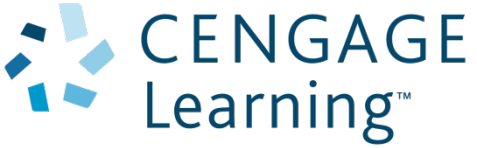
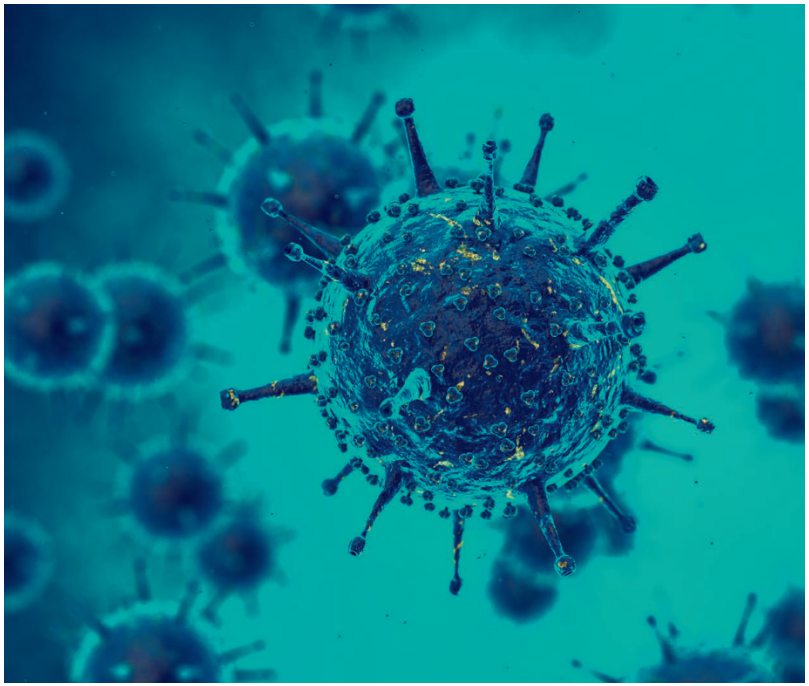
Chapter 12:
Pathogens and their diseases



Terminology

A **virus** is a non-cellular pathogenic agent, containing either DNA or RNA, that can only reproduce inside a living host cell. When a virus finds a host, multiplies and spreads, it can become a **disease**. A disease is any condition that interferes with how an organism, or any part of it, functions.



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Example:

The official name for the **virus** responsible for COVID-19 is the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).
The official name for the **disease** caused by the SARS-CoV-2 virus is COVID-19 (coronavirus disease).

Terminology

Diseases are described as **infectious (communicable)** if they are caused by an invasion by a **pathogen** and can be transmitted from one host to another.

A **pathogen** is an infectious agent that causes disease.

A **host** is an organism infected with a pathogen.

An **infection** is occurring if a pathogen has entered a host, has established its residence and is replicating.

Unwanted signs and symptoms usually result from damage to the tissues and organs of the host.

A micro-organism or virus is not a pathogen (not ‘pathogenic’) unless it causes disease.

Koch's postulates

Humans have attempted to identify, prevent and manage infectious diseases for centuries.

To identify the specific cause of an infectious disease, scientists have (and still apply) a series of postulates that were developed by Robert Koch.

1 The potential pathogen must always be present when the disease occurs.

2 The organism can be isolated from the host and grown in pure culture.

3 When organisms from the pure culture are inoculated into a healthy, susceptible host and the disease develops, this is further evidence for a specific cause.

4 The organism can then be re-isolated, grown in pure culture and compared with the organism first injected for confirmation.

Pathogen types

A **pathogen** is an infectious agent that causes disease. There are several different types of pathogens, but the four most common pathogen groups are:

- viruses
- bacteria
- fungi
- protists.

This chapters describes 10 infectious diseases that are caused by these four types of pathogens.

