**Q.1 On the basis of position of centromere describe the four types of chromosomes.**

**Ans.** Chromosomes are categorized based on the position of the centromere into four types:

i. **Metacentric:** The centromere is located in the center, creating arms of equal length.

ii. **Submetacentric:** The centromere is slightly away from center, creating arms of unequal length.

iii. **Acrocentric:** The centromere is near one end, making one arm significantly shorter than the other.

iv. **Telocentric:** The centromere is at the very end, effectively forming only one arm.

**Q.2 What is chromatin fibre? What is the difference between the two regions of chromatin fibre?**

**Ans.** Chromatin fiber is a thicker fiber formed when the nucleosome string further coils around its axis, about 30 nm thick. There are two regions of chromatin fiber:

- **Heterochromatin:** Highly condensed and typically not expressed.
- **Euchromatin:** Less condensed and contains actively expressed genes.

**Q.3 Write the functions of DNA polymerase I, II and III.**

**Ans.** **DNA Polymerase I:** It removes the RNA primers and replaces them with DNA nucleotides in the termination phase of replication.

- **DNA Polymerase II:** It plays a role in DNA repair and proofreading during and after DNA synthesis.
- **DNA Polymerase III:** It is the primary enzyme responsible for adding nucleotides to the new DNA strands along the template during replication.

**Q.4 Describe central dogma of gene expression.**

**Ans.** The central dogma of gene expression is the concept that DNA makes protein via an intermediate RNA. It involves two key processes:

- **Transcription:** The DNA sequence of a gene is transcribed to produce an mRNA molecule.
- **Translation:** The mRNA molecule produced during transcription is used to assemble amino acids into a protein.

**Q.5 Describe the four characteristics of genetic code.**

**Ans.** The genetic code has four key characteristics:

i. **Universality:** It is consistent across almost all organisms.

ii. **Degeneracy:** Multiple codons can encode the same amino acid, providing a buffer against mutations.

iii. **Non-overlapping:** It is read three bases at a time without overlapping.

iv. **Punctuation:** It lacks punctuation marks between codons during mRNA translation, ensuring seamless translation.

**Q.6. Explain why the length of transcribed m-RNA (in Eukaryotes) shortens as it enters the cytoplasm for translation.**

**Ans.** In eukaryotes, the length of transcribed mRNA shortens as it enters the cytoplasm due to the removal of introns (non-coding sequences) and addition of a poly-A tail and 5' cap, which are part of post-transcriptional modification processes that stabilize and prepare mRNA for translation.

**Q.7 Interpret how many types of t-RNA molecules are necessary for a living cell, if the genetic code is triplet code.**

**Ans.** Since the genetic code is a triplet code and each triplet (codon) specifies a particular amino acid, at least one type of tRNA is required for each of the 20 amino acids coded by the genetic code. Thus, a minimum of 20 different types of tRNA molecules are necessary for a living cell.

**Q.8 Make a list of some commonly occurring minor mutations in human.**

**Ans.** Common minor mutations in humans include:

- **Point mutations:** Changes to a single nucleotide.
- **Silent mutations:** Mutations that do not change the amino acid sequence of a protein.
- **Missense mutations:** Mutations that change one amino acid in a protein sequence.
- **Nonsense mutations:** Mutations that introduce a premature stop codon into the mRNA.

**Q.9 Suggest possible ways in which the synthesized protein can be used within or outside a cell that synthesized it.**

**Ans.** Within the cell, synthesized proteins may function as enzymes, structural proteins, or signaling molecules. Outside the cell, proteins can be secreted to act as hormones, antibodies, or enzymes in various physiological processes such as digestion or immune response.

**Q.10 Write the differences between:**

**Ans.**

**(a) Metacentric vs Submetacentric Chromosome**

- **Metacentric:** The centromere is located near the center, creating two arms of equal length.

- **Submetacentric:** The centromere is slightly off-center, resulting in one arm being longer than the other.

**(b) Acrocentric vs Telocentric Chromosome**

- **Acrocentric:** The centromere is located close to one end, creating a very short arm and a significantly longer arm.
- **Telocentric:** The centromere is at the very end, effectively forming only one arm.

