

Microbes as tools in genetic studies

Microbiology VI

Introduction

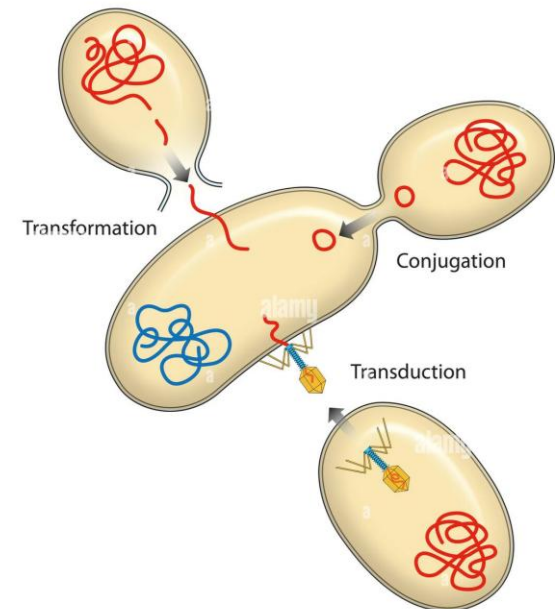
- Microbial genetics studies microorganisms for different purposes & have various applications.
- They are used to study the genotype and expression system.
- They have **rapid growth rates** and **short generation times** are used by scientists to study evolution.
- Microbial genetics also has applications in being able to study **processes** and **pathways** that are similar to those found in humans such as **drug metabolism**.

The role of microorganisms in genetic studies

Bacteria:

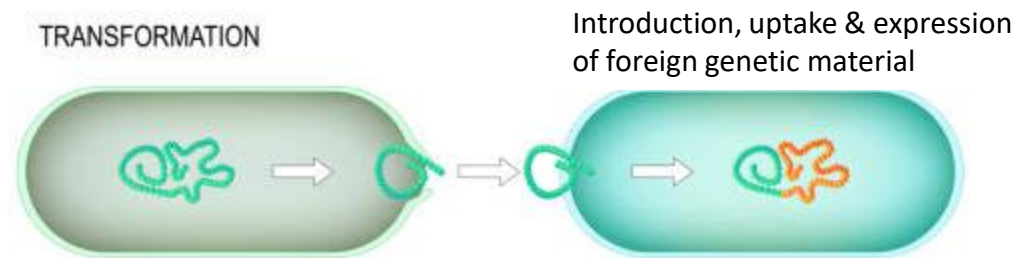
- Bacterial genetics studies the mechanisms of :
 - heritable information
 - chromosomes
 - plasmids
 - transposons
 - phages.

- **Gene transfer** systems extensively studied in bacteria include:
 - genetic transformation
 - conjugation and
 - transduction

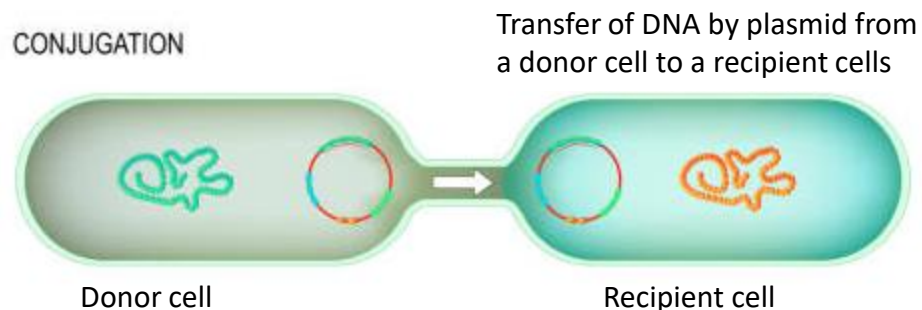


Natural **transformation** :

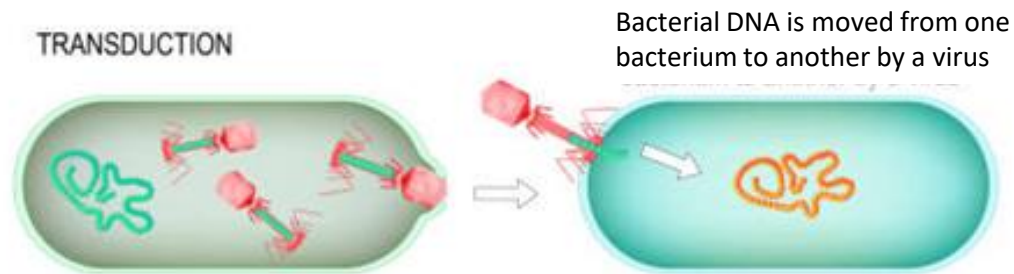
- Is a bacterial adaptation for **DNA transfer** between two cells through the intervening **medium**.
- In general, transformation is a complex, energy-requiring developmental process that appears to be an adaptation for repairing DNA damage.



