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III Biological Mutagens

Virus, bacteria, transposon (non coding DNA sequence)

- Virus insert their DNA into our genome and disrupt the normal function of DNA or a gene once it insert DNA, the DNA is replicated transcribed & translated viral protein instead of our protein.

- Bacteria some bacteria also dangerous to our DNA cause DNA breakage or DNA damage

- Transposons These non coding DNA sequences jumps from one place to another in a genome and influence the function of genes

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② Base Analogues

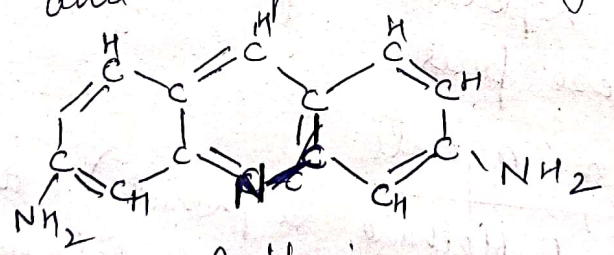
Already discussed on pages ⑦

These base analogues gets incorporated into replicating DNA strand and hinders the normal process of replication.

③ DNA Intercalating Compounds

The Acridine molecules, of which Proflavin have dimensions roughly the same as of Purine-Pyrimidine pair.

- Other example euflavin, acridine orange ethidium bromide etc.
- 5-amino acridine gets intercalated b/w two adjacent purines and increase the distance between them from 3.4 Å to 6.8 Å. This process is called Intercalation.
- This leads to stretching of DNA molecules and unequal crossing over.



Proflavin

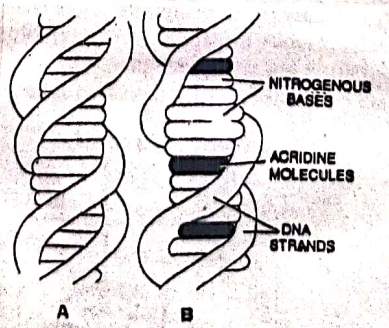
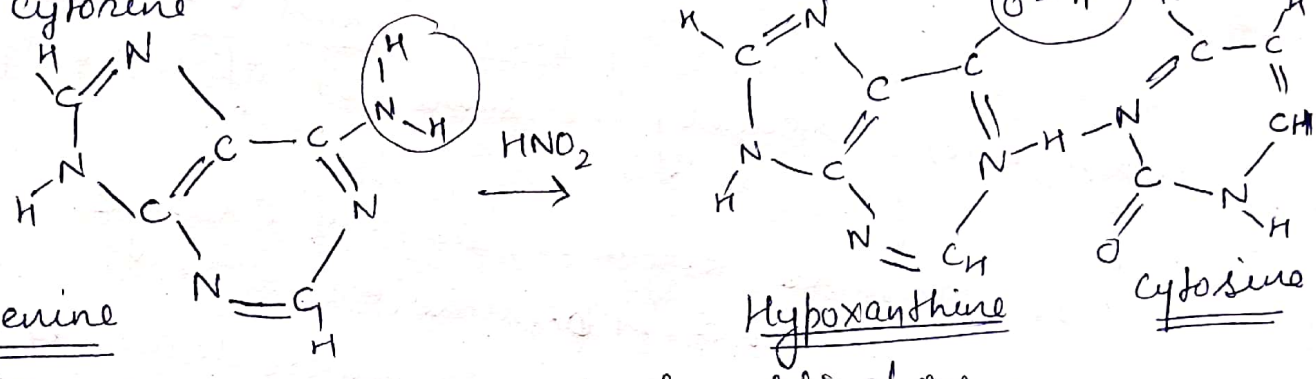


Fig. 12. A. Normal DNA molecule; B. DNA molecule with acridine molecule inserted between purines.

eg:- Adenine have NH_2 at 6-Carbon due to deamination Adenine convert to Hypoxanthine and form bond with Cytosine



⇒ Thus deamination disturb replication, transcription & translation

b) Hydroxylamine NH_2OH

It reacts with amino group of cytosine and results in replacement of C-G base pair by A T base pair

c) Alkylating agents

- EMS (Ethyl Methane Sulphonate) alter the bases by methylation, ethylation etc
- Causing structural distortion of DNA
- They also cause depurination (removal of Purine)
- Other agents are nitrogen mustard, diethyl Sulphate (DES) Ethyl Ethane Sulphonate (EES)

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b) Ionizing Radiations

α & β rays:- do not penetrate beyond human skin and would not produce heritable mutations.

Gamma and X rays:
Collide with the molecules of the cells at high speed and eject electrons from outer shell of atoms. They produce ions and thus produce mutagenic effect.

- These rays produce breaks in the chromosomes, chromatids. These breaks involve sugar-Phosphate backbone.
- These breaks leads to deletion, duplication, translocation, Inversions.
- These changes may cause cell death and often form cancers specially Leukemia.

II. Chemical Mutagens

C. Auerbach first to find the effect of nitrogen mustard.

Chemical Mutagens include peroxides, morphine, caffeine, colchicine, mustard gas, nitrous acid, formaldehyde, base analogues and acridine dyes.

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Induced Mutation

Any physical or chemical agent which is used in artificial induction of mutations is called Mutagens

I. Physical Mutagens

① Temperature: ↑ in temp ↑es the rate of mutation with $Q_{10} = 5$.

⇒ High temp, break the H-bonds and denature the DNA

⇒ Rarely low temp also cause mutation as in Paddy

② Radiations: effect of radiation depends on penetration and ionizing power of rays

a) Non Ionizing Radiations

UV rays – have longer wavelength and carry much lower energy

Noethling and Stubbe – worked on effect of UV rays on pollen grains of Snapdragon.

Knapp – studied the effect of UV rays on spermatozoa of liverwort.

- UV rays are absorbed by nucleic acid and cause alterations in the bonds of Purine and Pyrimidines. The bases so altered are known as Photoproducts
- Pyrimidines are found more prone to such changes and form dimers (Thymine dimers)
- In human beings, the inherited autosomal Recessive disease Xeroderma pigmendosum is the result of defect in repair UV damaged DNA. Person is extremely sensitive to sunlight and cause pigmentation, skin Lesions and than became cancerous.

Spontaneous Mutation

- which occur in nature itself.
- Exact reason is not known but some scientists are of the view that they may be due to radiations in environment
- May be due to Tautomerism. (already Explained)
- due to slow spontaneous deamination
- due to defective proof reading and DNA repair mechanisms.

Rate of spontaneous mutations in some species

Species	Trait	Mutation rate (per 100000 gametes)
Homo sapiens	Retinoblastoma	2
	Albinism	2.8
	Colour blindness	2.8
	Haemophilia	3.2
Diplococcus pneumoniae	Penicillin resistance	0.01
Drosophila melanogaster	Eyeless	2.0

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Induced and Spontaneous Mutations

Spontaneous Mutations	Induced Mutations
• These mutations continuously arise in nature automatically	• These are man made and induced by mutagens.
• These appear in the progeny of parents which were not treated or induced with any known mutation-producing substances	• Produced by various mutagenic agents
• Exact cause of their appearance is not known.	• Cause of mutation is known.
• Produced by naturally occurring mutagenic agents such as cosmic rays, electric currents, atomic particles etc	• X rays, gamma rays, UV rays, chemical agents etc.
• Also called Background mutation as their origin is unknown	
• Mutation rate is very low at all the loci in all the organisms	• Muller's Experiments decided that the mutation rate is much higher in the progeny of Drosophila when treated with X-rays.

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