MODULE 7: GENE, GENOME AND GENE EXPRESSION

Q.1. Short answer questions:

i. There are -----possible codes of which ---- code for amino acids and the rest ------ code as stop codons.
ii. The genetic code was deciphered by ------
iii. ---------- enzyme proofreads the newly synthesized DNA strands.
iv. Semi conservative mode of replication was proved by ----- and -----
v. Okazaki fragments are formed on the ---- strand.
vi. Enzyme involved in elongation process during translation is ----------
vii. Initiation codon in prokaryotic cells codes for ----------

Answers:

i. 64, 61, 3
ii. Marshall Nirenberg and Hargovind Khorana.
iii. DNA polymerase III.
iv. Matthew Messelson and Franklin Stahl.
v. Lagging.
vi. Peptidyl transferase.
vii. Formyl Methionine.

Q.2. State one key difference between?

(a) Gene and Genome
(b) Exon and Intron
(c) Codon and Anticodon
(d) Translation and Transcription
(e) Sense and Antisense strand
(f) DNA polymerase I, II and III

Answers:

(a) Gene and Genome: The segment of DNA that carries genetic information are called genes. Genes hold the information to build and maintain an organism's cells and pass genetic traits to offspring. Genome is the sum total of an organism's hereditary information. It is encoded either in DNA or, for many types of virus, in RNA. The genome includes both the genes and the non-coding sequences of the DNA.

(b) Exon and Intron: Exons are the coding sequences that appear on split genes and primary transcripts, and will be expressed to matured mRNA. Introns are the non-coding sequences that are transcripted into primary mRNAs.

(d) Codon and Anticodon: A codon is the triplet sequence in the messenger RNA transcript which codes for a corresponding amino acid. An anticodon is the corresponding triplet sequence on the transfer RNA (tRNA) which brings in the specific amino acid to the ribosome during translation. The anticodon is complementary to the codon.

(e) Translation and Transcription: Translation: Process by which genetic information encoded in DNA is copied onto messenger RNA. Transcription: Process by which information encoded in mRNA is used to assemble a protein at a ribosome

(f) Sense and Antisense strand: The strand from which the RNA is gets transcribed is called the TEMPLATE strand or ANTISENSE strand. The CODING strand is the strand whose base sequence specifies the amino acid sequence of the encoded protein. Therefore, it is also called as SENSE strand.

(g) DNA polymerase I, II and III:

DNA polymerase I	• Proofreading (3'-5' exonuclease activity) • Repairing DNA damage • 5'-3' exonuclease activity • Ploymerization rate: 16-20 nucleotides/second • Processivity: 3-200 nucleotides added before polymerase dissociates
DNA polymerase II	• 3'-5' exonuclease activity for proofreading • Temporary functional when DNA-pol I and l III are not functional • Capable for doing synthesis on the damaged template • DNA repairing • Ploymerization rate: 40 nucleotides/second • Processivity: 1500 nucleotides added before polymerase dissociates
DNA polymerase III	• 3'-5' exonuclease activity for proofreading • Having the highest polymerization activity • Responsible for the elongation process • Ploymerization rate: 250-1000 nucleotides/second • Processivity: >500000 nucleotides added before polymerase dissociates

Q.3. Explain
(a) Wobble hypothesis
(b) Shine-Dalgarno sequences
(c) Degeneracy of the genetic code
(d) Central dogma of molecular biology
(e) Reverse transcription

Answers:

(a) Wobble hypothesis: According to the Wobble hypothesis, the third position of a codon is often interchangeable. For example: GCU codes for alanine and so does GCC tRNA with anticodon CGG can bind to this codon and bring alanine.

(b) Shine-Dalgarno sequences: There is a specific sequence of bases on the mRNA, upstream of the start codon, that allows the ribosome to recognize and bind onto the start site to initiate the translation process. Such sequences are referred to as the Shine Dalgarno sequences.

(c) Degeneracy of the genetic code: The same amino acid may be coded by more than one number of codons. This is called the Degeneracy of the genetic code

(d) Central dogma of molecular biology: According to this dogma, DNA holds the coded hereditary information in the nucleus. The sequence involved in the expression of hereditary characteristics runs from DNA to RNA to protein.

(e) Reverse transcription: In certain RNA viruses, the flow of genetic information is from single stranded RNA to DNA. Reverse transcription is therefore the process in which ssRNA is used as the template to synthesize dsDNA.

Q.4. Enlist all enzymes involved in DNA replication with their respective functions?

Ans:
Dna A protein
Dna B protein or helicase
Dna C protein
Dna G protein or primase
Single-strand binding proteins (SSB)
DNA topoisomerase or gyrase
DNA polymerase
RNAse
Ligase

Q.5. Name the three major post-transcriptional modifications that occur on a nascent RNA

Ans: Post transcriptional modification includes:

- Capping at the 5′- end
- Tailing at the 3′- end
- mRNA splicing