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Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

I SEMESTER B.TECH END SEMESTER EXAMINATIONS, NOV/DEC 2015

SUBJECT: BIOLOGY FOR ENGINEERS [BIO 1001]

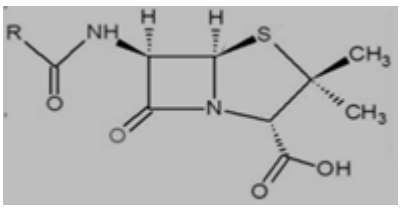
REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.

1A. In 1848, a party led by Sir John Franklin set out on an ill-fated expedition to find the Northwest Passage between the Atlantic and Pacific Oceans. Scientists have now been able to show how the members of the party died. Their method involved analyzing the lead in human remains from the site of their last camp, and comparing it with lead from the soldier used to seal their food containers. This showed that members of the party had absorbed large (and presumably fatal) quantities of lead from their contaminated food. Why did lead even get absorbed by the humans and what is the fate of this absorbed lead in human organs? **1**

1B. 

The diagram depicts the structure of penicillin antibiotic. Observe the structure and answer the following questions: **1**

a) Whether the drug is water soluble? Explain.

b) The mode of action of this antibiotic is through hydrophobic interactions. Determine which part of the drug is responsible for this action.

1C. For the following coupled reaction: **2**

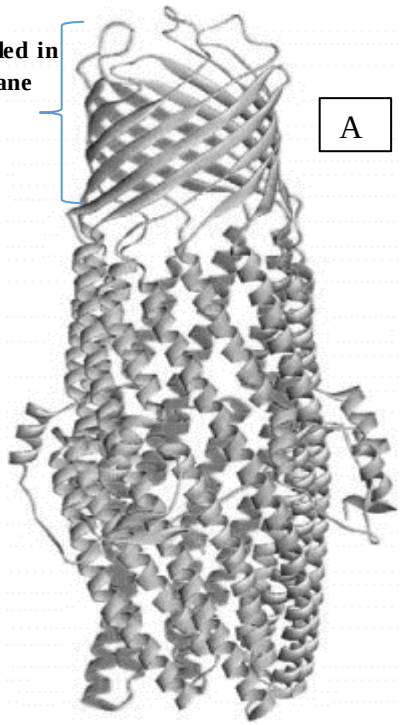
Glucose $+PO_4 \leftrightarrow$ Glucose 6 phosphate$+H_2O$ $\Delta G^O = +11.6$ kJ/mol

$ATP+H_2O \leftrightarrow ADP+PO_4$ $\Delta G^O = -32.5$kJ/mol

(a) Calculate the overall ΔG^O' for this reaction.

(b) In which direction does the reaction proceed? Justify.

1D. The following figure illustrates a transmembrane protein, which interacts with the membrane of a bacterial cell. It helps in the transfer of small molecules across the cells and contributes antibiotic resistance to the bacteria (against hydrophilic drug). Analyze the structure and answer the following questions: **3**



a) Identify the secondary structures observed in this protein.

b) Predict the properties of the amino acids at the inner surface of the protein pore.

c) An amino acid present on the surface of the protein at part A, will be hydrophobic or hydrophilic? Why?

