**Mid-Term Assignment**

**Course Title: Fundamental Microbiology-ll**

**BS (Microbiology 2nd)**

**Instructor: Ms. Pashmina**

**Time: 6 days Max Marks: 30**

**Note:**

* **Attempt all questions from this section, all questions carry equal marks.**
* **Answer Briefly and to the point, don’t cut past avoid un-necessary details**

Case Study #2

September 24, 2015

populations can overgrow and produce their enterotoxins. These toxins released are ultimately

responsible for the diarrhea symptoms of the host.

6. What is the major virulence factor for this microorganism?

# **Q1: (10 Marks)**

**What are the significant differences in the process of DNA replication, transcription and Translation in prokaryotes?**

**DNA Replication:**

**Definition:**

DNA Replication, also known as Semi-Conservative Replication, is the process by which DNA is essentially “doubled”. It is an important process that takes place within the dividing cell.

**Stages in DNA Replication:**

1. **Initiation:**

DNA synthesis is initiated at particular points within the DNA strand known as ‘origins’, which are specific coding regions. These origins are targeted by initiator proteins, which go on to recruit more proteins that help aid the replication process, forming a replication complex around the DNA origin.

1. **Elongation:**

Once the DNA Polymerase has attached to the original, unzipped two strands of DNA (i.e. the template strands), it is able to start synthesizing the new DNA to match the templates.

1. **Termination:**

The process of expanding the new DNA strands continues until there is either no more DNA template left to replicate (i.e. at the end of the chromosome), or two replication forks meet and subsequently terminate.

**DNA Transcription:**

**Definition:**

Transcription is the first step in gene expression, in which information from a gene is used to construct a functional product such as a protein. The goal of transcription is to make RNA copy of a gene's DNA sequence. For a protein-coding gene, the RNA copy, or transcript, carries the information needed to build a polypeptide (protein or protein subunit).

**Stages in DNA Transcription:**

1. **Initiation:**

RNA polymerase binds to a sequence of DNA called the promoter, found near the beginning of a gene. Each gene (or group of co-transcribed genes, in bacteria) has its own promoter

1. **Elongation:**

One strand of DNA, the template strand, acts as a template for RNA polymerase. As it "reads" this template one base at a time, the polymerase builds an RNA molecule out of complementary nucleotides, making chain.

1. **Termination:**

Sequences called terminators signal that the RNA transcript is complete. Once they are transcribed, they cause the transcript to be released from the RNA polymerase.

**Translation in Prokaryotes:**

**Definition:**

The process by which proteins are produced with amino acid sequences specified by the sequence of codons in messenger RNA is called translation. Translation is the first stage of protein biosynthesis.

**Stages in DNA Transcription:**

1. **Site:**

Translation occurs in the cytoplasm where the ribosomes are located. Ribosomes are made of a small and large subunit which surrounds the mRNA. In prokaryotic translation 70S ribosomes with 30S and 50S subunits are used. The mRNA is synthesized from DNA only. In prokaryotes, there are several initiation and termination sites.

**2. Template:**

In translation, messenger RNA (mRNA) is decoded to produce a specific polypeptide according to the rules specified by the genetic code. This uses an mRNA sequence as a template to guide the synthesis of a chain of amino acids that form a protein. Many types of transcribed RNA, such as transfer RNA, ribosomal RNA, and small nuclear RNA are not necessarily translated into an amino acid sequence.

**3. Requirements:**

The translation process requires mRNA, rRNA, ribosomes, 20 kinds of amino acids and their specific tRNAs.

**4. Factors Involved:**

In prokaryotes, three factors are involved in the initiation of translation one factor in the elongation of polypeptide chain and three factors in chain termination.

**5. Enzymes Involved:**

Two types of enzymes are used in translation. Aminoacyl tRNA synthetase (an enzyme) catalyzes the bonding between specific tRNAs and the amino acids. The enzyme peptidyl transferase connects A site and P site by forming a peptide bond [the nitrogen carbon bond] during elongation phase.

# **Q2:** **(10 Marks)**

Differentiate between

* **Mitosis and Meiosis**

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| **Mitosis** | **Meiosis** |
| **Definition**  It is a process of asexual reproduction in which the cell divides in two producing a replica, with an equal number of chromosomes in each resulting diploid cell. | **Definition**  It is a type of cellular reproduction in which the number of chromosomes is reduced by half through the separation of homologous chromosomes, producing two haploid cells. |
| The type of reproduction in the mitosis is asexual. | The type of reproduction in the meiosis is sexual. |
| They are genetically similar. | They are genetically different. |
| The mother cells can be either haploid or diploid. | The mother cells are always diploid. |
| The chromosomes numbers remain the same. | The chromosomes numbers are reduced by half. |