- Bacterial **conjugation** has been extensively studied in *Escherichia coli*
- Also occurs in other bacteria such as *Mycobacterium smegmatis*.
- *E. coli* conjugation is mediated by expression of **plasmid** genes
- Mycobacterial conjugation is mediated by genes on the bacterial **chromosome**.



- **Transduction** is the process by which foreign DNA is introduced into a cell by a **virus** or viral vector.
- Transduction is a common tool used by molecular biologists to stably introduce a **foreign gene** into a host cell's genome.

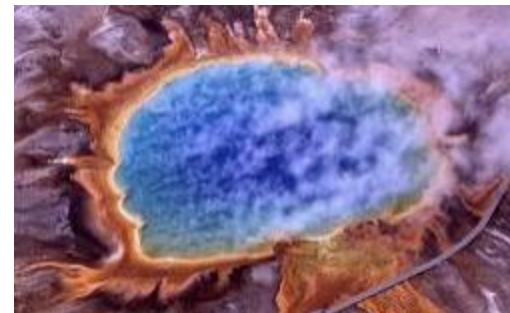
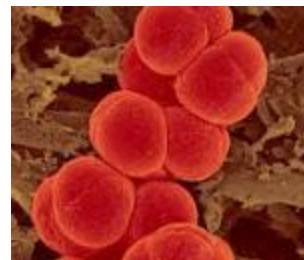


Archaea:

- Archaea is a domain of organisms that are prokaryotic and single-celled.
- They share a common ancestor with bacteria.
- But are more closely related to eukaryotes in comparison to bacteria.

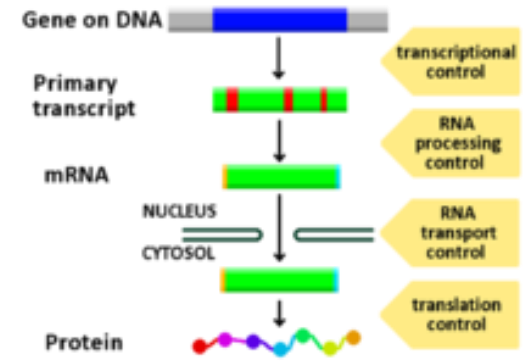
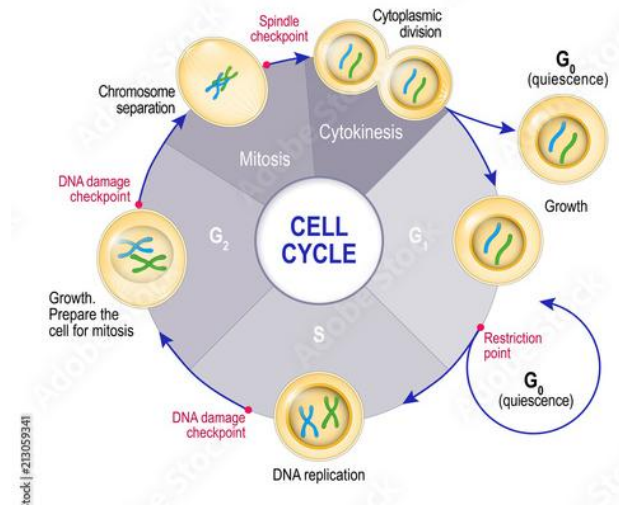
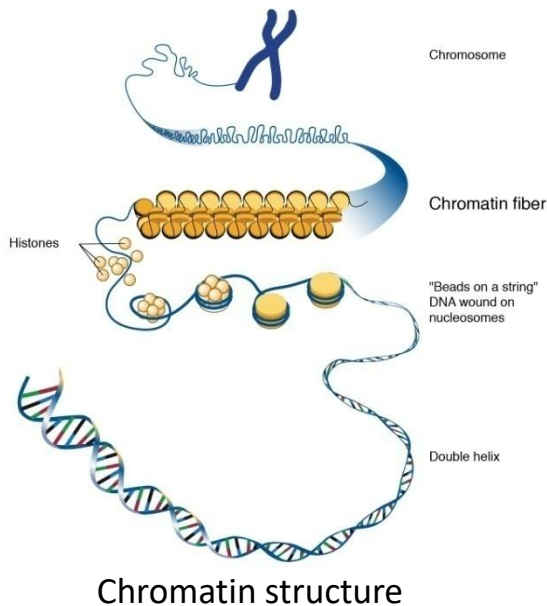
- Some Archaea are able to survive extreme environments, which leads to many applications in the field of genetics.
- Ex. Use of Archaeal enzymes in harsh *in vitro* conditions.

