Microbial Genetics

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Lab.2

Mutations

Mutation can be defined on the molecular level as any any change in the sequence of nitrogenous bases of any one of the gene responsible for genetic traits , even if the change is simple it may due to change in the genetic code and thus will change the nature of the protein which leads to appearance of new characters , or may be defined as changes in the genotype that can be inherited. The individual who shows this new characters will be called mutan.

A mutagen is an agent that causes genetic mutation by altering the DNA sequence. Mutagens can be classified into three types based on their origin: physical, chemical, and biological

1. Physical mutagens are agents that cause mutations by physically altering the DNA structure. Examples of physical mutagens include ionizing radiation, such as X-rays, gamma rays, and alpha particles, and ultraviolet radiation.
2. Chemical mutagens are agents that cause mutations by chemically altering the DNA structure. Examples of chemical mutagens include base analogs, intercalating agents, metal ions, and alkylating agents.
3. Biological mutagens are agents that cause mutations by interfering with the DNA repair or DNA synthesis process. Examples of biological mutagens include viruses, bacteria, and transposons.

It’s important to note that not all mutations emerge due to mutagens. Some mutations arise spontaneously by error in replication, hydrolysis or recombination errors.

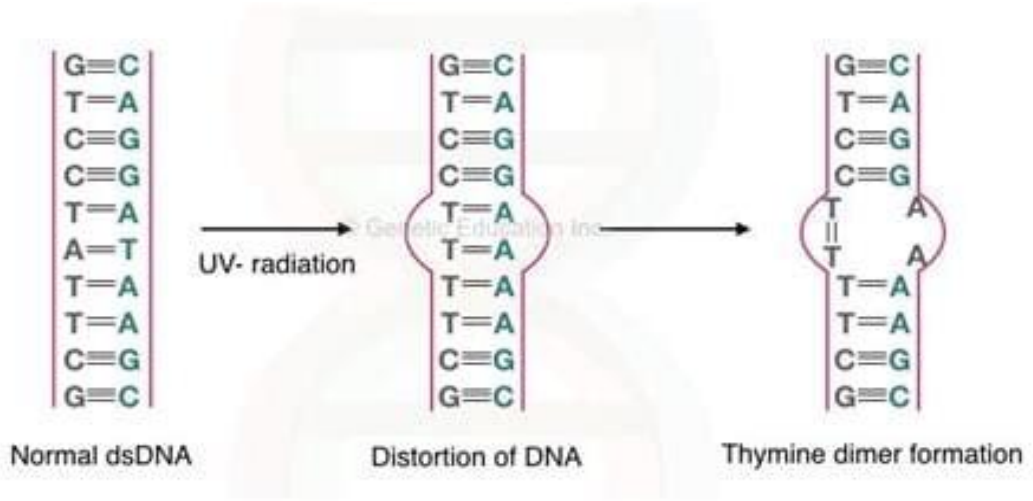
Mutations can be classified in various ways depending on their cause, effect on the function of the gene product, or the kind of changes to the structure of the gene itself.

Here are some ways mutations can be classified:

- Depending on the kind of cell in which mutations occur, they are classified into somatic and germinal mutations. They may be autosomal or sex chromosomal according to their type of chromosome in which they occur. They may be spontaneous or induced according to their mode of origin. They may be forward or backward according to their direction.
- Gene mutations and chromosomal mutations are two broad categories in which the mutation is classified.
- Spontaneous mutations occur in the body without any external factor, while induced mutations are caused by external factors.
- Frameshift mutations, point mutations, and small-scale mutations are some types of mutations.

A- Physical Mutagens

- Ultra violate Radiation U.V. :- these rays directly affect or indirectly . The main damage results from direct effect through dimers formation between adjacent pyrimidines in the DNA molecule especially (Thymine dimers) which due to distortion of DNA strand and imbalance in the DNA replication . While the indirect effect cause surrounding water molecules catalysis and production of free radicals that affect the genetic materials .



- Ionizing Radiation :- Such as X-rays , β-rays and γ rays .Which have direct impact such as chromosome breaking or indirect effect such as the conversion of some components in the cytoplasm to cytoplasm to effective components as mutagens . U.V.is preferred for mutagenesis for the following reasons:- a- High impact in mutations induction. b- Low cost compared with ionizing radiation. c- Less dangerous than the ionizing radiation.