Ten infectious diseases and the types of pathogens that cause them

Viral	Bacterial	Fungal	Protist
• Influenza • Ross River fever/ disease • Viral diseases of honeybees • Australian bat lyssavirus disease	• Tuberculosis (TB) • Tetanus • Crown gall of plants	• Chytridiomycosis (amphibian chytrid fungus disease)	• Malaria • Phytophthora dieback (jarrah dieback

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Transmission

Transmission is the passing of an infectious disease from an infected host to another individual.

Pathogens have a variety of adaptations that enable transmission from host to host in a number of ways.

Infectious diseases, such as TB, are caused by an agent that can be passed from an infected host to a susceptible (future) host.

Diseases that are easily transmitted by close contact with an infected organism or their secretions (body fluids) are called **contagious**.

A disease can be infectious but not contagious, as is tetanus.

Zoonoses

Zoonoses are infectious diseases that can be transmitted from one vertebrate group to another.

Humans, for example, can be infected with avian (bird) or swine influenza viruses.

Transmission is primarily through *direct contact* with infected animals. Direct contact with an infected host's saliva, mucous, faeces, blood or urine may happen when handling birds or by being bitten or scratched.

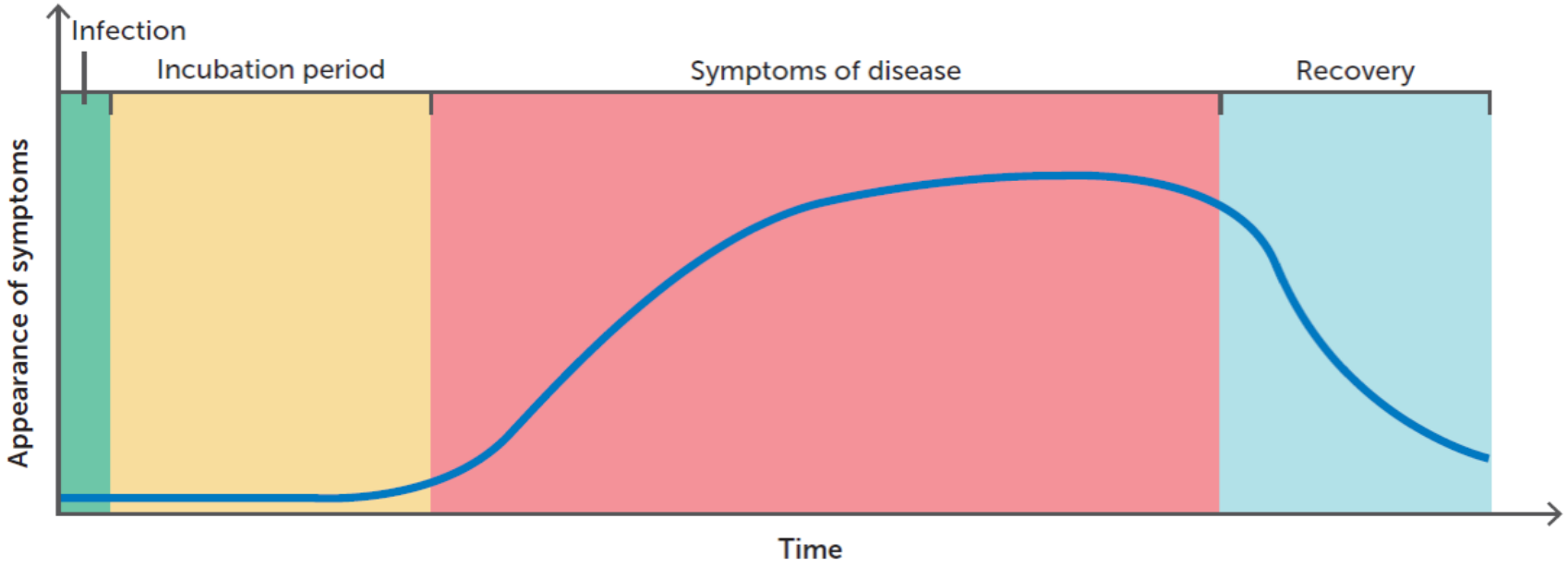
Transmission may also happen through *close contact*, such as being near an infected bird when it shakes its feathers. The virus may become airborne and inhaled.