- Gene transfer and genetic exchange have been studied in:
- Halophilic archaeon:
 - *Halobacterium volcanii*
- Hyper thermophilic archaeon :
 - *Sulfolobus solfataricus*
 - *Sulfolobus acidocaldarius*



Fungi:

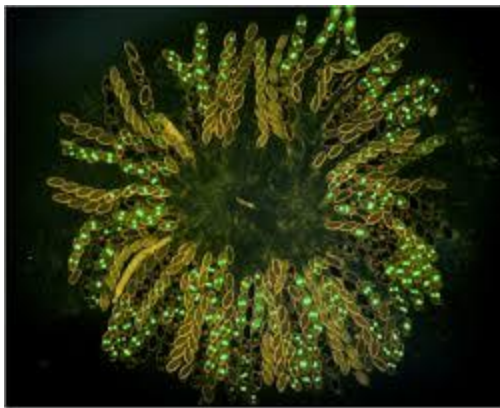
- Fungal genetics uses yeast, and filamentous fungi as model organisms for
 - eukaryotic genetic research
 - cell cycle regulation
 - chromatin structure and
 - gene regulation



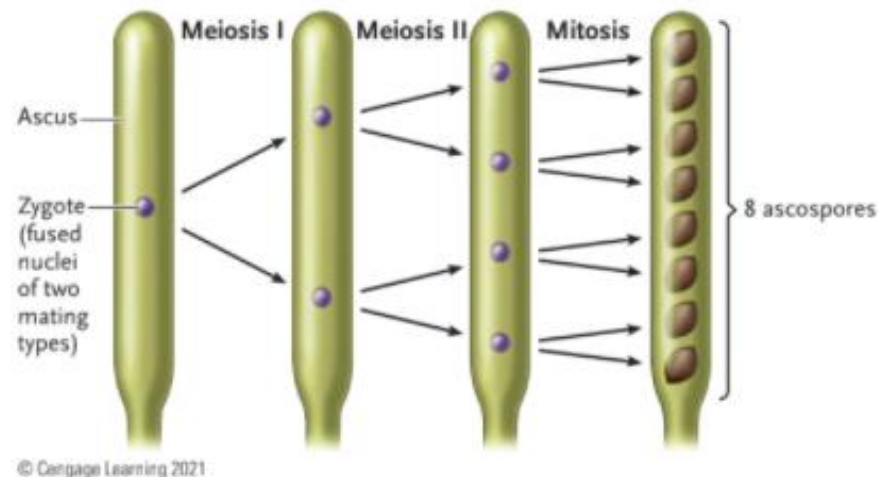
Gene regulation

Neurospora crassa :

- Used as a model organism, it is easy to grow, it has a **haploid** life cycle that makes genetic analysis simple since recessive traits will show up in the offspring.
- Analysis of genetic recombination is facilitated by the ordered arrangement of the products of meiosis in ascospores.
- *Neurospora* was used by **Edward Tatum and George Beadle** in their experiments that led to the **one gene-one enzyme hypothesis** that specific genes code for specific proteins.

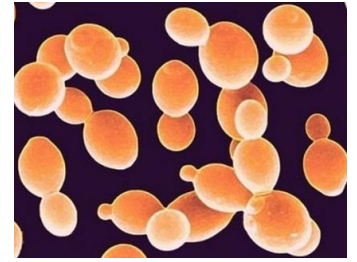


Neurospora crassa



***Saccharomyces cerevisiae* :**

- Is a yeast used to study cell division and mating.
- Vegetative growth it reproduces by mitosis as diploid cells.
- When nutrients are depleted these cells undergo meiosis to form haploid spores.



***Candida albicans*:**

- Is a diploid fungus that grows both as a yeast and as a filament.
- *C. albicans* is the most common fungal pathogen in humans.
- The mating strategy is important for its survival in the human host.
- ***Aspergillus*** species exhibits sexual cycle which is homothallic or self-fertilizing.

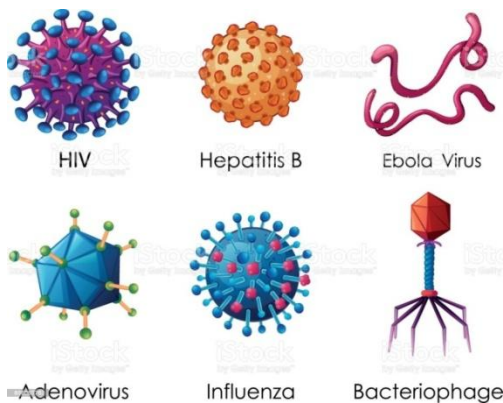


Protozoa

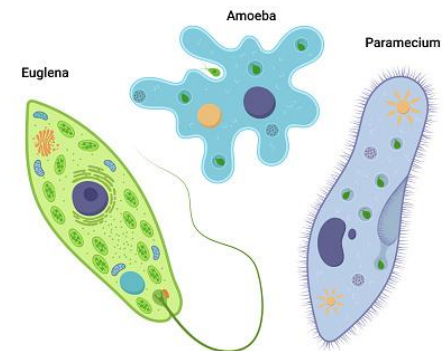
- One particular aspect of protozoa that are of interest to human geneticists is their **flagella**, which are very similar to human sperm flagella.
- Studies of *Paramecium* have contributed to our understanding of the function of **meiosis**.

Viruses

- The viral genome is important to study genetics and also for understanding their pathogenic properties.
- Many types of virus are capable of genetic recombination (transduction).



Viruses



Protozoa