

Bacterial Genetics

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Bacterial Genetics

- Genetic material of bacterial cell is single DNA molecule with specific molecular weight and base pairs.
- Molecular weight of DNA varies from smallest free living wall-less organism, (Mycoplasma) from 3×10^9 base pairs and encode 100,000 proteins to E. coli with Mol weight 5×10^6 base pairs. Human DNA is linear.

Bacterial Genetics

- Bacteria are haploid hence can produce single copy of each gene.
- Human cells are diploid and produce two copies of each gene, one is dominant and other recessive.

Mutation

- Its defined as change in the base sequence of DNA, which results in insertion of different amino acids into protein and presents as altered phenotype.
- Mechanism of mutation:
 - Base substitution
 - Frame shift mutation
 - Transposons insertion

Base Substitution

- One base is inserted in place of another base. This occurs during DNA replication either due to error in DNA polymerase enzyme or mutation which alters hydrogen bonding of the base i.e. wrong base is inserted.
- This can be miss-sense mutation. When different amino acids are inserted or nonsense mutation when the substitution stops protein synthesis permanently.

Frame Shift Mutation

- It occurs when one or more pairs are added or deleted with production of inactive proteins.

Transposons Insertion

- This occurs when transposons are integrated into DNA which can cause profound changes in the genes.

Causes of Mutation

- Three causes are
 - Chemical
 - Radiation
 - Viruses
- **Chemical :**
 - Some chemicals e.g. nitrous acids and alkylating agents alter the existing base and it forms a hydrogen bond with wrong base. Adenine would not pair with thymine but with cytosine.

- Some chemicals such as benzpyrene found in tobacco bind to existing DNA base and cause frame shift mutation.
 - Since these chemicals are mutagens and carcinogenic, they distort the DNA sequence.
 - **Radiations:**
 - Two forms X-ray ,UV.
 - X-rays have high energy and can damage DNA by breaking the covalent bond or by producing free radicals which can attack the base or alter the electrons in the base.
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- UV radiation is low in energy and cause the cross linking of adjacent pyrimidine base to form dimers, which results in inability of DNA to replicate.

- **Viruses:**

- Certain bacterial viruses MU (mutator bacteriophage) cause high mutation when DNA is inserted into the bacterial chromosomes.

Conditional Lethal Mutations

- They can be useful in vaccines.
- Mutation is only under special conditions.
- These mutations are temperature sensitive.
- Influenza viruses cannot grow at 37 degree centigrade and hence cannot infect the lungs to cause pneumonia, but can grow at 32 C in the nose where it replicates and produces immunity.

DNA Transfer within Bacterial Cells

- Transposons are capable of transferring DNA from one site on bacterial chromosome to another site or to plasmid.
- They synthesize copy of DNA and insert to another site. This transfer of transposons to plasmid and subsequent transfer of plasmid to another bacterium by conjugation results in spread of antibiotic resistance.

- Transfer of DNA can also occur by programmed re-arrangements. It consists of movements of genes from a silent storage site to active site where transcription and translation occurs.

DNA Transfer between Bacterial Cells

- Most important consequence of this transfer is that antibiotic resistance genes are spread from one bacteria to another.
- It is done by three methods:
 - Conjugation
 - Transduction
 - Transformation

Conjugation:

- Mating of two bacterial cells which result in transfer from donor to recipient.
- Fertility plasmid (F Factor) carries the genes for proteins needed for conjugation.
- Pilin protein forms sex pilus, which attaches to the receptors on the surface of recipient female bacterium.

- The cells are drawn into the direct contact by reeling in the pilus.
- Recipient, now F positive male is capable of transmitting the plasmid.
- Some F positive cells become high frequency recombination cells since this plasmid gets integrated into the bacterial DNA and they acquire the capability of transferring the chromosomes into another cell.

Transduction:

- Transfer of DNA by means of bacterial virus called bacteriophage.
- The phage DNA can integrate into cell DNA and the cell acquires new trait i.e lysogenic conversion.
- This can change a non-pathogenic bacteria into pathogenic one e.g diphtheria toxin, cholera toxin, botulinum toxin and erythrogenic toxin (strep.pyogenes).

- Transduction can be generalized when the virus carries a segment from any part of the bacterial chromosome or specialized when the bacterial virus DNA is excised and carries with it an adjacent part of the cell DNA.

Transformation:

- Transfer of DNA itself from one cell to another.
It happens in two ways:
 1. In nature dying bacteria release their DNA which can be taken up by the recipient cells. It does not create a significant effect.
 2. Purified DNA, when injected into eukaryotic cells is called transfection which is frequently used in genetic engineering procedures.

Recombination

- DNA material transferred from one donor to the recipient is integrated by recombination process.
 1. **Homologous recombination** - where two pieces of DNA with extensive homologous regions pair up and exchange pieces by breaking and reunion process.
 2. **Non Homologous recombination** - little homology is needed.