Indirect contact may occur when a susceptible host comes into contact with areas where infected animals live or roam, where surfaces or objects have been contaminated. Examples of contaminated materials include chicken coops, pet food dishes and soil.

Incubation period

Symptoms are the effects the pathogen has on the body of the host. For many pathogens, symptoms of the disease do not appear immediately upon infection.

The time between infection and the onset of symptoms is known as the **incubation period**.



Viruses are non-cellular

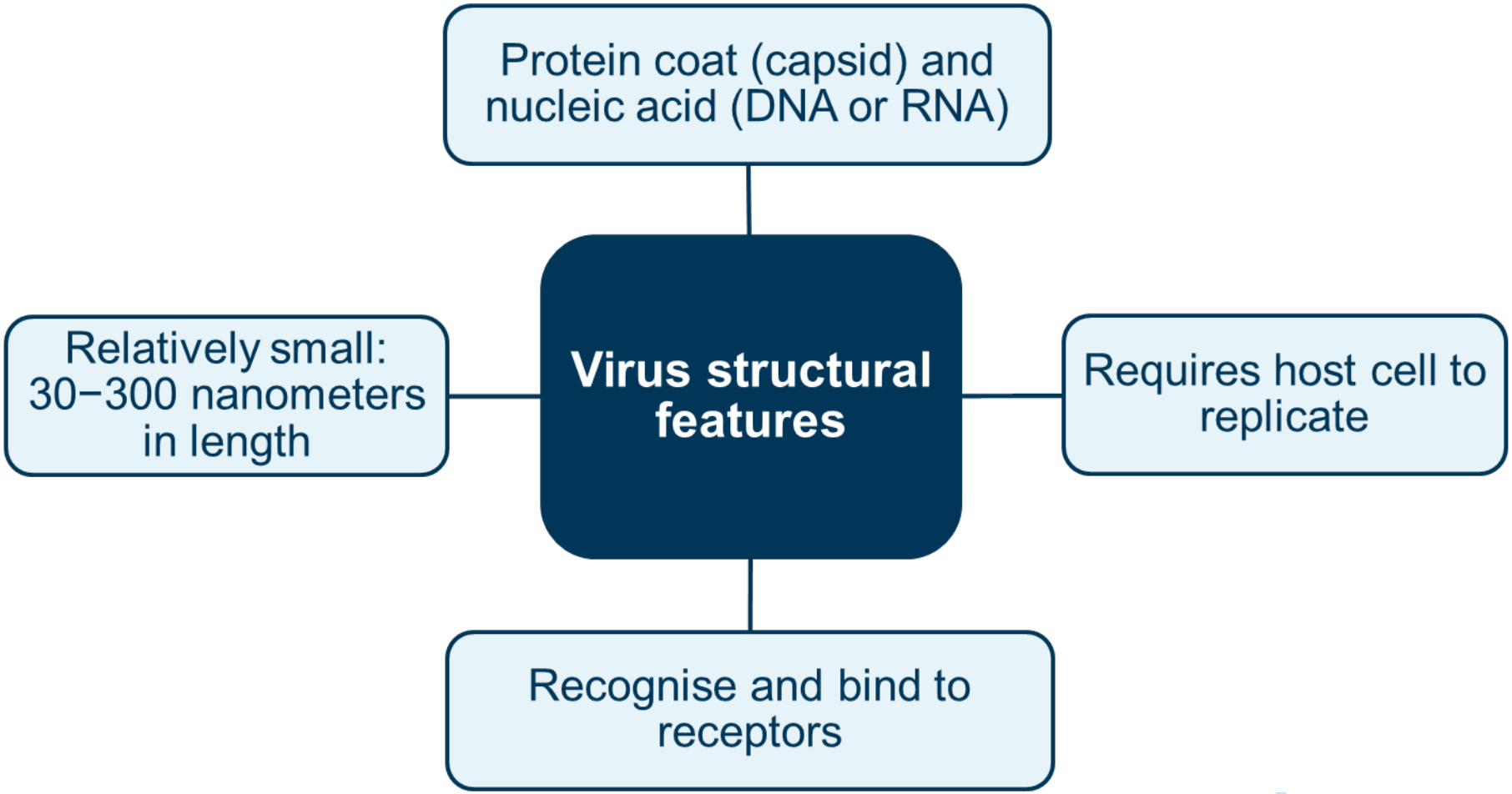
Viruses are non-cellular pathogens.

