Algae
Characteristics and Classification
• Algae are photosynthetic, eucaryotic organisms.
• All algal cells consist of cytoplasm, a cell wall (usually), a cell membrane, a nucleus, plastids, ribosomes, mitochondria, and Golgi bodies.
– Some have a pellicle, a stigma, and/or flagella
– Algae range in size from unicellular microorganisms (e.g., diatoms) to large, multi-cellular organisms (e.g., seaweeds or kelp).
– Algae produce energy by photosynthesis.
– Some may use organic nutrients.

Algae
Characteristics and Classification, cont.
• Algae may be arranged in colonies or strands and are found in fresh and salt water, in wet soil, and on wet rocks.
• Most algal cell walls contain cellulose.
• Depending on their photosynthetic pigments, algae are classified as green, golden, brown, or red algae.
• Algae include: diatoms, dinoflagellates, desmids, *Spirogyra*, *Chlamydomonas*, *Volvox*, and *Euglena*.
• Algae are an important source of food, iodine, fertilizers, emulsifiers, and stabilizers and gelling agents for jams and culture media.

Common Pond Water Algae and Protozoa
Algae: Medical Significance
• One genus of algae, *Prototheca*, is a very rare cause of human infections.
• Causes *protothecosis*
• Algae in several other genera secrete toxic substances called *phyctoxins*
– Poisonous to humans, fish, and other animals
– If ingested by humans, the phycotoxins produced by the dinoflagellates that cause “red tides” can lead to a disease called paralytic shellfish poisoning

Protozoa
Characteristics, cont.
Protozoa
Characteristics (continued)
• Protozoa are divided into groups, based on their method of locomotion:
  – Amebæ move by means of pseudopodia (“false feet”) – example: *Entamoeba histolytica*, the cause of amebic dysentery.
  – Ciliates move by means of hairlike cilia – example: *Balantidium coli*, the cause of balantidiasis.
  – Flagellates move by means of whiplike flagella – example: *Giardia lamblia*, the cause of giardiasis.
  – Sporozoans have no visible means of locomotion – example: *Plasmodium* spp., which cause malaria.

Fungi
Characteristics
• The study of fungi is called *mycology*; scientists who study fungi are called mycologists.
• Fungi are found virtually everywhere.
• Some fungi are harmful, some are beneficial.
• Fungi represent a diverse group of eucaryotic organisms that include yeasts, moulds, and fleshy fungi (e.g., mushrooms).
• Fungi are the “garbage disposers” of nature.
• Fungi are not plants – they are not photosynthetic.

Fungi
Characteristics, cont.
• Fungal cell walls contain a polysaccharide called *chitin*.
• Some fungi are unicellular, while others grow as filaments called *hyphae*.
  – Hyphae intertwine to form a mass called a *mycelium*.
• Some fungi have *septate hyphae* (the hyphae are divided into cells by cross walls or septa).
• Some fungi have *aseptate hyphae* (the hyphae do not have septa).
• Whether or not a fungus has aseptate or septate hyphae is an important clue to its identification.

Fungi
Reproduction
• Depending on the species, fungal cells can reproduce by budding, hyphal extension, or the formation of spores.
  – There are 2 general categories of spores:
    – Sexual spores
    – Asexual spores (also called *conidia*)
  – Some fungi produce both asexual and sexual spores.
  – Fungal spores are very resistant structures.

Fungal Colonies and Terms
Relating to Hyphae
Fungi
Classification
Classification of fungi is based primarily on their mode of sexual reproduction and the type of sexual spore they produce.

- The 5 phyla of fungi are: Zygomycotina, Chytridiomycotina, Ascomycotina, Basidiomycotina, and Deuteromycotina.
- Deuteromycotina or Deuteromycetes include the medically important moulds such as Aspergillus and Penicillium.
  - Fungi in this phylum have no mode of sexual reproduction or the mode of sexual reproduction is not known.

Microscopic Appearance of Various Fungi

Fungi: Yeasts
- Yeasts are eucaryotic, unicellular organisms that lack mycelia.
- Individual yeast cells, also referred to as blastospores or blastoconidia, can only be observed using a microscope.
- Yeasts usually reproduce by budding, but occasionally by a type of spore formation.
- A string of elongated buds is known as a pseudohypha (not really a hypha).
- Some yeasts produce thick-walled, spore-like structures called chlamydospores (or chlamydoconidia).

Microscopic Appearance of the Yeast Candida albicans

Fungi: Yeasts, cont.
- Yeasts are found in soil and water and on the skins of many fruits and vegetables.
  - Yeasts have been used for centuries to make wine and beer.
  - Saccharomyces cerevisiae is a yeast used in baking.
  - Candida albicans is the yeast most frequently isolated from human clinical specimens, and is also the fungus most frequently isolated from human clinical specimens.

