

## Common bacterial diseases

| Disease                  | Causative agent                   | Description of agent            | Organs affected                   | Transmission or vector |
|--------------------------|-----------------------------------|---------------------------------|-----------------------------------|------------------------|
| Pertussis                | <i>Bordetella pertussis</i>       | Gram-negative; rod              | Upper respiratory tract           | Air                    |
| Meningococcal Meningitis | <i>Neisseria meningitidis</i>     | Gram-negative; diplococcus      | Upper respiratory tract; meninges | Air                    |
| Tuberculosis             | <i>Mycobacterium tuberculosis</i> | weakly Gram-positive; Acid-fast | Lungs, Bones, other organs        | Air                    |
| Typhoid fever            | <i>Salmonella typhi</i>           | Gram-negative; rod              | Intestine, blood, gall bladder    | Food, water            |

| Disease   | Causative agent              | Description of agent                        | Organs affected                                      | Transmission or vector |
|-----------|------------------------------|---------------------------------------------|------------------------------------------------------|------------------------|
| Cholera   | <i>Vibrio cholerae</i>       | Gram-negative; rod                          | Intestine                                            | Food, water            |
| Tetanus   | <i>Clostridium tetani</i>    | Gram-positive; spore-forming; anaerobic rod | Nerves at synapse                                    | Soil                   |
| Syphilis  | <i>Treponema pallidum</i>    | Spirochete; Gram-negative                   | Skin, cardio-vascular organs                         | Sexual                 |
| Gonorrhea | <i>Neisseria gonorrhoeae</i> | Gram-negative; Diplococcus                  | Urethra, cervix, oviduct, pharynx, epididymis, eyes, | Sexual                 |
| Leprosy   | <i>Mycobacterium leprae</i>  | Acid-fast; bacillus, Gram-positive          | Skin, bones, peripheral nerves                       | Contact                |

## Archaea

- They belong to the domain Archaea.
- They are unicellular, microscopic organisms that live as producers or decomposers.
- They are similar to bacteria.
  - Circular chromosome
  - No membrane-bound organelles
  - Asexual reproduction

## Characteristics of Archaea

- They are single-celled, prokaryotic organisms.
- They lack membrane bound nucleus and membrane bounded organelles.
- No true peptidoglycan in their cell walls.
- Their cell membrane lipids have branched hydrocarbon chains.
- Many are found in extreme environments.

## Major groups of archaea

- The **three** major groups of archaea based on physiological characteristics are:

### 1. Methanogens

- They are strictly anaerobic organisms.
  - They are isolated from anaerobic environments like waterlogged soil and GIT of animals.
- They generate methane by degrading organic molecules.

### 2. Extreme halophiles

- They grow in highly saline environments.
  - They can grow in environments even with 15% (w/v) salt to saturation.
- They expend energy to exclude salt from their cytoplasm to avoid protein aggregation.
- They are generally obligate aerobes.

### **3. Extreme thermophiles (Hyperthermophiles)**

- They thrive at relatively high temperatures, between 41 and 122°C.
- They are found near volcanic vents and fissures that release hot vapours.
- They may be either obligate aerobes, facultative aerobes, or obligate anaerobes.

### **4. Thermophilic Extreme Acidophiles**

- They grow in extremely acidic, hot environment.
- They live at low pH (as low as pH 1 and die at pH 7).

### A comparison of archaea and bacteria

| Characteristics             | Bacteria           | Archae       |
|-----------------------------|--------------------|--------------|
| True peptidoglycan          | Yes                | No           |
| Membrane lipid              | Ester-linked       | Ether-linked |
| Protein synthesis initiator | N-Formylmethionine | Methionine   |

### Reproduction in Archaea

- They multiply by binary fission, budding, fragmentation or other mechanisms.

### Nutrition in Archaea

- They are either aerobic, facultative anaerobic or strictly anaerobic.
- They are chemolithoautotroph to organotrophs.

## Beneficial aspects of archaea

- They have been exploited for a wide variety of commercial uses.
  1. Their proteases and lipases are added to detergents
  2. They bear the potential for bio-remediation
  3. An enzyme from *Thermus aquaticus* is used in the amplification of DNA in PCR.

