

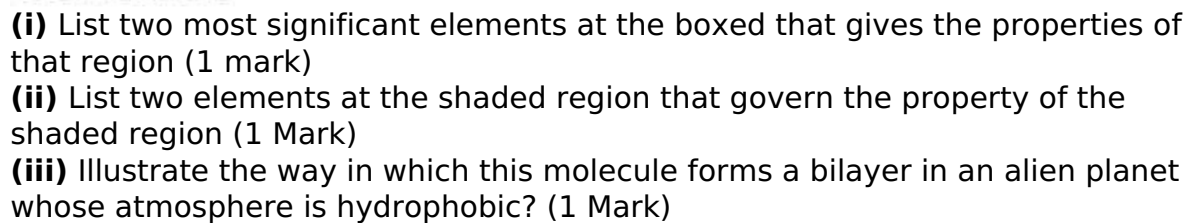
Exam Date & Time: 21-Nov-2018 (08:30 AM - 11:30 AM)

**Marks: 50**

A

Instructions to Candidates: Answer ALL questions Missing data may be suitably assumed

- A)

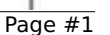


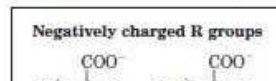
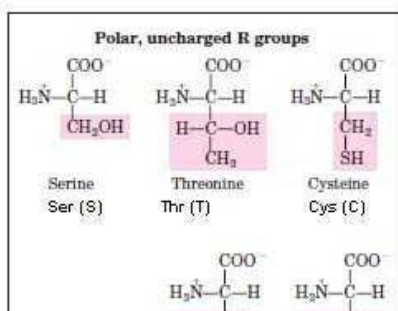
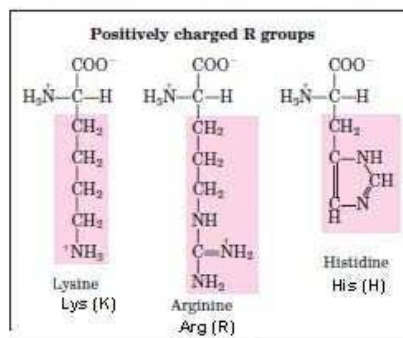
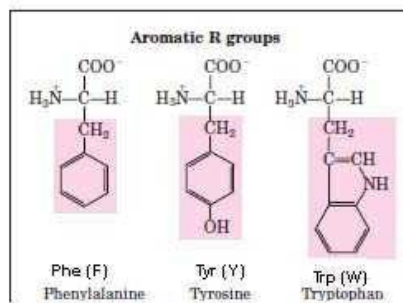
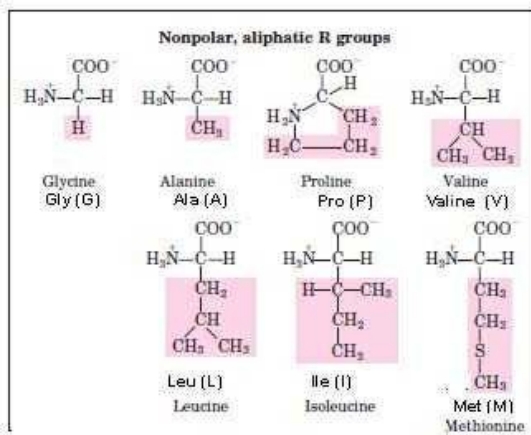
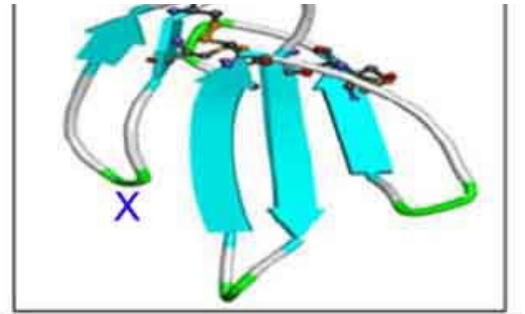
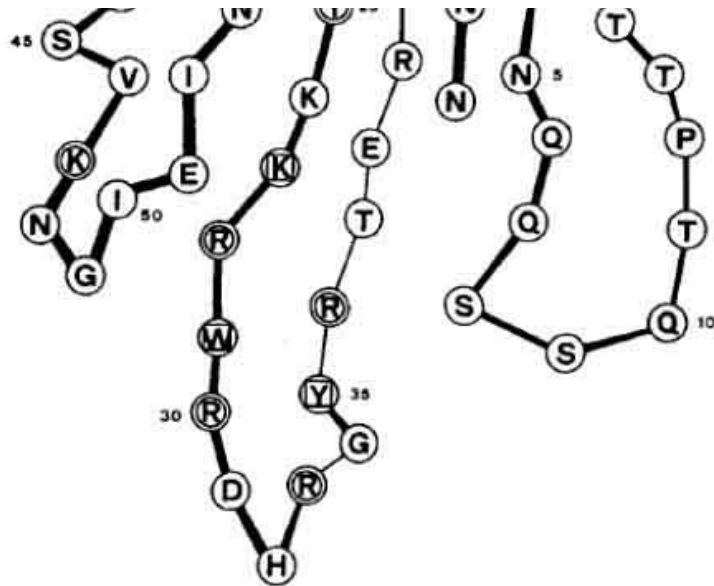
- (A) Calculate the physiological ΔG for the reaction:

