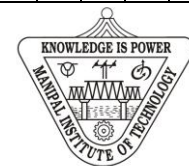# Manipal Institute of Technology, Manipal

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II SEMESTER B.TECH END SEMESTER EXAMINATIONS, JAN-MAY 2016
SUBJECT: BIOLOGY FOR ENGINEERS [BIO 1001]
REVISED CREDIT SYSTEM

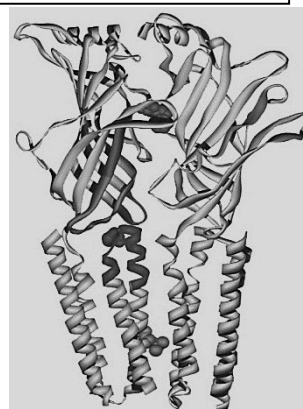Time: 3 Hours   MAX. MARKS: 50
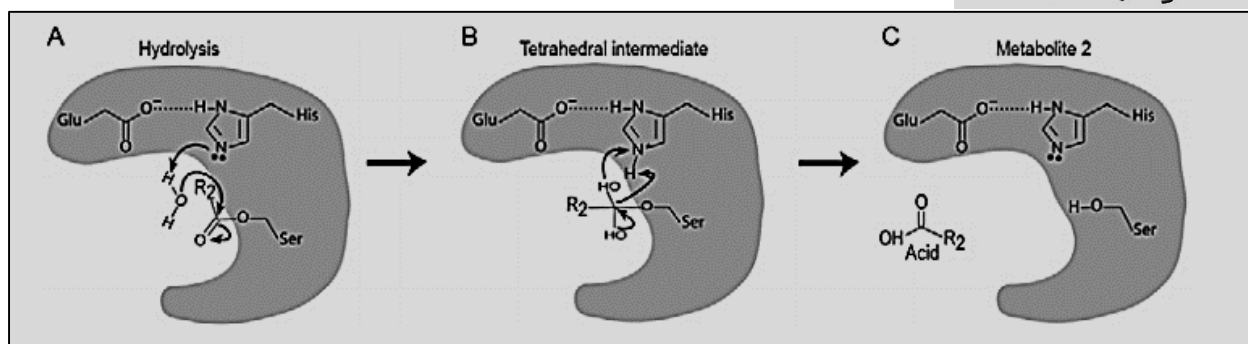
Instructions to Candidates:
- ❖ Answer **ALL** the questions.
- ❖ Missing data may be suitable assumed.

1A. Given is the representation of a transmembrane protein. If only the alpha helices are embedded in the membrane, calculate the thickness of the membrane. (Note: One turn= 5.4 A^O)   **2**


1B.   **2**

Carboxylesters are cleaved by carboxylesterases via the addition of water to form an alcohol and an acid metabolite. The image represents the concluding steps in the hydrolysis reaction of a hypothetical carboxylester, leading to the formation of an acid metabolite. Observe the image and answer the following questions:

(a) If water molecule is omitted from this reaction, what will be the effect on the reaction? Explain.
(b) If histidine is substituted by (a)lysine or (b)phenylalanine, which would reduce the efficiency of the reaction?

1C   **2**
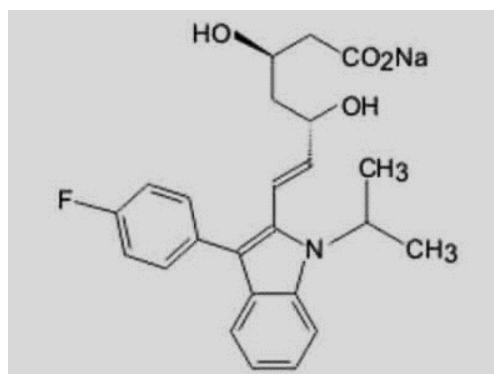
Given here is the structure of a fluvastatin drug molecule. Answer the following questions, with valid explanations:

(a)   Is the drug soluble in water?
(b)   Can it form ionic bonds?
(c)   Can it form covalent bonds?
(d)   Whether the drug is lipophilic?

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1C. Consider the following reaction, and determine the tricks utilized by the system, to allow each step of the reaction to proceed in the forward direction. The step numbers are written on each arrow. **2**

$$A \xrightarrow{1} B \xrightarrow{2} C \xrightarrow{3} D \xrightarrow{4} E$$
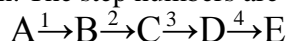
ΔG value for step 1= 20 kJ/mol; for step 2= -1.35 kJ/mol; for step 3= 2.57 kJ/mol; for step 4= -10.67 kJ/mol.