Viruses consist of one or more strands of **nucleic acid** (RNA or DNA) inside a protein coat. They maintain this structure during the inert phase of their life cycle; that is, when they are not inside a host.

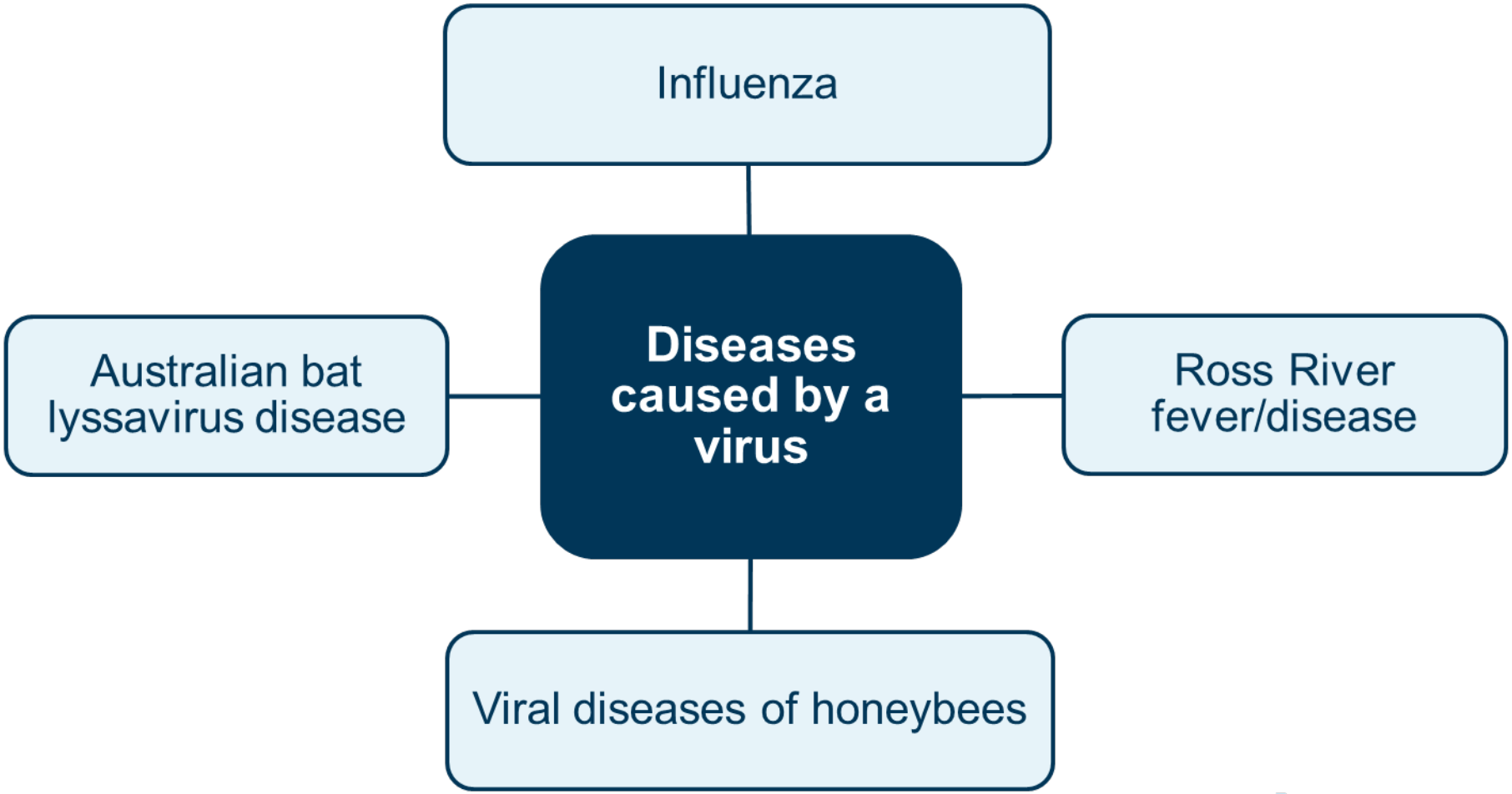
Viruses are NOT made out of cells and therefore are non-living. They possess no metabolic machinery for processes such as cellular respiration.