**(c) Nucleosome vs Primosome**

- **Nucleosome:** A structural unit of a eukaryotic chromosome, consisting of a length of DNA coiled around a core of histones.
- **Primosome:** A protein complex involved in the initiation of DNA replication, including helicases and primases that create RNA primers.

**(d) Heterochromatin vs Euchromatin**

- **Heterochromatin:** It is highly condensed, transcriptionally inactive, typically gene-poor regions of DNA, and generally remains compacted during the cell cycle.
- **Euchromatin:** It is less condensed, transcriptionally active, generally gene-rich, and accessible to RNA polymerase and other regulatory proteins.

**(e) Conservative vs Dispersive Model of DNA Replication**

- **Conservative Model:** The original DNA molecule is preserved, and an entirely new copy is produced.
- **Dispersive Model:** Each strand of both daughter molecules contains a mixture of old and newly synthesized DNA interspersed along the strand.

**(f) DNA Helicase vs DNA Gyrase**

- **DNA Helicase:** It unwinds the DNA double helix at the replication fork to allow the replication machinery to access the DNA strands.
- **DNA Gyrase:** A type of topoisomerase in bacteria that relieves the strain while double-stranded DNA is being unwound by helicase.

**(g) DNA Polymerase I vs II**

- **DNA Polymerase I:** It removes RNA primers from the fragments of lagging strand and replaces them with DNA, also involved in DNA repair.
- **DNA Polymerase II:** It is involved in DNA repair processes, not the primary enzyme for replication.

**(h) Leading Strand vs Lagging Strand of Replication Fork**

- **Leading Strand:** It is synthesized continuously in the direction of the replication fork.
- **Lagging Strand:** It is synthesized discontinuously in fragments (Okazaki fragments) opposite to the direction of the replication fork.

**(i) Translation vs Transcription in Gene Expression**

- **Translation:** The process by which mRNA is decoded by a ribosome to produce a specific amino acid chain, or polypeptide, that will later fold into an active protein.
- **Transcription:** The process of copying a segment of DNA into RNA, particularly mRNA, which carries the genetic information needed for protein synthesis.

**(j) Intron vs Exon**

- **Intron:** It is a non-coding segment of DNA or RNA that are removed during the RNA splicing process before translation.
- **Exon:** It is a regions of DNA or RNA that code for proteins and is retained in the final mRNA.

**(k) Start Codon vs Stop Codon**

- **Start Codon:** Typically AUG, which signals the start of translation and the amino acid methionine.
- **Stop Codon:** Codons (UAA, UAG, UGA) that signal the termination of protein synthesis by not coding for any amino acid.

**(l) Nonsense Codon vs Sense Codon**

- **Nonsense Codon:** Another term for stop codon, which does not encode for an amino acid and stops protein synthesis.
- **Sense Codon:** Refers to codons that specify amino acids and are involved in the process of constructing protein sequences in translation.

**(m) Point Mutation vs Chromosomal Mutation**

- **Point Mutation:** A mutation affecting only one or very few nucleotides in a gene sequence.
- **Chromosomal Mutation:** Changes that affect entire chromosomes or large segments of them, often impacting multiple genes.

**(n) Harmful vs Useful Aspects of Mutation**

- **Harmful Mutation:** It leads to negative effects on the organism, possibly causing diseases or malfunctions.
- **Useful Mutation:** It contributes to positive adaptations that can improve an organism's survival and reproduction in its environment.

**(o) Down Syndrome vs Klinefelter Syndrome**

- **Down Syndrome:** Typically characterized by an extra copy of chromosome 21 (trisomy 21).
- **Klinefelter Syndrome:** A genetic condition affecting males, characterized by an extra chromosome (XXY).

**(p) Klinefelter Syndrome vs Turner Syndrome**

- **Klinefelter Syndrome:** Males with an extra chromosome, often leading to physical and reproductive features that are somewhat atypical.
- **Turner Syndrome:** Females with only one chromosome (45, X), leading to developmental abnormalities and infertility.