1E

Cationic liposomes are structures that are made of positively charged lipids and are increasingly being researched for use in gene therapy. After adding liposomes to DNA, what kind of interaction and result can be expected in a neutral pH condition? **2**
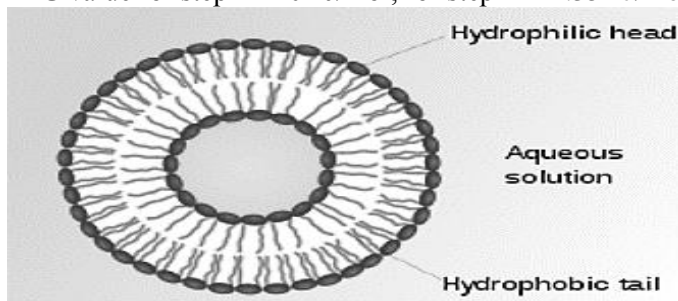
2A

Observe the given pedigree chart and answer the following questions: **3**
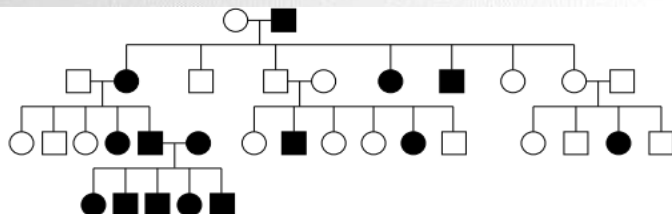
(a)   What is the most probable mode of inheritance? Justify.

(b)   There are 4 generations seen in the given chart. What is the genotype of affected and unaffected daughters of generation 2 and 3?

(c) If the affected female from generation 3 marries an unaffected male what will be the genotype of the child?

2B Determine the sequence of genes along a chromosome based on the following recombination frequencies A-B 8cM, A-C 28cM, A-D 25cM, B-C 20cM, B-D 33cM. Select from the following options and justify your selection with valid calculations: (a) A_B_C_D; (b) C_B_D_A; (c) D_A_B_C; (d) D_B_A_C **2**

2C

Mice	Injected bacteria	Result
1	Live smooth	Dead
2	Live rough	Survives
3	Heat killed smooth	Survives
4	Heat killed smooth+live rough	Dead

Griffith performed a series of experiments using mice and two strains of pneumococcus bacteria: a virulent encapsulated strain called as 'smooth strain' and a nonvirulent unencapsulated strain called as 'rough strain'. Four **2**

different groups of mice were injected with different combinations of bacterial strains. The results of the experiment are given in the table.

(a) If Griffith has injected a fifth group of mice with a combination of heat-killed rough strain and heat-killed smooth strain, would the mice have died? Justify your answer.

(b) If a sixth group of mice is injected with a combination of live smooth strain and heat killed rough strain, will the mice survive? Justify your answers.

2D A boy is color-blind, although neither of his parents have the condition. Color-blindness is an X-linked recessive trait. If his parents have a daughter, what is the probability that she will be color-blind? **1**

(a) 100%; (b)50%; (c)75%; (d)0%; (e)25%

2E A particular genetic condition in a mammalian species causes an inability to digest starch. Both males and females are equally affected with this disorder. Frequently, the disorder appears in an offspring, even if both the parents are unaffected. **2**

 (a) Describe the most probable pattern of inheritance for this condition. Explain your reasoning.

 (b) Include in your discussion a sample cross(es) sufficient to verify your proposed pattern.

3A The following is a small stretch of normal gene sequence for the beta chain of hemoglobin. **2**

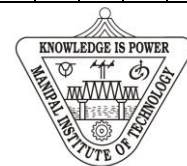5' ATG GTG CAC CTC ACT CCT GAG GAG AAG TCT GCC GTT ACT GCC CTG TAA 3'

A mutation event results into changes of this normal gene sequence resulting in faulty mRNA production. Answer the following questions:

(a)   Construct the labelled mature mRNA encoded by normal gene sequence.

(b)   If the protein sequence encoded by the mutated gene is as follows, determine the effect of the

mutation event on normal protein synthesis.

