2)

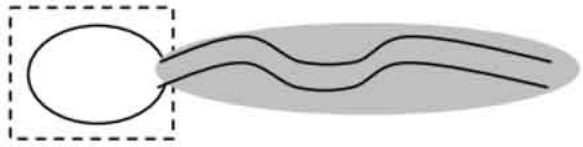


Analyze the pedigree chart above and answer the following
(a) What is the **most probable** mode of inheritance? (0.5 Marks)
(b) What is the genotype of **individual 1** ? (0.5Mark)
(c) What is the reason that only males are affected in this family? (0.5 Mark)
(d) What will be the genotype if a female has to be affected? (0.5 Mark)

12) (A) Red-green color blindness is caused by a sex-linked recessive allele. A color-blind man marries a woman with normal vision whose father was color-blind.
(i) What is the probability that they will have a color-blind daughter? (0.5 Mark)
(ii) What is the probability that their first son will be color-blind? (0.5 Mark) (2)

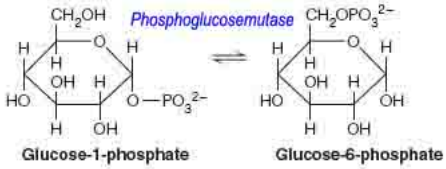
(B) Construct a model of alpha helix and beta pleated sheet of proteins illustrating the interactions that **makes these structures different** (1 Mark)

13) Given below is an illustration of a phospholipid. Analyze the structure and answer the following questions



(i) Assume that , Chandrayaan -2 has discovered a lot of liquid water and some life forms on the dark side of the moon. Construct model for the cell boundary for these living forms using the phospholipid molecules illustrated above (0.5 mark) (2)
(ii) Moon has formed out of the debris left over from a collision between Earth and an astronomical body the size of Mars. Based on these fact, what will be the element most suitable for life forms on lunar surface? Justify (0.5 Mark)
(iii) How could ammonia equate to liquid water inside an ice-covered moon in one of the chillier neighborhoods of our solar system? Justify (0.5 Mark)
(iv) Does their cell membrane design will be a problem for their survival on earth? Justify (0.5 Mark)

14) Analyze the following reaction



The equilibirum concentrations are: (2)

Glucose-1-phosphate	glucose-6-phosphate
4.5×10^{-3} M	9.6×10^{-2} M

Calculate K'_{eq} and $\Delta G^{o'}$ for this reaction at 25 °C.

Value of R = 0.00831447 kJ/mol/K

15) In an experiment you crossed a strain of a plant having (double heterozygous) yellow seeds and round shape with a homozygous recessive strain having green and wrinkled seeds. The results are (Yellow and round are dominant)
Yellow round : 320
Yellow wrinkled : 25
Green round: 25
Green wrinkled: 70 (2)
a) Construct the punnett square illustrating this cross (0.5 Mark)
b) What is the reason for deviation from Mendelian outcome? Justify your reasoning (0.5 Mark)
c) Calculate recombination frequency (0.5 Mark)
d) What is the distance between factors responsible for seed color and seed shape in cM? (0.5 Mark)

-----End-----

Q No. 11

(a) What is the **most probable** mode of inheritance? (0.5 Marks)
(b) What is the genotype of **individual 1** ? (0.5Mark)
(c) What is the reason that only males are affected in this family? (0.5 Mark)
(d) What will be the genotype if a female has to be affected? (0.5 Mark)

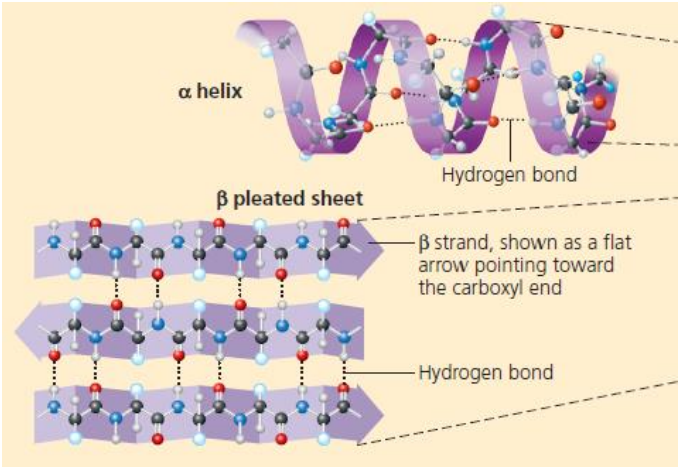
(a) X linked recessive
(b) X^AX^a
(c) Males have only one X chromosome, therefore even if male carries a recessive factor on X chromosome, it will express
(d) X^aX^a