## Physical factors that affect microbial growth

- The major factors are solutes and water activity, pH, temperature, oxygen level, pressure and radiation.

## Fungi

- They are eukaryotic organisms.
- They are spore-bearing.
- They lack chlorophyll and have absorptive nutrition.
- They reproduce sexually and asexually.

- The study of fungi is called *mycology*.
- Scientists who study fungi are *mycologists*.
- The study of fungal toxins and their effects is called *mycotoxicology*.
- The diseases caused by fungi in animals are known as *mycoses*.

## General Characteristics of True Fungi

- All are eukaryotic.
- Most are filamentous.
  - They are composed of individual microscopic filaments called **hyphae**.
    - ✓ A network of hyphae is called **mycelium**.
  - Some have septate hyphae and the other have nonseptate (coenocytic hyphae).

- Some are unicellular. e.g. yeasts
- The cell wall of fungi is composed mainly of chitin, glucans and in some fungi cellulose.
- Many fungi reproduce both sexually and asexually.
  - Both sexual and asexual reproduction often result in the production of spores.

- Their nuclei are typically haploid and hyphal compartments are often multinucleate.
  - Although the Oomycota and some yeasts possess diploid nuclei.
- All are achlorophyllous.
- All are chemoheterotrophic (chemoorganotrophic)
- They possess characteristic range of storage compounds e.g. trehalose, glycogen, sugar alcohols and lipids.

- Nutritionally, they are categorized into three:
  1. **Saprophytic:** obtain food by absorbing dissolved organic material
  2. **Parasitic:** living on another organism.
  3. **Symbiotic:** close and long-term biological inter-action with other organism

## Ecology of Fungi

- They have colonized nearly all environments.
  - They are frequently found in cool, dark, and moist places.
- They are saprobes that decompose organic matter.
- They form mutualistic associations with other organisms. These are:

1. **Mycorrhiza:** A fungus which grows in association with the roots of a plant.
2. **Ant-fungus mutualism:** A symbiosis seen between certain ant and fungi.
3. **Lichens:** A symbiotic relationship between a fungus and a photosynthetic organism.
4. **Animal-fungus relationship:** Some animals disseminate fungal spores over long distances.

## Classification of Fungi

- There are five major groups of fungi.

| Fungal group    | Description               | Examples               |
|-----------------|---------------------------|------------------------|
| Chytridiomycota | Zoospore producing fungi  | Allomyces, Water molds |
| Zygomycota      | Sporangial fungi          | Rhizopus, Mucor        |
| Ascomycota      | Ascospore producing fungi | <i>S. cerevisiae</i>   |
| Basidiomycota   | Basidia producing fungi   | Rusts and Smuts        |
| Glomeromycota   | Form mycorrhizas          | Orchid mycorrhiza      |

## Reproduction in Fungi

- Most fungi reproduce by forming spores that can survive extreme conditions such as cold and lack of water.
  - The process of producing spores is called sporulation or spore formation.
- Fungal spores are extremely light and are easily blown by wind.
- The important methods of reproduction in fungi are asexual and sexual reproduction.

**a. Asexual reproduction**

- Asexual reproductive structures develop at the ends of hyphae.
  - Many asexual spores (sporangiospores) develop within sporangia.
  - Other fungi produce spores (conidia) on conidiophores.
  - Spores (arthrospores) may also form by fragmentation of the hyphae.

- Many yeasts reproduce asexually by budding.
  - A blastospore is an asexual fungal spore produced by budding.

**b. Sexual Reproduction**

- Spores are produced by sexual reproduction.
- Opposite mating types of fungi come together and fuse to form a heterokaryon.

- A heterokaryon is a multinucleate cell that contains genetically different nuclei.
- The nuclei fuse and a diploid cell forms.
- Meiosis returns the cell or organism to a haploid condition.
- Fruiting body is the location of the haploid spores.

## **Economic Importance of Fungi**

### **i. Beneficial aspects of fungi**

- Fungi exist either as saprobes or parasites.
- Edible mushrooms (Basidiomycetes) are important as food sources.
- Some fungi (e.g. yeasts) are essential to many industrial processes involving fermentation.