* **R-Selection and K-selection**

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| **R-Selection** | **K-Selection** |
| **Definition**  On one extreme are the species that are highly r-selected. r is for reproduction. Such a species puts only a small investment of resources into each offspring, but produces many such low effort babies. | **Definition**  On the other extreme are species that are highly K-selected. K refers to the carrying capacity, and means that the babies are entering a competitive world, in a population at or near its carrying capacity. |
| The benefit of this strategy is that if resources are limited or unpredictable, you can still produce some young. | K-selected reproductive strategies tend towards heavy investment in each offspring, are more common in long-lived organisms, with a longer period of maturation to adulthood. |
| They have a very small lifespan. | They have a very long lifespan. |
| The early mortality rate is high between these organisms. | The early mortality rate is low between these organisms. |
| The example of r-selected species are mice, rabbits, bacteria. | The example of k-selected species are elephants, tortoise and people. |

* **Point Mutation and Silent Mutation**

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| **Point Mutation** | **Silent Mutation** |
| **Definition**  In a point mutation, one nucleotide is swapped out for another. Therefore, the mutation occurs at a single point or location within the DNA strand. | **Definition**  In this mutation there is a base change, but the new codon means exactly the same thing as the old one |
| In point mutation is when a single base pair is altered. | In the silent mutation the base substitution happens this is due to the degeneracy of the codon -> amino acid conversion code |
| They have single bases. | They have substitution bases. |

* **Telophase and Metaphase**

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| **Telophase** | **Metaphase** |
| **Definition**  The final stage of mitosis or meiosis during which the daughter chromosomes move towards opposite ends of the nuclear spindle. | **Definition**  The stage of mitosis and meiosis, that follows prophase and comes before anaphase, during which condensed chromosomes become aligned before being separated. |
| It is the last stage of mitosis. | It is the third stage of mitosis. |
| The mitotic spindle is broken down into its building blocks. | The spindle has captured all the chromosomes and lined them up at the middle of the cell, ready to divide. |
| Two new nuclei form, one for each set of chromosomes. Nuclear membranes and nucleoli reappear. | The nuclear envelope breaks down, releasing the chromosomes. |

* **Leading strand and lagging strand**

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| **Leading Strand** | **Lagging strand** |
| **Definition**  The final stage of mitosis or meiosis during which the daughter chromosomes move towards opposite ends of the nuclear spindle. | **Definition**  Lagging strand is a replicated strand of DNA which is formed in short segments called Okazaki fragments. Its growth is discontinuous |
| It is the last stage of mitosis. | DNA-ligase is required for joining Okazaki fragments. |
| Its template opens in 3′ -> 5′ direction. | The direction of growth of the lagging strand is 3′ -» 5′ though in each Okazaki fragment it is 5′ —> 3. |
| Formation of leading strand begins immediately at the beginning of replication. | Formation of lagging strand is slower. |

# **Q3: (10 Marks)**

1. **What is mutation? What are the roles of mutation in human diseases?**

**Definition:**

A mutation is a change that occurs in our DNA sequence, either due to mistakes when the DNA is copied or as the result of environmental factors such as UV light and cigarette smoke.

**Role of mutation in human disease:**

Mutation plays a very significant role in increasing the rate of human disease duet to following factors that are listed and described below,

1. The relationship between disease-associated mutation positions and evolutionary conservation has been reported in specific cases. An analysis of the breast and ovarian cancer susceptibility gene, showed that disease-associated mutations tend to occur in highly conserved regions.
2. Mutations contribute to genetic variation, because it can also be inherited, particularly if they have a positive effect. **For example**, the disorder sickle cell anemia. It is caused by a mutation in the gene that instructs the building of a protein called hemoglobin. This causes the red blood cells? to become an abnormal, rigid, sickle shape.
3. Mutation can also disrupt normal gene activity and cause diseases, like Cancer. Cancer is the most common human genetic disease; it is caused by mutations occurring in a number of growth-controlling genes. Sometimes faulty, cancer-causing genes can exist from birth, increasing a person’s chance of getting cancer.

1. **Differentiate between DNA and RNA? What was the first?! DNA or RNA explains with suitable reasons?**

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| **DNA** | **RNA** |
| **Definition**  It is a long polymer. It has a deoxyribose and phosphate backbone having four distinct bases: thymine, adenine, cytosine, and guanine. | **Definition**  Is a polymer with a ribose and phosphate backbone with four varying bases: uracil, cytosine, adenine, and guanine. |
| It is located in the nucleus of a cell and in the mitochondria. | It is found in the cytoplasm, nucleus, and in the ribosome |
| DNA is functional is the transmission of genetic information. It forms as a media for long-term storage | RNA is functional is the transmission of the genetic code that is necessary for the protein creation from the nucleus to the ribosome. |
| The DNA is a double-stranded molecule that has a long chain of nucleotides. | The RNA is a single-stranded molecule which has a shorter chain of nucleotides. |

**DNA / RNA Discovery:**

DNA is found in every cell in the body, and is passed down from parent to child. Although the discovery of DNA occurred in 1869 by Swiss-born biochemist Fredrich Miescher, it took more than 80 years for its importance to be fully realized.

The discovery of RNA began with the discovery of nucleic acids by Friedrich Miescher in 1868 who called the material 'nuclein' since it was found in the nucleus