

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, ALLAHABAD

C1 Review test: 23rd February 2022

**Program Code & Semester: B.Tech. IT-VI Sem.
Paper Title: Eng. Biology, Paper Setter: Dr. Sintu Kumar Samanta**

**Max Marks: 30
Duration: 50 min**

Answer all the questions. Each question carries 2 marks

(1) Why genetic codon is considered as redundant but non-ambiguous?

In the genetic code, or the mapping of RNA codons to protein amino acids, each amino acid is encoded by multiple different codons. In this way, the genetic code is redundant, as each amino acid is encoded more than once. However, the genetic code is not ambiguous, as each codon specifies exactly one amino acid.

(2) How does 5' UTR and 3' UTR region of a gene help in its expression (protein synthesis)?

The 5' and 3' untranslated regions (UTRs) are mRNA domains that control critical post-transcriptional gene regulation processes. Within the 5' UTR is a sequence that is recognized by the ribosome which allows the ribosome to bind and initiate translation. The mechanism of translation initiation differs in prokaryotes and eukaryotes. The 3' UTR is found immediately following the translation stop codon. The 3' UTR plays a critical role in translation termination as well as post-transcriptional modification

UTR: Untranslated region

5' UTR (for initiation of protein
synthesis) Shine-Dalgarno (SD)
sequence

3'UTR (for termination of protein synthesis)

(3) A diluted (5 times) sample was loaded in the Hemocytometer and cells were counted. If the total number of cells was found to be 500 in the 5 squares of the Hemocytometer, calculate the number of cells/ml in the original sample.

total cells/ml = total cells counted * dilutionfactor * 10^4 cells/ml / number of squares counted

$$= 500 * 5 * 10000 / 5$$

$$= 5 * 10^6 \text{ cell/ml}$$

(4) Consider that length of the coding region of a gene is 1500 base pairs. Calculate the number of codons in the corresponding mRNA molecule and molecular weight of the corresponding protein molecule (average molecular weight of an amino acid is 110 Da).

A codon is a sequence of three nucleotides (base pairs) in a mRNA molecule that specifies a particular amino acid. Since a codon consists of three base pairs, the number of codons in a 1500 base pair coding region of a gene can be calculated as follows:

$$1500 \text{ base pairs} / 3 \text{ base pairs/codon} = 500 \text{ codons}$$

The molecular weight of the corresponding protein molecule can be calculated as follows:

$$500 \text{ codons} * 110 \text{ Da/amino acid} = 55000 \text{ Da (or 55 kDa)}$$

(5) How active transport of molecules is differed from passive transport?

Active transport requires energy for the movement of molecules whereas passive transport does not require energy for the movement of molecules.

In active transport, the molecules move against the concentration gradient whereas in passive transport, the molecules move along the concentration gradient.

(6) What is the logic behind the serial dilution method to isolate a pure culture?

A serial dilution is a series of sequential dilutions used to reduce a dense culture of cells to a more usable concentration. Each dilution will reduce the concentration of bacteria by a specific amount.

(7) What is the difference between batch culture and continuous culture?

The main difference between batch and continuous culture is that batch culture is a closed system that carries out fermentation with a fixed amount of nutrients whereas continuous culture is an open system, which continuously carries out fermentation.

In a fed-batch culture, nutrients are added systematically for an extended duration, unlike in a continuous batch where nutrients are added, and products are removed continuously.

(8) Why the DNA synthesis in lagging strand of DNA double helix is not continuous?

The DNA synthesis in the lagging strand of the DNA double helix is not continuous because DNA polymerases, the enzymes responsible for synthesizing new DNA, can only add nucleotides to the 3' end of the strand. During replication, the leading strand is continuously synthesized in the 5' to 3' direction, but the lagging strand must be synthesized in short fragments in the opposite direction, from 3' to 5', due to the limitations of DNA polymerases. These fragments are then joined together by another enzyme called ligase to form a continuous strand. This process is referred to as "Okazaki fragments."

(9) Why the polarity of a DNA molecule is conventionally denoted by 5' to 3' ?

The polarity of a DNA molecule is denoted by 5' to 3' because the 5' carbon atom of the deoxyribose sugar in one nucleotide is covalently linked to the 3' carbon atom of the deoxyribose sugar in the next nucleotide, forming the backbone of the DNA molecule. This direction of linkage defines the polarity of the DNA molecule and is conventionally referred to as 5' to 3'.

(10) Why sterilization of media is necessary?

When microbiological media has been made, it still has to be sterilized because of microbial contamination from air, glassware, hands, etc. Within a few hours there will be thousands of bacteria reproducing in the media so it has to be sterilized quickly before the microbes start using the nutrients up.

(11) What functional groups attach to the 1st, 3rd and 5th carbon of the sugar in a nucleotide?

In a nucleotide, the 1st carbon of the sugar is attached to a nitrogenous base the 3rd carbon is attached to a hydroxyl (OH) group, and the 5th carbon is attached to a phosphate group, .

(12) How does 'Phagocytosis' help in immuno-protection of human body?

Phagocytes can ingest microbial pathogens, but importantly also apoptotic cells. In this way, they contribute to the clearance of billions of cells that are turned over every day. By doing so, phagocytosis helps in the immuno-protection of the human body by removing harmful substances and preventing their spread.

(13) The nucleotide sequence of the sense strand of a DNA molecule is 5' ATGCATACTTAA 3'. Write the nucleotide sequence of the corresponding antisense strand and the encoded mRNA molecule.

The nucleotide sequence of the corresponding antisense strand is 3' TACGTATGAATTT 5'.

The encoded mRNA molecule is transcribed from the sense strand and has a sequence of 5'

AUGCAUACUUA 3'

(14) How tRNA and mRNA are involved in protein synthesis in cells?

Transfer RNA (abbreviated tRNA) is a small RNA molecule that plays a key role in protein synthesis. Transfer RNA serves as a link (or adaptor) between the messenger RNA (mRNA) molecule and the growing chain of amino acids that make up a protein.

The role of mRNA is to carry protein information from the DNA in a cell's nucleus to the cell's cytoplasm

(15) A liquid sample was serially diluted with sterile water. 200 µl of sample from the 10^{-6} dilution was plated. It gave rise to 65 colonies on an agar plate. Determine the number of cells in the original sample in 'number of cells/liter'.

The number of colonies formed after plating 200 µl of a 10^{-6} dilution indicates the number of cells in the original sample. 65 colonies on an agar plate means there were $65 \times (10^6) = 65,000,000$ cells in the original sample. Therefore, the number of cells in the original sample in number of cells/liter is $65,000,000 \times (10^{-6}) = 65 \times 10^6$ cells/liter.