- Fungi play a major role in the preparation of some cheeses, soy sauce, sufu, Enjera, and traditional alcoholic drinks.
- They are important in the commercial production of the following:
  - organic acids (e.g. citric, gallic, oxalic, gluconic and itaconic acid),
  - certain drugs (ergometrine, cortisone)

- antibiotics (Penicillin, Amphotericin B, Adriamycin and Bleomycin, etc.), and
  - immunosuppressive drugs (cyclosporin).
- Fungi are useful tools for studying complex eukaryotic events, such as cancer and aging within simple cell.

## ii. Harmful aspects of fungi

- Fungi are the major cause of plant disease.
- Molds can cause deterioration of manufactured goods.
- They can spoil vegetables, fruits and cereals.
- Mycotoxicoses (ingestion of fungal toxins) and mycetismus (mushroom poisoning)

- a. **Aflatoxins:** poisonous carcinogens and mutagens that are produced by certain molds, particularly *Aspergillus* species.
- b. **Ergotism:** poisoning produced by eating food affected by ergot.
  - *Claviceps purpurea* produces alkaloids (ergot) that can cause ergotism.
- c. **Mycetism:** The harmful effects from ingestion of toxic substances present in a mushroom.

- They can cause superficial fungal infections.
  - Superficial fungal infections (mycoses) are infections of the skin, scalp, hair and nails.
  - They are caused by filamentous fungi in the genera *Trichophyton*, *Epidermophyton*, and *Microsporum*.
  - They include tinea corporis, tinea pedis, tinea capitis, tinea barbae, and tinea unguium.

| Infections                      | Cause (s)                                                                     | Affected body part                 |
|---------------------------------|-------------------------------------------------------------------------------|------------------------------------|
| Tinea corporis<br>(Ring worm)   | <i>Microsporum canis</i> and <i>Trichophyton mentagrophytes</i>               | Affects hairless skin              |
| Tinea pedis<br>(Athlete's foot) | <i>T. rubrum</i> , <i>T. mentagrophytes</i> , <i>Epidermophyton floccosum</i> | Affects mainly the lower legs      |
| Tinea capitis                   | <i>T. Tonsurans</i> & <i>M. canis</i>                                         | The scalp, eyebrows, and eyelashes |

| Infections                       | Cause (s)                                                             | Affected body part                             |
|----------------------------------|-----------------------------------------------------------------------|------------------------------------------------|
| Tinea barbae<br>(Beard ringworm) | <i>T. Rubrum</i> and <i>T. mentagrophytes</i>                         | Hair follicles in the beard and mustache area. |
| Tinea unguium<br>(Onychomycosis) | <i>T. Rubrum</i> , <i>T. mentagrophytes</i> , and <i>E. floccosum</i> | Affect the nails                               |

- Superficial fungal infections are transmitted by:
  - Direct human contact
  - Animal-human contact
  - Indirect contact (clothes, carpets, swimming pools, showers, wardrobes, gyms etc)
- They can be prevented by regular disinfection of showers and wardrobes.

| Disease                  | Causative agent                                                                                                   | Signs and Symptoms                         | Transmission                         | Prevention and control                                                                                      |
|--------------------------|-------------------------------------------------------------------------------------------------------------------|--------------------------------------------|--------------------------------------|-------------------------------------------------------------------------------------------------------------|
| Dermatophytosis (tineas) | <ul style="list-style-type: none"> <li>• Epidermophyton</li> <li>• Microsporum</li> <li>• Trichophyton</li> </ul> | Blister-like lesions                       | Fragments of skin on floors/surfaces | <ul style="list-style-type: none"> <li>• Keeping skin dry</li> <li>• Not sharing personal items</li> </ul>  |
| Candidiasis              | <i>Candida albicans</i>                                                                                           | Itching, burning pains, "cheesy" discharge | Sexual                               | <ul style="list-style-type: none"> <li>• Avoiding baths hot and tubs</li> <li>• Avoiding douches</li> </ul> |

| Disease        | Causative agent              | Signs and Symptoms                                     | Transmission                    | Prevention and control                                                                                            |
|----------------|------------------------------|--------------------------------------------------------|---------------------------------|-------------------------------------------------------------------------------------------------------------------|
| Thrush         | <i>Candida albicans</i>      | White flecks on mucous membranes                       | Passage through the birth canal | <ul style="list-style-type: none"> <li>• Practicing good oral hygiene</li> <li>• Limiting sugar intake</li> </ul> |
| Aspergilliosis | <i>Aspergillus fumigatus</i> | Bloody cough, chest pain, Wheezing shortness of breath | Air borne spores                | <ul style="list-style-type: none"> <li>• Staying away from sources of mold</li> </ul>                             |