B- Chemicalmutagens

are substances that can induce changes in DNA called mutations.Examples of chemical mutagens include :

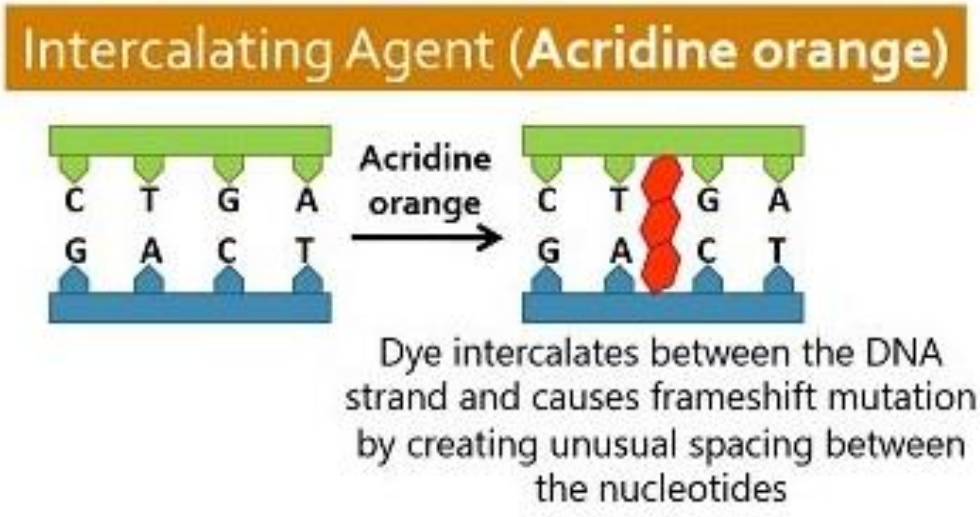
- Nitrous oxide, hydroxylamine
    1. Nitrous acid :- remove or oxidation the amino group for number of nitrogenous bases in DNA and thus change them into other compounds have the ability to bind with other bases which due to change the genetic code and show a new characters.
    2. Hydroxylamine:- This mutagenic factor change the chemical structure of nitrogenous bases C to U which links with A not with G .
- Base analogs, such as 5-bromouracil and 2-aminopurine

  Have replacement effect which replace N.b. by another , 5- Bromo Uracil has chemical structure similar to the chemical structure of **T** and has the ability to bind with A so it take T place in the DNA so it change the form A-T to A-5-BU which due to change of genetic code so produce a new character .

  The 2-aminopurine analogy with nitrogenous bases like **A**
- Alkylating agents, such as ethyl-nitrosourea,methyl-methane-sulphonate(mms) ethyl-methane-sulphonate(ems).

  t removes purines especially G which makes it place empty so any N.b. of the four N.b. can take this empty place in the DNA replication , therefore there is a change in the genetic code .
- Reactive oxygen species, such as hydrogen peroxide and superoxide
- Intercalating Agents such as acridine dyes, proflavin, and ethidium bromide etc

Has the ability to access between N.b. in DNA and can remove N.b. which due to new characters because of genetic code change



Mutations can be divided into several types based on their effect on cell

1- Sensitivity to certain substances :- This type of mutation means the sensitivity or resistance to antibiotic and U.V. radiation . This resistance may appear in step or multiple steps which means that there is a gene responsible for resistance to the given substance in certain concentration.
We find that the bacteria of particular genus and certain species is sensitive to 10μg/ml of certain antibiotic while there are other strains of the same genus have the resistance to 100μg/ml of the same antibiotic , either with respect to the resistance and sensitivity to U.V. radiation mutation can be divided into sensitive and resistant , the sensitive will be killed by dose less than natural cells while the resistant cell killed by dose higher than natural cells .

2- Anabolism –Related Mutations:- Nutritional mutation is an example as it is also known that natural bacteria (Wild type) to be manufacture all nutrional requirements, whether amino acids, vitamins or other , but when bacteria lose the ability to make one of the amino acids as a result of mutation it is called mutant strain , there are many benefits of nutritional mutations one of these benefits it has enabled scientists to study the metabolic pathways of many materials that are made within cells .

3- Catabolism –Related Mutation :- Most types have the ability to consumption of carbohydrates for getting energy , as it is known that this character is under genetic control , so the bacteria can be transformed from sugar-fermenter to non-sugar-fermenter

4- Bacteriophage –Related Mutations :- Relationship between bacteria and phage will be through specific receptors located on the bacterial cell surface which enable the bacteriophage to attach to the bacterial cell surface and then inserting its DNA inside the bacteria , bacteria will be bacteriophage sensitive when it bhas receptors , so it can be infected and analyzed , while it will be bacteriophage resistant when it loss these receptors (phage typing) as a result of mutation .

5- Cell structure –Related Mutations:- The bacterial cells can be divided into two types based on the motion : motile (contain flagella) and the other non-

motile (without flagella) these flagella are responsible for motility of bacteria . Which is composed of protein called (flagellin) . Since it is composed of protein so it is under the DNA influence , so the motility can be affected by mutations .

As it is found at least 15 genes are responsible for the motility in Salmonella , as well as E.coli . Therefore it is possible genetically for the cell to transform from motile to non-motile when these cell expose to mutation. It is also found that there are at least 20 genes are responsible for spore-formation in Bacillus subtilis, these genes are spreading in different locations of chromosome , it is possible to convert spore- former bacteria to non-spore –former bacteria .In general some mutations are useful for bacteria and some of them are useful for human for producing strains for certain materials. Some mutations are lethal to the cell especially when occur in sensitive or necessary locations in the cell.