Viruses cannot be classified as prokaryotes or eukaryotes, because they are non-cellular. Instead of cellular features such as ribosomes and mitochondria, they have some nucleic acid and a protective coat.

Virus structural features



Examples of diseases caused by a virus



Non-cellular pathogens

Viral disease example:

Ross River disease is also known as Ross River fever. Symptoms of the disease include a rash on the limbs or trunk for 5–10 days; painful and swollen joints, usually lasting for months; fever and headache.

The primary replication of the virus occurs in skeletal muscle cells before it enters the blood. The virus also replicates in the mosquito vector.

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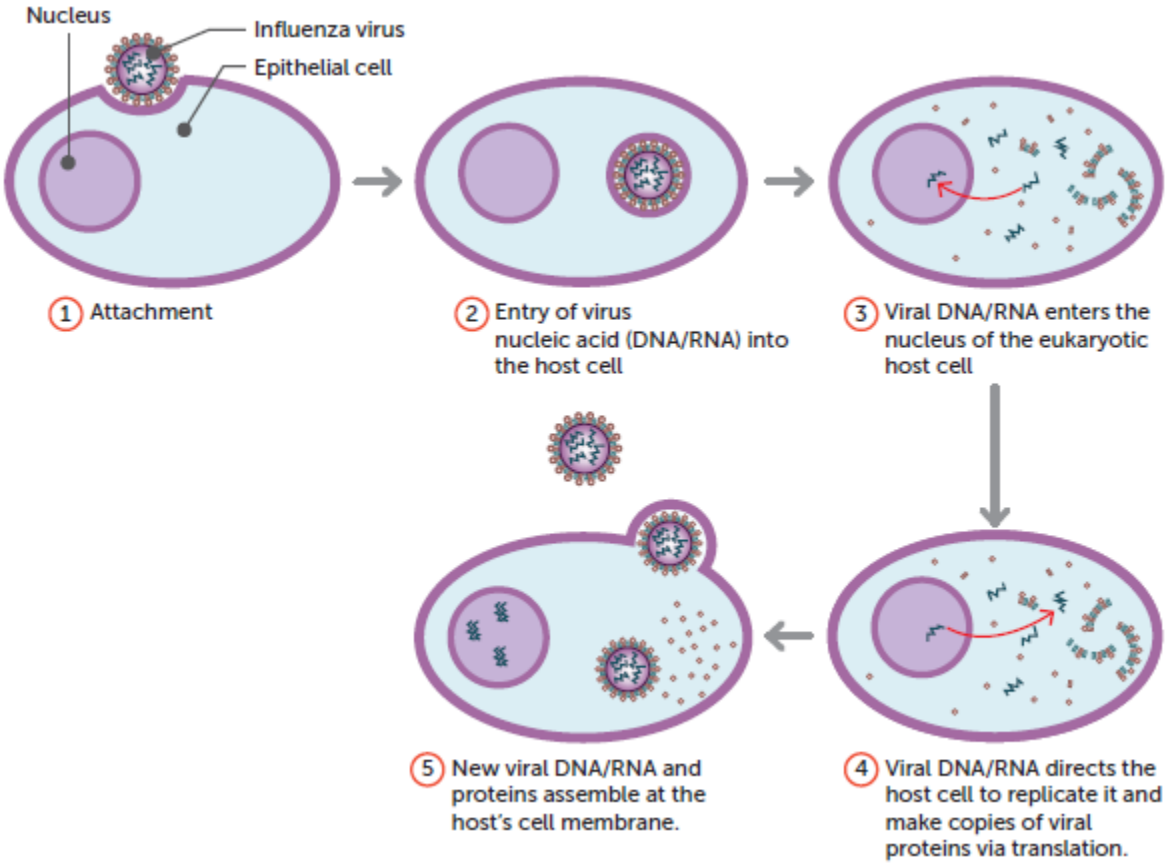
Viral replication in a eukaryotic host