Fungi: Yeasts, cont.
- Yeast colonies may be difficult to distinguish from bacterial colonies.
  - A simple wet mount can be used to differentiate yeast colonies from bacterial colonies.
  - Yeasts are larger than bacteria and are usually oval-shaped.
  - Yeasts are often observed in the process of budding.
  - Bacteria do not bud.

Colonies of C. albicans on Blood Agar

Gram-Stained Clinical Specimen Containing Yeasts, Bacteria, and White Blood Cells

Fungi: Moulds
- Often spelled “molds.”
- Moulds are often seen in water and soil and growing on food.
- Moulds produce cytoplasmic filaments called hyphae.
  - Aerial hyphae extend above the surface of whatever the mould is growing on.
  - Vegetative hyphae grow beneath the surface.
- Reproduction is by spore formation, either sexually or asexually, on the aerial hyphae (also known as reproductive hyphae).

Fungi: Moulds, cont.
- Moulds have great commercial importance.
  - Some produce antibiotics.
    - Examples: Penicillium and Cephalosporium
  - Some moulds are used to produce large quantities of enzymes that are used commercially.
  - The flavor of cheeses like bleu cheese, Roquefort, camembert, and limburger are due to moulds that grow in them.

Fungi: Fleshy Fungi
- Include mushrooms, toadstools, puffballs and bracket fungi
- Consist of a network of filaments or strands (the mycelium) that grows in soil or on rotting logs
- The fruiting body that grows above the ground forms and releases spores
- Some mushrooms are edible; some are extremely toxic

Fungi Medical Significance
- A variety of fungi including yeasts, moulds, and some fleshy fungi, are of medical, veterinary and agricultural importance because of the diseases they cause in humans, animals, and plants.
- The infectious diseases of humans and animals that are caused by moulds are called mycoses.
- Fungal infections of humans are categorized as superficial, cutaneous, subcutaneous, and systemic mycoses.
- Superficial and Cutaneous Mycoses
  - Superficial mycoses are fungal infections of the outermost areas of the human body – hair, nails and epidermis.
  - Cutaneous mycoses are fungal infections of the living layer of the skin, the dermis.
    - A group of moulds collectively referred to as dermatophytes cause tinea (“ringworm”) infections.
    - Note that “ringworm” infections have nothing to do with worms.
    - The yeast, Candida albicans, can also cause cutaneous, oral, and vaginal infections.
- Subcutaneous and Systemic Mycoses
  - Subcutaneous and systemic mycoses are more severe types of fungal infections.
  - Subcutaneous mycoses are fungal infections of the dermis and underlying tissues. Example: Madura foot.
  - Systemic mycoses are fungal infections of the internal organs of the body.
Spores of some pathogenic fungi may be inhaled with dust from contaminated soil or dried bird or bat feces. They may also enter through wounds of the hands and feet. Subcutaneous and Systemic Mycoses, cont.

- Examples of deep-seated pulmonary infections include blastomycosis, coccidioidomycosis, cryptococcosis, and histoplasmosis.
- Inhalation of common bread moulds like *Rhizopus* and *Mucor* spp. can cause disease and even death in immunosuppressed patients.
- Diagnosis of mycoses is accomplished by culture techniques and immunodiagnostic procedures.
  - Yeasts are identified using a series of biochemical tests.
  - Moulds are identified using a combination of macroscopic and microscopic observations.

### Dimorphic Fungi

- A few fungi, including some pathogens, can live as either yeasts or moulds, depending on growth conditions. This phenomenon is known as *dimorphism* and the fungi are called *dimorphic fungi*.
  - When grown in vitro at body temperature (37°C), dimorphic fungi grow as yeasts and produce yeast colonies.
  - When grown in vitro at room temperature (25°C), dimorphic fungi exist as moulds, producing mould colonies.
  - In vivo, dimorphic fungi exist as yeasts.

### Dimorphic Fungi, cont.

- Dimorphic fungi that cause human diseases include:
  - *Histoplasma capsulatum* (histoplasmosis)
  - *Sporothrix schenckii* (sporotrichosis)
  - *Coccidioides immitis* (coccidioidomycosis)
  - *Blastomyces dermatitidis* (blastomycosis)

### Lichens and Slime Moulds

- Lichens are observed as colored, often circular patches on tree trunks and rocks.
  - Lichens are composed of an alga and a fungus living in a mutualistic relationship.
  - Lichens are classified as protists.
- Slime moulds are found in soil and on rotting logs.
  - Slime moulds have both fungal and protozoal characteristics.
  - Slime moulds are classified as protists.

### Different Types of Lichens