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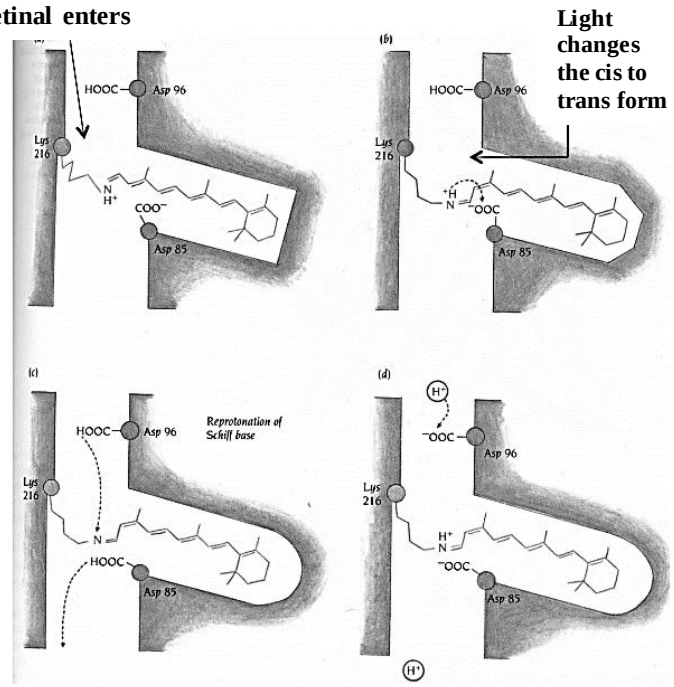
1E. The generation of cis-retinal compound from trans-retinal compound by rhodopsin is used for the pumping of ions across the membrane. The adjoining figure illustrates the mechanism of operation of the ion pump. Analyze the figure and answer the following questions: **3**



(i) What will be the effect on the working of the proton pump, if the Asp96 is substituted by

i. (a) Phenylalanine
ii. (b) Glutamate.

(ii) What will be the effect on protein functioning, if Lys216 is substituted by Histidine?

2A. All of us understand that the information for a trait in eukaryotic biological system is stored in the form of a gene (DNA sequence) at a specific location of a chromosome. Now you have to analyze the pedigree chart illustrated here and answer the following questions **3**

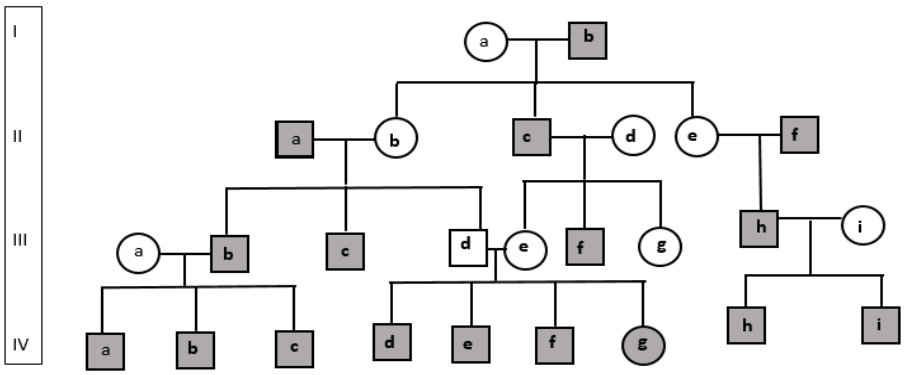
i. Copy the following table and fill appropriately

Trait	Yes/No	Justification
Autosomal dominant		
Autosomal recessive		
X linked dominant		
X linked recessive		
Y linked		

ii. Calculate the highest probability of children affected if IV g marries IV h?

iii. If eldest male is heterozygous, whether the pattern of inheritance remains same or different? Why?

iv. How will you represent the genotype of Ia?



2B. In guinea pig an allele for spotted pattern is dominant for solid color and an allele for short hair is dominant over long hair. A pure breed spotted short haired strain was mated to a solid colored long-haired guinea pig and the F1 animals are then backcrossed to the solid-colored long-haired stock. If the back cross produces 26 spotted long haired, 144 solid long hair, 157 spotted short **3**

Reg. No.										

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haired and 23 solid short-haired. What is the percentage of recombination and the distance between these two genes?

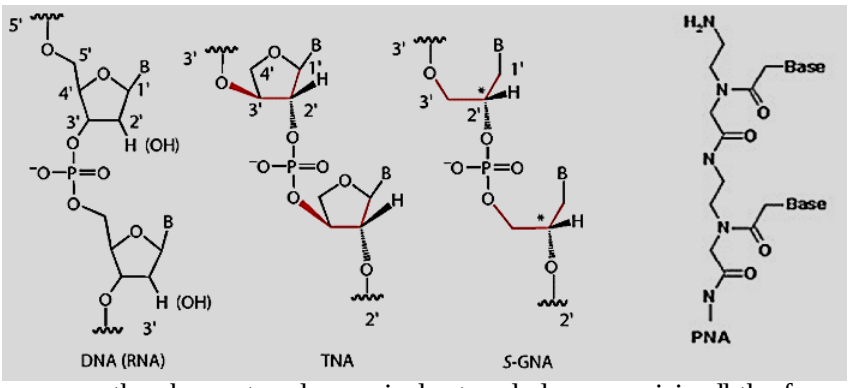
2C. In a typical Mendelian pea plant experiment, a student crossed peas with round, green seeds with peas having wrinkled, yellow seeds. All F1 plants had seeds that were round and yellow. Predict the results of testcrossing these F1 plants. **1**