Bacteria

Bacteria are prokaryotic.

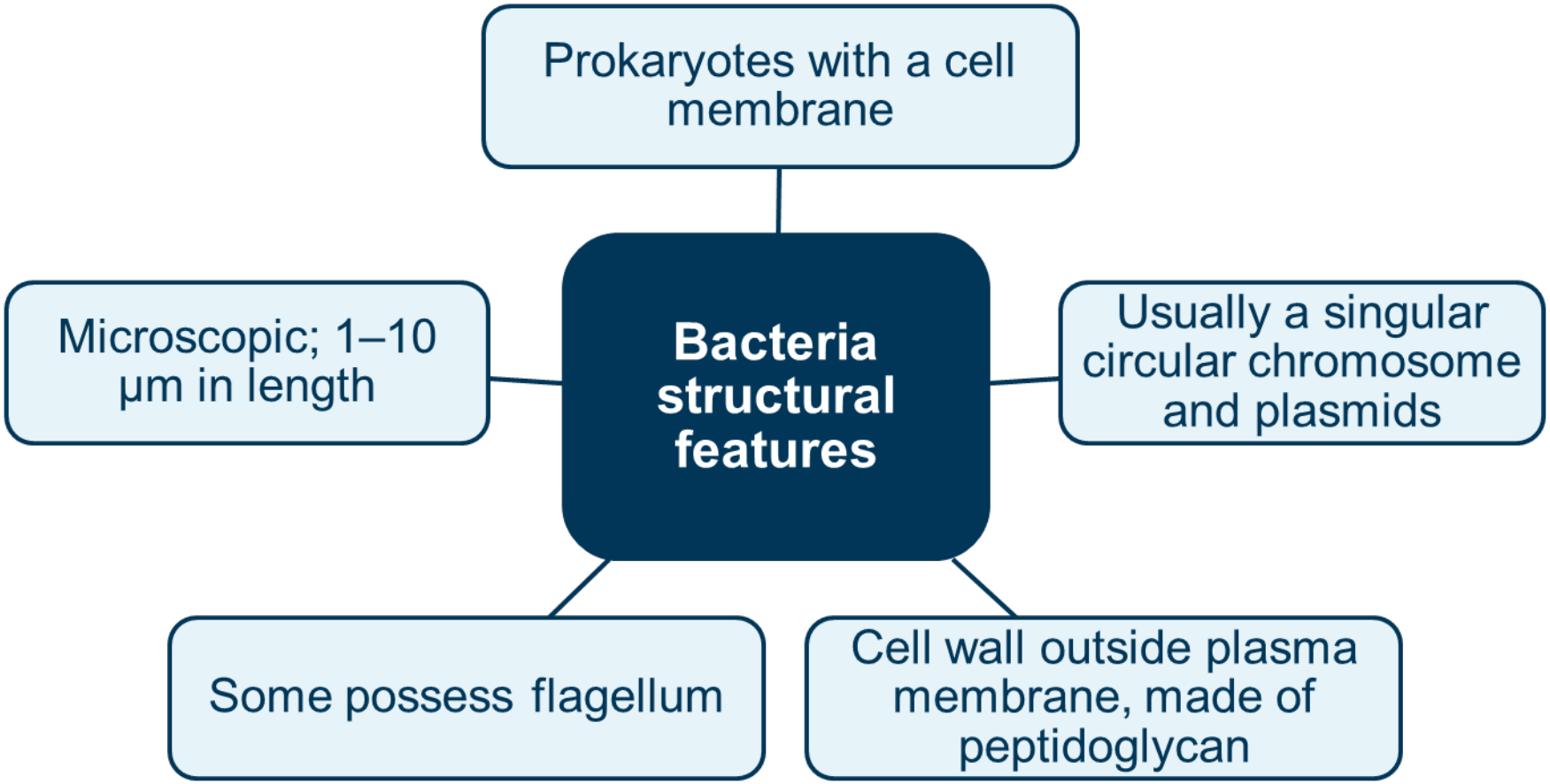
Bacteria are the most abundant and diverse group of organisms.