Q no 12

(A) Genotype of color blind man = X^aY; genotype of women must be heterozygous for color blind since her father is color blind ie X^AX^a

(i) What is the probability that they will have a color-blind daughter? (0.5 Mark)
(ii) What is the probability that their first son will be color-blind? (0.5 Mark)

(i) X^AX^a -- X^aY → X^AX^a , X^aX^a (in case of daughter) ie 50% probability
(ii) X^AX^a -- X^aY → → X^AY , X^aY (in the case of son). Here also 50% probability since mother is heterozygous

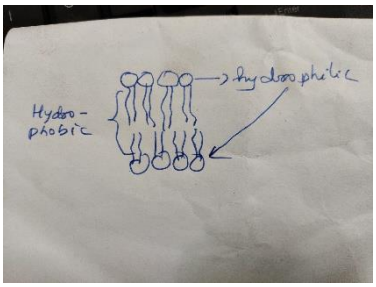
(B) 

(The model must show the difference in the arrangement of hydrogen bonds)

Q No. 13

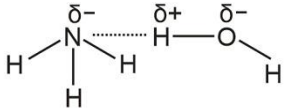
(i) Assume that , Chandrayaan -2 has discovered a lot of liquid water and some life forms on the dark side of the moon. Construct model for the cell boundary for these living forms using the phospholipid molecules illustrated above (0.5 mark)
(ii) Moon has formed out of the debris left over from a collision between Earth and an astronomical body the size of Mars. Based on these fact, what will be the element most suitable for life forms on lunar surface? Justify (0.5 Mark)
(iii) How could ammonia equate to liquid water inside an ice-covered moon in one of the chillier neighborhoods of our solar system? Justify (0.5 Mark)
(iv) Does their cell membrane design will be a problem for their survival on earth? Justify (0.5 Mark)

(i) Water means hydrophilic environment, hence the life forms there will have similar boundary of earth life forms ie



(ii) Since moon is faced in collision with earth as per the statement, moon will also have similar elements on earth. Therefore we can predict that it must be based on carbon

(iii) Hydrogen bonding as illustrated below



Intermolecular hydorgen bonding between water and ammonia molecules

(iv) Earth is hydrophilic, hence will have similar cell membrane design as that of the anticipated environment in moon. Hence survival is possible

Q No, 14

Given

Value of R = 0.00831447 kJ/mol/K

Ie 8.315 J/mol/K

$$Keq = \frac{[Glc\text{-}6\text{-}P]}{[Glc\text{-}1\text{-}P]} = \frac{9.6\ 10^{-2}}{4.5\ 10^{-3}} = 21.3$$

$$\Delta G^{o\prime} = -RT \ln K'_{eq} \qquad R=8.315\ J/mol^{o}K \quad T=298^{o}K$$

$$\Delta G^{o\prime} = -8.315\ (298) \ln 21$$
$$= -7.5\ kJ/mol$$

Qno. 15

Yellow round : 320
Yellow wrinkled : 25
Green round: 25
Green wrinkled: 70
a) Construct the punnett square illustrating this cross (0.5 Mark)
b) What is the reason for deviation from Mendelian outcome? Justify your reasoning (0.5 Mark)
c) Calculate recombination frequency (0.5 Mark)
d) What is the distance between factors responsible for seed color and seed shape in cM? (0.5 Mark)

(a) YyRr X yyrr

Ie

	YR	Yr	yR	yr
yr	YyRr Yellow Round	Yyrr Yellow wrinkled	yyRr Green round	Yyrr Green wrinkled

(b) Factors are located on same chromosome or factors are linked

(c) Recombinants = 25+25= 50 Total sample size = 440

Hence recombination frequency = Recombinants/n = 50/440 = 0.11 or 11%

(d) Distance between factors will be 11 cM since recombination frequency is 0.11 (11%).