REPRODUCTION IN FUNGI
Reproduction is the biological process by which new individual organisms (offspring) are produced from their "parents".

Reproduction is a fundamental feature of all known life; each individual organism exists as the result of reproduction.

Reproduction involves the production of new individuals resembling the parent(s).

When fungal mycelium has reached a certain stage of maturity and has accumulated reserve food, it starts reproducing.

In fungi, reproduction is of 3 kinds: Vegetative, Asexual and Sexual reproduction.

However, many mycologists include all methods of reproduction (vegetative and spore formation) which do not involve union of nuclei or sex cells or sex organs under asexual or somatic reproduction.
It is the type of reproduction which involves the somatic portion of the fungal thallus where new individuals are formed without the production of seeds or spores by meiosis or syngamy.

This may take place by the following methods:

- Fragmentation of the body of the fungus,
- Fission,
- Budding
- Rhizomorphs and
- In some cases through special bodies called Sclerotia.
This is the separation of hyphae from the mycelium through the splitting of the cross wall or septum into segments or single cells (fragments) called Arthrospores or Arthroconidia or Oidia.

Each fragment/segment behaves as asexual spore and grow apically into new individual or branch into a new mycelium under favourable condition.

Occur in milk mould: *Endomyces lactis*, *Rhizopus stolonifer* and some Ascomycetes.

In some fungi, these cells (fragments) are surrounded by a thick wall and are referred to as Chlamydospores.
Chlamydomospores

- Chlamydomospores are large thick-walled, spore-like resting cells
- They are one-celled fragments
- They contain a lot of reserve food, are resistant to drying and can remain dormant for long periods.
- Any cell could become a chlamydomospore and with the approach of adverse conditions (drying and sunlight), the mycelium dies but the chlamydomospore remain alive but dormant.
- With the onset of conditions favourable for vegetative growth, the chlamydomospore germinates, each producing a new mycelium e.g. *Mucor, Fusarium*. 
Fragmentation in Fungi

A- Arthrospores

B- Chlamydomospores
This is a kind of cell division in which the mother cell elongates and divides into two.

The nucleus divides first and the 2 daughter nuclei move apart with the appearance of a wall in the middle of the cell which forms a complete partition called the **septum**.

The septum thickens and then splits into 2 layers; one for each daughter cell before they separate.

The Ascomycetes with a unicellular thallus such as some yeast (Schizosaccharomyces) usually multiply by this method.
This is common among the yeast (*Saccharomyces sp*).

In this method, the cell protoplast covered by the cell wall bulges out in form of a small protuberance (bud) at or near one pole of the yeast cell which gradually increases in size.

The nucleus of the parent cell along with the vacuole divides and one of the daughter nuclei migrates into the enlarging bud.

A double wall forms in between the bud and the yeast cell and the 2 cells become physiologically distinct.

They subsequently separate from each other leading independent life.

Spores produced from a vegetative mother cell by budding are called **Blastospores**.
In some higher fungi, several hyphae may become interwoven to form rope-like structures called **rhizomorphs**.

These fine, root-like strands, usually dark brown in colour, serve as a means of perennation.

Under unfavourable conditions rhizomorphs remain dormant.

With the onset of favourable conditions, the rhizomorphs resume growth and give rise to new mycelia or fruiting bodies.
This is a compact, often hard and interwoven mass of hyphae occasionally with a dark firm outer covering layer but normally without any spore in it.

They remain dormant under unfavourable conditions and germinate into new mycelia or fruit-body on the return of favourable conditions e.g. *Claviceps* (ergot).

They may be rounded, cylindrical, cushion-shaped or irregularly shaped with a dense mass of thick walled hyphae.

They serve as a means of perennation and vegetative propagation.
ASEXUAL REPRODUCTION
Asexual reproduction takes place by the formation of special reproductive cells called spores.

**Sporulation** is the formation of spores of various natures in Fungi.

Spore formation is the most widely distributed and most highly differentiated method.

Spores are the common propagative units of fungi because asexual spores are formed with more ease; they are small and light.

The majority of the spores are air-borne and thus frequently aid in fungal dissemination.

Some are often spread by adhering to the bodies of insects and other animals.

The size, shape, colour, ornamentation and number of spores produced are useful in the identification of fungal species.

Asexual spore formation occurs in an individual fungus through mitosis and subsequent cell division.

There are several types of asexual spores produced:
These are asexual spores produced endogenously in special sac-like asexual reproductive organs called **Sporangium**, borne at the tips of the hyphae called sporangiophores.

The sporangiospores may be motile or non-motile (aplanospores).