Only a relatively small number of bacteria cause disease.

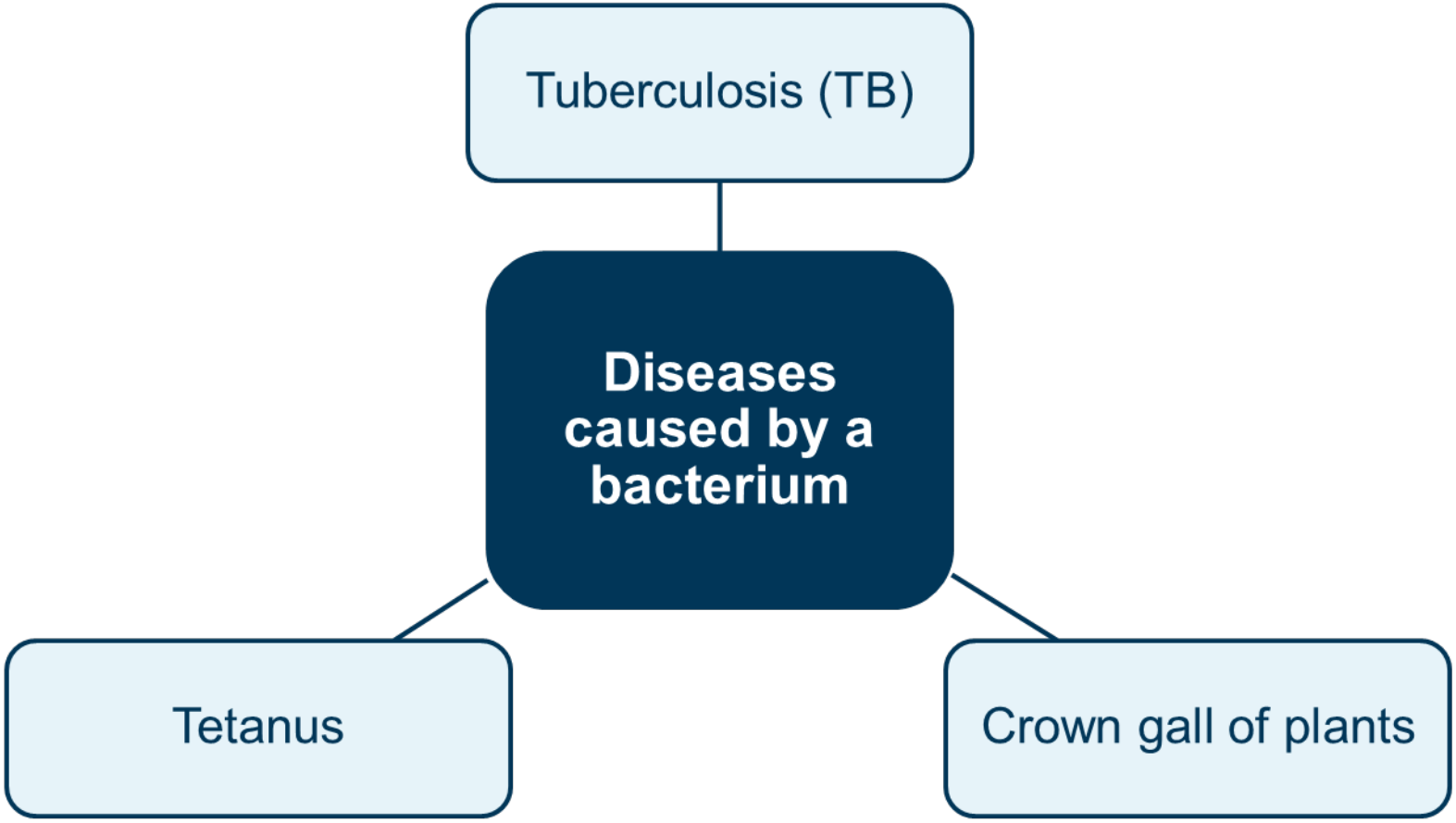
There are billions of bacteria living on our skin and in our bodies that are not pathogenic and are often beneficial.