2D. Mendel chose seven characters for studying the inheritance in pea plants. What was the major reason that, in a dihybrid cross independent assortment was observed by Mendel? **1**

a) Location of plantation
b) Short life span of pea plant
c) Location of alleles for different characteristics on separate chromosomes for pea plant
d) Extreme contrast of selected traits

2E. Mendel discovered that the phenotype of full pods are dominant over constricted pods, while round seeds are dominant over wrinkled seeds. One of his crosses was between full, round plants and constricted, wrinkled plants. From this cross, he obtained an F1 generation that was all full and round. In the F2 generation, Mendel obtained his classic 9:3:3:1 ratio. Using this information, determine the expected F1 and F2 results of a cross between homozygous constricted, round plants and full, wrinkled plants. **2**

3A. The figure below illustrates the three possibilities of genetically coded information, the DNA, PNA (Peptide Nucleic Acid), GNA (Glycol Nucleic Acid) and TNA (Threose Nucleic Acid) **3**

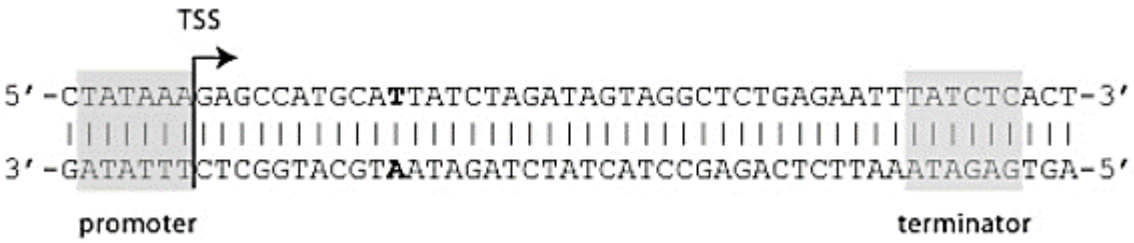


A student has taken 1 ml each of these compounds into different test tubes and added restriction endonuclease. Predict what will happen in each case? (Note: B- Base)

(a) Assuming that the above strands are single stranded, can we join all the fragments to one strand? How?

(b) Can TNA form double strand according to Watson and Crick structure? Explain your answer.

3B. Given is the double-stranded DNA sequence of part of a hypothetical yeast genome, which happens to contain a very small gene. Transcription starts at the Transcription Start Site (TSS) **3**



after the promoter (darkened at the start of sequence), and proceeds in the direction of the arrow. Transcription stops at the end of the Transcription Terminator (darkened at the end of sequence). Analyze the sequence and answer the following question:

a) Write the mRNA sequence and label the 5' and 3' ends.
b) What will be the sequence of the polypeptide chain formed?
c) If the base pair TA (in bold) is deleted, will the resulting protein be affected?

Reg. No.										

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3C. Analyze the following pentapeptide. **2**

Methionine-Cystine-Cystine-Cystine-Methionine

(a) Construct an mRNA sequence for this protein and label 5' and 3' ends.

(b) Construct a dsDNA sequence and label 5' and 3' ends.

(c) What is the probability of a mutation event in the nucleotide sequence that does not change the amino acid sequence on the carboxyl and amino terminus of this protein? Justify your answer.