Examples are found in *Rhizopus* and *Mucor*.
CONIDIOPORES/CONIDIA

- These are exogenously produced non-motile, deciduous asexual spores which are not enclosed in a sac.
- but are exposed singly or successively at the tips or sides of the hypha called Conidiophores.
- Examples are found in Aspergillus sp and Penicillium sp.
Zoospores:

- These are motile asexual spores lacking cell wall e.g. aquatic fungi like *Pythium*
- The spores have flagella and may be **Uniflagellate** (Chytridiomycetes) or **Biflagellate** (Oomycetes)
- The sporangium bearing them is called zoosporangium
- After a swarming period, it secretes a wall and germinates to form a germ tube.
- In contrast to zoospores, the aplanospores have a definite spore wall and are dispersed by wind and insects

Flagellation in the Lower Fungi

- **A**- a single whiplash flagellum with a pointed tip
- **B**- a single tinsel flagellum
- **C**- anterior biflagellate whiplash
- **D**- anterior biflagellate pyriform shape (one tinsel type and the other whiplash)
- **E**- lateral biflagellate kidney-shaped (one tinsel type and the other whiplash)
SEXUAL REPRODUCTION

- This involves the union or conjugation or fusion of 2 nuclei to form a zygote nucleus.
- Some fungal species are self-fertilizing and produce sexually compatible gametes on the same mycelium (homothallic).
- Other species require outcrossing between different but sexually compatible mycelia (heterothallic).
- Depending on the species, sexual fusion may occur between two compatible haploid gametes (sexual cells) or gamete-producing bodies called gametangia or hyphae of opposite strains.
- Haploid fungi form hyphae that have gametes at the tips.
- Two different mating types (represented as “+ type” and “– type”) are involved.
- Sexual reproduction yields sexual spores e.g. zygote develops into a zygospores in Zygomycetes, ascospores in Ascomycetes, and basidiospores in Basidiomycetes.
- Sexually reproduction is usually divided into 3 phases:
PHASES OF SEXUAL REPRODUCTION

1. PLASMOGAMY:
   • This is the fusion of 2 protoplasts (or cytoplasms) resulting to a cell with 2 distinct haploid nuclei (dikaryotic cell) one from each parent.

2. KARYOGAMY:
   • This is the fusion of 2 haploid nuclei (from plasmogamy) to form a diploid nucleus of the zygote.
   • Ordinarily, karyogamy occurs immediately after plasmogamy in lower fungi.
   • However, in the higher fungi (the basidiomycetes), a time lag occurs in between the 2 phases resulting in bi-nucleate cells called Dikaryons.

3. MEIOSIS:
   • This is the reduction division of the chromosome to the haploid number
   • Diploid nucleus undergoes meiosis to produce haploid nuclei
   • It helps in the recombination of genetic materials and restoration of the haploid condition of the cells producing four genetically different spores
   • The spores germinate to start the haploid stage, which eventually creates more haploid mycelia.
Fungi reproduce by a number of sexual methods which includes the following:

1. **PLANOGAMETIC COPULATION:**
   - This involves the fusion of 2 naked gametes (**Planogametes**) one or both of which are motile to form a diploid zygote.
   - The gametes may be morphologically similar (**Isogametes**) e.g. *Catenaria*, and the fusion is called **Isogamy**
   - Or morphologically dissimilar (**Anisogametes**) e.g. *Allomyces*, and the fusion is called **Anisogamy**
   - The male gametangia are called **Antheridia** and the female ones called **Oogonia**.
   - The gametes could also be oogamous type where female gamete (**egg**) is non-motile and the male gamete (**sperm**) is motile
   - In **oogamy**, the motile antherozoid enters oogonium and unites with egg or oosphere forming a zygote e.g. *Pythium* and *Albugo*. 
1. PLANOGAMETIC COPULATION
2. GAMETANGIAL CONTACT:

- In this case, non-motile gametes (Aplanogametes) are produced.
- The gametes are not physically released from the gametangia to the outside but instead,
  - The 2 gametangia of opposite sex come in contact and one or more of the gametes migrates from the male (antheridium) to the female gametangium (oogonium) through a slender, tubular outgrowth called the fertilization tube.
- Occurs in *Pythium, Saprolegnia* and *Albugo*. 
3. GAMETANGIAL COPULATION (Conjugation):

- Involves the fusion of the entire contents of 2 gametangia (male and female) that have come into contact.
- This is common among the *Mucor* and *Rhizopus sp.*
4. SOMATOGAMY:

- This is common in the higher fungi (the Basidiomycetes) and yeasts.
- In this case, no sex organs are produced.
- Involves fusion between matured somatic cells (undifferentiated vegetative cells) of the same thallus or two different thalli thereby taking over the sexual role.
- E.g. involves fusion of hyphae.
5. SPERMATOGAMY:

- It involves numerous uninucleate, unicellular, non-motile male cells called spermatia which are borne externally or inside the cavities or hyphae.
- These spermatia are carried to the female gametangia by various agents like wind, water e.t.c.
- A pore is developed at the point of contact and the contents of the spermatium are transferred to the receptive hyphae and form a dikaryon.
Types of sexual reproduction in fungi

- ISOGAMY
- ANISOGAMY
- OOGAMY
- PLANOGAMETIC COPULATION
- GAMETANGIAL CONTACT
- GAMETANGIAL COPULATION
- SPERMATOGAMY
- SOMATOGAMY

Types of sexual reproduction in fungi.