N terminus Met-Gly-Val-His-Leu-Thr-Pro-Glu-Ala-Val-Asp-Glu-Lys-Ser-Ala-Val-Thr-Ala-Leu C terminus

3B If a molecule of DNA containing radioactively labelled sugar molecules is used as a template for replication and transcription processes, what percentage of the DNA strands will remain radioactive after 3 generations of replication cycles? Also, comment on what percentage of RNA molecules will be radioactive? **2**

3C Ms. Aswathi got a 1 cm long double stranded DNA fragment. Experimental analysis finds that it contains 20% adenine. Based on this information, calculate the number of cytosine residues in 1 cm of DNA and also calculate the number of cytosine bases in 1 cm stretch of DNA. Note: 3.4 A^O is the distance between two bases. 1 cm = 100000000 A^O **2**

3D Identify the defective protein that would case this problem with valid explanation: RNA bases are found in newly replicated DNA. **2**
(a)DNA Polymerase III; (b) Primase; (c) DNA Polymerase I; (d) DNA Ligase

3E Replacement of an A by a T in a region of the human gene for the β chain of hemoglobin is associated with sickle-cell anemia (given in Bold). Gene sequence for first 10 amino acids of β chain of hemoglobin is given using the sequence answer the following question. **2**
Normal: 5′-ATGGTGCACCTGACTCCTG**A**GGAGAAGTCT-3′
Sickle cell: 5′-ATGGTGCACCTGACTCCTG**T**GGAGAAGTCT-3′
(a) What is the labelled amino acid sequence in this part of the β polypeptide chain, and what is the amino acid replacement that results in sickle-cell hemoglobin?
(b) Why might this amino acid substitution make a difference in protein structure?

4A Arrange in the correct order of the hierarchical units given below and make a note on the constraints applied at each level. **2**
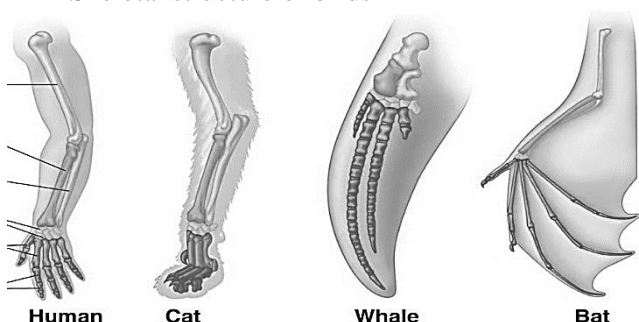Pelican bird, Atoms, Nucleus, DNA, Nervous system, Nerve cell, Nervous tissue

4B Scientists studied the composition of atmosphere on Titan (one of Saturn's moons) and were able to give the following list of substances: Nitrogen, Methane, Argon, Hydrogen and carbon monoxide. Can the Miller's experiment be used to imitate the conditions on Titan, in order to study possibilities of life? Explain. **2**

4C What bioinspiration can be made from the following which can be applied to various areas of engineering? **4**
(a) Touch me not plant; (b) Chitin (compound in exoskeleton of certain animals like crab); (c) Ants; (d) Skeletal structure of birds

4D The figure depicts skeletal structure of forelimbs from different animals. **2**
a) Why is it that the skeletal structure is so drastically different in these animals, even though the skeletal structure indicates that they have evolved from a common ancestor?
b) Can these forms be categorized as incremental changes? Comment on the form and function of these skeletal structures.

5A Antibiotics are highly effective against a wide variety of bacteria. Antibiotics target vital bacterial functions like ability to utilize an energy source (like glucose) or by targeting the bacterial cell wall (to name a few, there are still many activities that an antibiotic can target). Can an antibiotic work against a virus (considering the above mentioned targets)? Explain your answer. **2**

5B A plasmid vector's DNA was subjected to restriction digestion using an array of enzymes. The digested products were assessed for their lengths. The table below depicts the sizes of the products. What is the size of the plasmid vector? **2**

Sr. No.	Restiction Enzyme	Size of fragment in base pairs
1	X and Y	4200, 800
2	Z	3500,1500
3	Z and A	2500, 1500, 1000

5C The ascent of sap in plants occurs in the absence of a pump. Inspired by this, a student designs a building for the water transport. How can you help the student in setting the principles for this design? **2**

5D The codon for Tyrosine is UAC. Name the DNA nucleotide triplet that codes for tyrosine and identify the three mutation events which causes silent mutation, missense and nonsense mutation. **2**