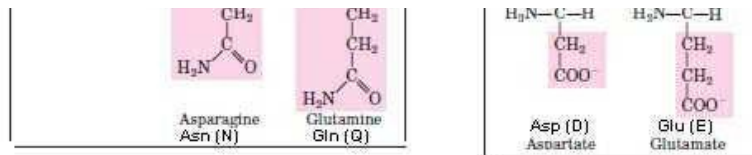
at 25°C as it occurs in the cytosol of neurons, in which phosphocreatine is present at 4.7 mM, creatine at 1.0 mM, ADP at 0.20 mM, and ATP at 2.6 mM.

- (B) Why are $\Delta G_o'$ and ΔG different?

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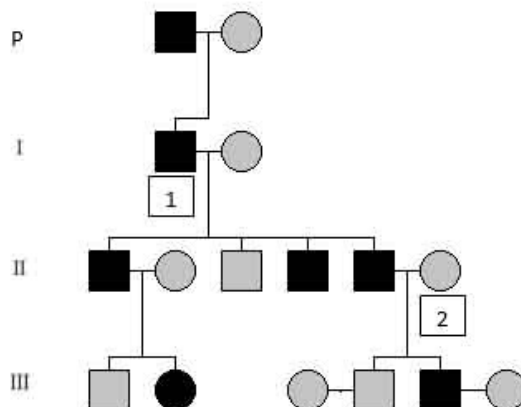


- (i) A student succeeded in replacing the amino acid Y at 35th position with R. Does the toxin still bind to its receptors? Justify (1 mark)
- (ii) How many amino acid residues are represented in this illustration? (1 Mark)
- (iii) A student heats the cobrotoxin and again bring back to normal temperature. Does the venom still works? Justify your reasoning (1 Mark)
- (iv) What is the protein structure marked as 'X' ? How you can further stabilize this structure? (1 Mark)

2) Based on the given pedigree chart, answer the following questions:

(3)

A)



- (i) Determine the most probable mode of inheritance (1 mark). Justify your reasoning (1 mark)
- (ii) Determine the genotype of individual 1 and 2. (1 mark)
- (iii) Consider the youngest affected female of the family. What is the probability of her son being affected? Show your calculation (1 mark)

B) (i) In the mouse, the dominant X-linked gene B results in a bent-tail. Its recessive allele b produces a normal tail. If a normal-tailed female is mated with a bent-tailed male (a) What phenotypic ratio should occur in the F1 generation? (b) Show the genotype of the parents (2 marks) (3)

- (ii) In Drosophila fly, there is a dominant gene for gray body color and another dominant gene for normal wings. The recessive alleles of those two genes result in black body color and vestigial wings, respectively. Flies homozygous for gray body and normal wings were crossed with flies that had black bodies and vestigial wings. The F1 progeny were then test-crossed, with the following results:

Gray body, normal wings 236

Gray body, normal wings	253
Black body, vestigial wings	50
Black body, normal wings	61

Based on the data can you predict whether the factors responsible for body color and wing shape are located on same chromosome or different chromosomes? Justify your reasoning (1 mark)

- C) In barley plants, the allele (factor A) for tall stalk is dominant over short stalk (factor a) and the allele for wide leaf (factor B) is dominant over thin leaf (factor b). (4)

(i) What would be the best way to determine the genotype of a barley plant with a tall stalk and wide leaves? Justify. (1 mark)

