

Chapter 9 Microbial genetics

Section 1 Material foundation of heredity and variation

1 Concepts

Heredity /inheritance is the phenomenon that parents pass a set of genetic material of their own to the next generation, and they carry on the corresponding characters of the parents.

Genotype is all the genetic information carried by whole genetic material of an organism.

Phenotype is all characters of an organism.

Variation is the change of genetic material.

Modification is the change of character of an organism under special condition, but genetic material does not change.

2 Arguments about genetic material

At the end of 19th century, A. Weismann believed that organism could be divided into two parts, namely, plasma and genosma. And the latter was supposed to be genetic material.

At the beginning of 20th century, T.H. Morgan put forward the theory of Gene.

After 1944, 3 classical microbial experiments proved that nucleic acid was genetic material.

3 The three classic experiments

Bacterial transformation

Phage infection

Recombination of plant virus

4 Location and existing state of the genetic material in the cell

On cellular level

On nucleic level

On chromosome level

On nucleic acid level

On gene level

On codon level

On nucleotide level

Section 2 Genetic Mutation

1 Genetic mutation and its types

Genetic mutation is an inherited change in the base sequence of the nucleic acid comprising the genome of an organism.

It includes point mutation and chromosomal aberration.

1) Point mutation

Point mutation includes Base substitution, Transition (A-G; T-C), Transversion (A-T; A-C; G-C; G-T), Frame-shift mutation, Phase-shift mutation, Deletion and Insertion.

2) Chromosomal aberration

Chromosomal aberration includes DNA macrolesion, Deletion Duplication Insertion, Translocation Inversion, Transposition and Transposable Element (TE).

2 Types of mutant

Wild type strain, natural strain, is the microbes that exist in nature.

Mutant is the strain that derives from natural strain, it includes selectable mutant and non-selectable mutant.

Auxotroph is the mutant that needs the supplementation of special nutrient to survive.

Resistant mutant is resistant to some harmful chemicals.

Conditional lethal mutant can not grow or reproduce under special condition.

Morphological mutant is the strain that shows Morphological changes.

Antigenic mutant is the strain that shows changes in its antigenic structures.

3 Characters of genetic mutation

4 Damage on DNA caused by ultraviolet ray and restoration

5 Mutation and breeding

Section 3 Genetic recombination

Genetic recombination is the process by which genetic elements contained in two separate genomes are brought together in one unit.

Genetic recombination usually involves much larger changes. Entire genes, sets of genes, or even whole chromosomes, are transferred between organisms. There are 4 types of genetic recombination.

1 **Transformation** involves donor DNA free in the environment transformant.

1) Competence

Competence is the state in which a cell that is able to take up a molecule of DNA and be transformed.

The cell in competence is called competent cell

2) DNA Transfer by Electroporation

Small pores are produced in the membranes of cells exposed to pulsed electric fields. When DNA molecules are present outside the cells during the electric pulse, they can then enter the cells through these pores. This process is called electroporation.

3) Transforming principle

A piece of 15kb DNA which usually contains 1 gene can be absorbed easily by the cell.

4) Process of transformation

5) Transfection

Bacteria can be transformed with DNA extracted from a bacterial virus rather than from another bacterium, a process known as transfection.

2 **Transduction** is the process in which the donor DNA transfer is mediated by a virus.

General Transduction is the process in which phages which envelope wrong genetic materials of their own hosts pass the genetic material to the recipient cells. It includes complete transduction and abortive transduction .

Specialized transduction is the process in which the DNA of a temperate virus excises incorrectly and brings adjacent host genes along with it; only genes close to the integration point of the virus are transferred. It includes low frequency transduction(LFT) and high frequency transduction(HFT).

3 **Conjugation** is the process in which in which the transfer involves cell-to-cell contact and a conjugative plasmid in the donor cell.

Pili is the way by which one bacterium passes genetic materials to another.

F Plasmid carries special genetic information which controls the formation of pili.

4 Protoplast fusion is the process in which two protoplasts are fused under artificial condition to obtain a new individual which carries the characters of both parents protoplasts.