3D. The prokaryotic genome is circular and eukaryotic genome is linear in nature; in spite of this, eukaryotic and prokaryotic cells follow almost the same procedure for DNA replication. What is the problem faced at the end of replication for a circular DNA and for a linear DNA, and how it is solved? **2**

4A.  An alien life form has been discovered in a distant galaxy with the following structure. Based on your idea in form and function, answer the following questions and justify each of your answers. **3**

(a)What will be the likely gravitational force of the planet? How this creature is adjusted to it?

(b) What will be the surface structure of this alien planet?

(c) What adaptation the alien form can undergo to protect itself from predators?

4B. A group of MIT students are looking for ideas from biology for designing the following: **3**

(a) A wall climbing robot (b) Slow and stable landing system on Mars (c) Shock absorbing structure of length 10cm. How you are going to help them?

4C. The nitrogen fixing bacteria induces root nodules in certain plants and lives in these nodules. What kind of relationship is this? **2**

4D. A group of students designed Miller Urey experiment using a generator power supply only for the vacuum pump. The rest of the instrument used the main power supply. At the beginning of the experiment, there was a power outage, however the group still carried out the experiment. **2**

a) What would be the expected results for this experiment?

b) What are the important biomolecules which are required for life?

5A. In 1918, there was a pandemic flu that killed thousands of people. In 1957, there was another pandemic flu caused by a different flu strain, but it was related to the 1918 strain. You are comparing two people's responses to the 1957 flu. Person 1 had the flu in 1918 and survived. Person 2 was born in 1937. Select all the correct choices and give reasons. **2**

a. Person 1, because they have antibodies to the 1918 flu

b. Person 1, because they have been exposed to similar antigens in the 1918 flu

c. Person 1, because they still have 1918 viral particles

d. Person 2 because the immune response to a novel virus is faster than response to a virus that has mutated from the original

5B. a) The bacterial cells are capable of producing restriction endonucleases which are active against viruses. However, the host genome remains unaffected. Explain. **2**

b) A group of students study bacterial cell's defense against viruses. They are observing two strains of bacteria (A and B) and a bacteriophage infection for this study. The virus first integrates in bacterial genome of bacteria A and even in the presence of the set restriction endonuclease produced by bacteria A, the virus genome is unaffected and is protected like the bacterial genome. The viral progeny produced from infection of bacterial strain A is used to infect strain B. On infection of the bacteria B by the virus, the set of restriction endonuclease produced by bacteria B successfully degrade the virus genome. Analyze the given data and determine the cause for this observed discrepancy.

5C. The trait for sickle cell anemia is represented as's' and the condition is inherited in an autosomal recessive manner. A man and woman living in a tropical area, where malaria is prevalent and healthcare is not accessible, have seven children. The genotypes of these children are ss, Ss, SS, ss, Ss, Ss, and SS. **3**

a) What are the genotypes of both parents?

Reg. No.										

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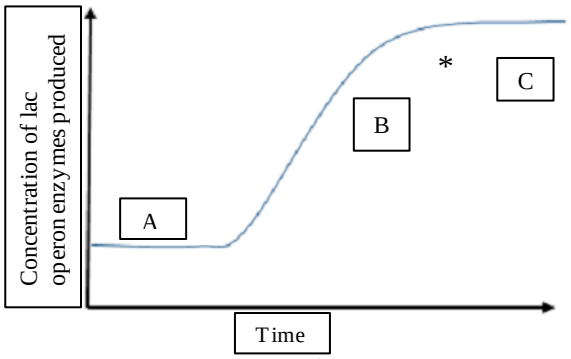
b) What kind(s) of gametes (eggs/sperm) can each parent produce?

c) Which of their children would you expect to be healthy, even after malarial infection?

5D. A group of students studied about regulation of gene expression in *E.coli* cultured in a media containing glucose and lactose. The group focussed on the utilization of glucose and lactose by *E.coli* . A graph is plotted for concentration of enzymes produced by lac operon versus time. **3**



a. Indicate which area in the graph refers to *E.coli* growing in the presence of Glucose.

b. Analyze the graph and explain at what conditions in the changes of the medium the structural genes of lac operon is going to be expressed.

c. Show the graphical representation of what will happen if we add glucose at the point * ?