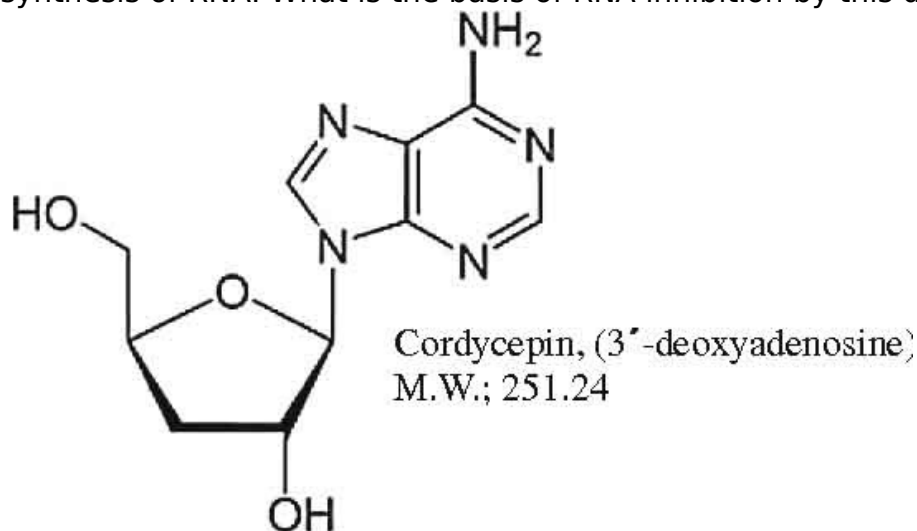
(ii) In a cross of heterozygous ($AaBb \times AaBb$) what fraction of the offspring can be expected to express blending of characters? Justify (1 mark) Show the Punnett square for the cross (1 mark)

(iii) In a monohybrid situation considering only the stalk height, suppose a cross between a tall stalk plant and a short stalk plant produces 43 tall offspring and 47 short offspring in F₁. If one of the F₁ tall offspring is crossed with one of the short offspring, what ratio of genotypes would be most likely in their offspring? (1 mark)

- 3) (i) The length of the mRNA becomes shorter immediately after transcription. (3)
A) Justify (1 mark)

(ii) Nature has preferred multiple origin of replications in organisms with lengthy DNA. Justify logically (1 mark)

(iii) Given structure is cordycepin which is generally used to block the synthesis of RNA. What is the basis of RNA inhibition by this drug? (1 mark)



- B) (i) Group of students from biotechnology department were asked to mimic the (3)
Avery, McCarthy and Macleod experiment. In this line, students have taken heat inactivated S strain, centrifuged and collected the supernatant, divided into three parts. Each part of the supernatant was mixed with DNase, RNase and Protease together. Following treatment, each mixture is mixed with live R strain and injected to mice to see the virulence. Could the students able to get similar results of Avery, McCarthy and Macleod experiment? What is the conclusion drawn from this experiment? Justify (1.5 marks)

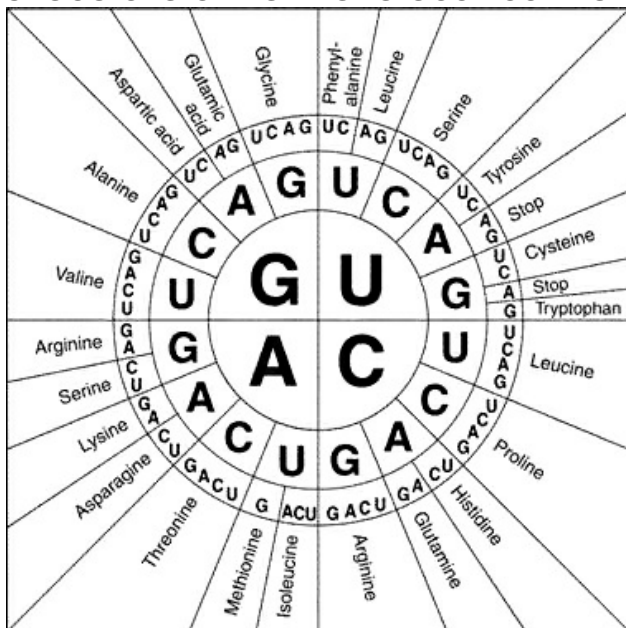
(ii) MIT student interested in learning "Central Dogma of Molecular Biology"

was asked to assign the following proteins/enzymes in their respective topic.
Can you assist him in identifying the main topic in each of the following cases?
(1.5 marks)

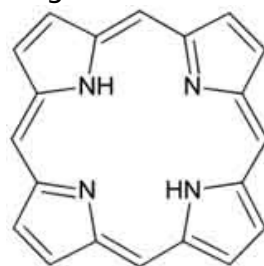
t-RNA, DNA polymerase, Single strand Binding proteins