5E An *E.coli* strain produces an ineffective repressor protein. The strain was allowed to grow in a media containing both glucose and lactose. Using a graph, depict the number of bacterial cells versus time. Also, determine the changes that will occur in this graph if the media is continuously replenished with fresh media, after a given time interval. **2**
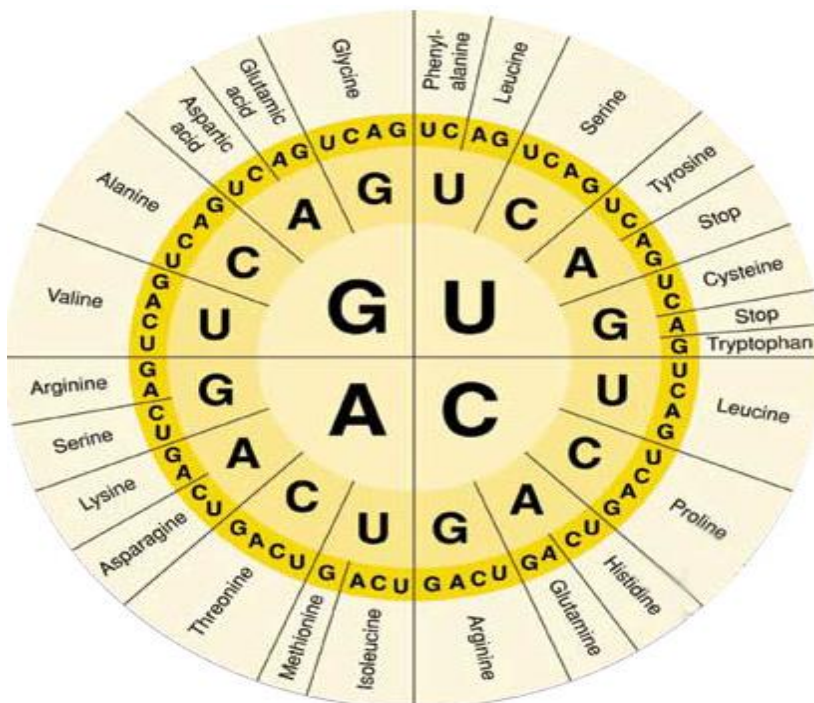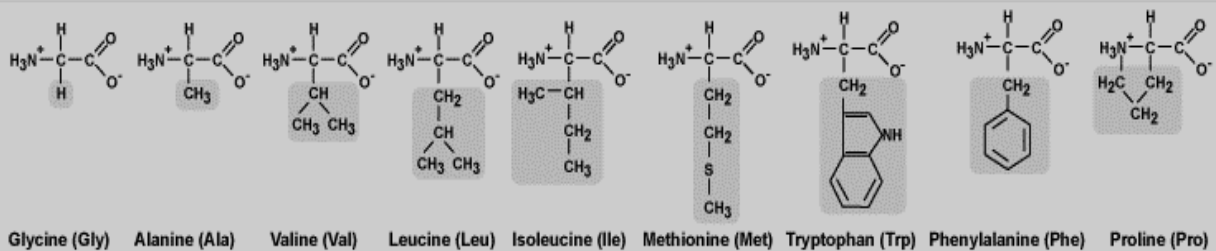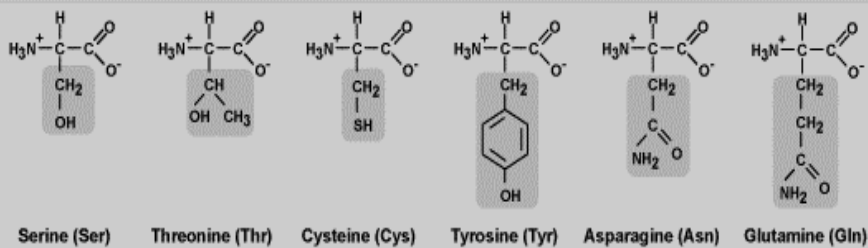
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NONPOLAR

Glycine (Gly)   Alanine (Ala)   Valine (Val)   Leucine (Leu)   Isoleucine (Ile)   Methionine (Met)   Tryptophan (Trp)   Phenylalanine (Phe)   Proline (Pro)

POLAR

Serine (Ser)   Threonine (Thr)   Cysteine (Cys)   Tyrosine (Tyr)   Asparagine (Asn)   Glutamine (Gln)

Electrically Charged

Acidic

Aspartic Acid (Asp)   Glutamic Acid (Glu)   Lysine (Lys)

Basic

Arginine (Arg)   Histidine (His)

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