## Protozoa

- The Protozoa are considered to be a subkingdom of the kingdom Protista.
- Protozoa are microscopic unicellular eukaryotes.
- They have a relatively complex internal structure and carry out complex metabolic activities.
- Historically, protozoans were regarded as "one-celled animals".

## Characteristics of Protozoa

- Unicellular microorganisms that lack cell wall.
- They are eukaryotes and possess true nucleus.
- Protozoa are either free-living or parasitic.
  - All parasitic protozoa require preformed organic substances.
- They appear to be obligate aerobes (they cannot survive without oxygen).

- Most are microscopic, only a few protozoa grow to a size large enough to be visible to the naked.
- Locomotion in protozoans can be flagellar, ciliary, or amoeboid.
  - Some protozoa do not move around (sessile).
- Autotrophic, heterotrophic and saprozoic nutrition.
  - Saprozoic: Using nutrients dissolved in the surrounding medium

- Free-living protozoa are common in fresh, brackish and salt water, as well as other moist environments.
- Reproduction is both asexual and sexual.
  - The most common type of asexual reproduction is binary fission.
  - ✓ They also reproduce by budding and cysts.

- They reproduce sexually by conjugation or syngamy.
  - ✓ Conjugation: Two individuals exchange haploid micronuclei but do not reproduce.
  - ✓ Syngamy: The union of gametes to form a zygote.

## Classification of Protozoa

| Category        | Locomotion               | Asexual Reproduction | Sexual Reproduction                            | Representatives                                                |
|-----------------|--------------------------|----------------------|------------------------------------------------|----------------------------------------------------------------|
| Ciliates        | Cilia                    | Transverse fission   | Conjugation                                    | Balantidium coli, Paramecium, Stentor, Tetrahymena, Vorticella |
| Amebae (amebas) | Pseudopodia (false feet) | Binary fission       | When present it involves flagellated sex cells | Amoeba, Naegleria, Entamoeba histolytica                       |

| Category    | Locomotion | Asexual Reproduction | Sexual Reproduction            | Representatives                                          |
|-------------|------------|----------------------|--------------------------------|----------------------------------------------------------|
| Flagellates | Flagella   | Binary fission       | None                           | Chlamydomonas, Giardia lamblia, Trichomonas, Trypanosoma |
| Sporozoa    | Non-motile | Multiple fission     | Involves flagellated sex cells | Plasmodium, Toxoplasma gondii, Cryptosporidium           |

## Reproduction in Protozoa

- Most Protozoa are asexual and reproduce in one of the below three ways:
  - 1. Fission:** A cell divides evenly to form two new cells.
  - 2. Budding:** A cell divides unevenly.
  - 3. Multiple fission (Schizogony):** The nucleus of the cell divides multiple times before the rest of the cell divides. e.g. parasitic sporozoans

- Sexual reproduction also occurs during the life cycle of most protozoa.
- It takes place by means of conjugation.
  - Sexual reproduction occurs most often in ciliates.
  - It requires two cells of the same species to exchange genetic information so that a uniquely-genetic offspring will be created.

### Nutrition in Protozoa

- The nutrition of all protozoa is holozoic.
  - They require organic materials, which may be particulate or in solution.
- They are heterotrophic and can grow in both aerobic and anaerobic environments.
- Some protozoa (e.g. *Euglena*) obtain nutrients from organic matter and by photosynthesis.

- Protists obtain food in one of the following ways:
  - i. Absorption:** Food absorption across plasma membrane
  - ii. Ingestion:** moving food into a cytosome
  - iii. Engulf:** Surround and pull food into the cell using phagocytosis.
- Vacuole digests food and waste products are excreted by exocytosis.