- C) Given is the nucleic acid sequence of single stranded DNA virus. This virus needs to replicate, transcribe and translate in the host for the successful infection. (4)
- (i) Provide DNA sequence (both the strands) label the ends (1 mark)
- (ii) Provide the mature mRNA produced which is able to produce a protein (1 mark)
- (iii) Find out the protein produced by the given viral DNA sequence, label the ends. (2 marks)

5' GCG CTG CTA GTA GAG GCC TCC ATG TTG CAT CTT TAG TAT AAG 3'



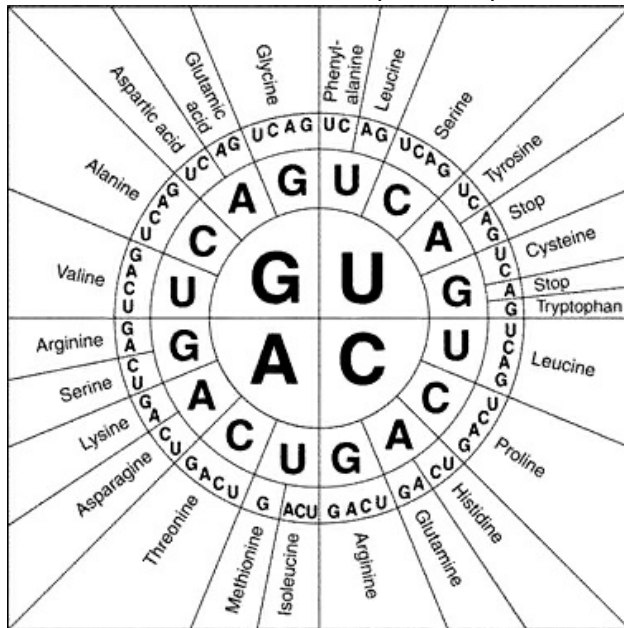
- 4) A small change in a molecule has led to diverse functions. Given below is the structure of porphyrin ring. Nature has utilized the properties of the porphyrin ring in different ways for multiple functions. (3)
- A)



- (i)** Give four examples modified porphyrins with the functions they carry out (2 marks)
- (ii)** How will you consider these modifications in the context of evolution? (1 Mark)

- B) **(i)** Some of the wasp species are known to lay their eggs inside young hosts, usually larvae. The eggs and the larvae grow together for an extended period of time. Finally the hatched wasps emerge, leaving their host dead eaten from inside. What would be the association of the wasp with the larvae. (1 Mark) (3)
- (ii)** One of the students studying mutations noticed an unusual mutation in the hemoglobin's beta subunit. The mutation was in the codon "GAG" to "GCG".

What is this mutation type called? Will the person experience anemic condition? Give reasons (1 mark)



(iii) Influenza virus, is a RNA based virus with two main protein namely neuraminidase and Hemagglutinin on its envelope. The vaccines to control the spread of the virus are directed towards these proteins. What according to you might be a reason that we still have not been able to mount an immune response against this virus. (1 mark)

C) E.coli cells are growing in a medium containing lactose but no glucose. (4)

Indicate whether each of the following changes or conditions would increase, decrease, or not change the expression of the lac operon. **Give proper justification in each of the following case**

(i) Addition of a high concentration of glucose.

(ii) A mutation that prevents dissociation of the lac repressor from the operator.

(iii) A mutation that completely inactivates Beta galactosidase.

(iv) A mutation that prevents binding of cAMP -CAP (or the activator protein) to its binding site near the lac promoter.

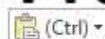
5) (i) The phloem tissue is involved in the transport of nutrients while xylem is involved in water transport. What is the benefit for the phloem vessel to be (3)

A) made of living cells while the xylem to have of dead cells? (2 marks)

(ii) A school student paints colourless nail polish on the lower surface of all the leaves of a potted plant. How this is going to affect the water absorption? Justify (1 mark)

B) (i) For a +ssRNA virus, the site of replication is in the cytoplasm. The virus produces mature virus progeny particles and exits the cell. With the help of a flow chart, represent the life cycle of the virus including the enzymes required at each step (1.5 marks) (3)

(ii) As part of the "Biology challenge" for MIT students, the following equation was given. How will you analyze this? (1.5 mark)



C) (i) As part of the "Design your Microbe" an MIT student designs a unique DNA (4)

sequence for a microbe. Now he wants to amplify (clone) it. Help him by providing a working plan (1.5 mark)

(ii) Determine the bioinspiration that can be drawn from the following: (1.5 marks)

(a) Colony of ants (b) Sun flower (c) Spiders

(iii) How will you convince next year juniors "Evolution as a tool for the life systems to improve the existing form of life"? (1 mark)

-----End-----