Bacterium is the singular term for bacteria.

Bacteria structural features



Examples of diseases caused by a bacterium



Cellular pathogens

Bacterial disease example:

Crown gall is a plant disease caused by the bacterium *Agrobacterium tumefaciens*, which enters the host through a wound. It involves the induced growth of tumour-like galls around the stem of plants. When the pathogen enters a wound, it inserts a gene from its plasmid into the genome of the host cell, causing rapid cell growth and the formation of galls. The galls are malformed growths that become a barrier in the infected host plant's transport system for water and nutrients, causing the plant to wilt and have stunted growth.

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Bacteria reproduction by binary fission

One cell splits into two identical daughter cells. Binary fission begins when the DNA of the bacterium doubles in quantity then divides into two (replicates). The bacterial cell then elongates and splits into two daughter cells, each with DNA that is identical to that of the parent cell.

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Bacteria classification

Bacteria can be classified according to their shape:

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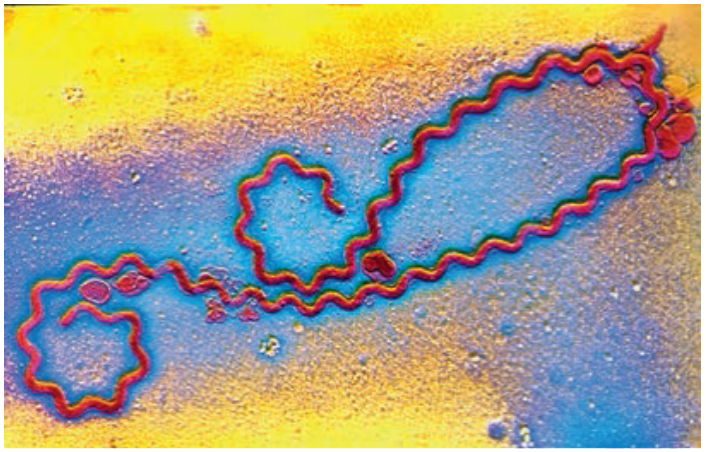
◀ rod-shaped, known as bacillus (plural bacilli)



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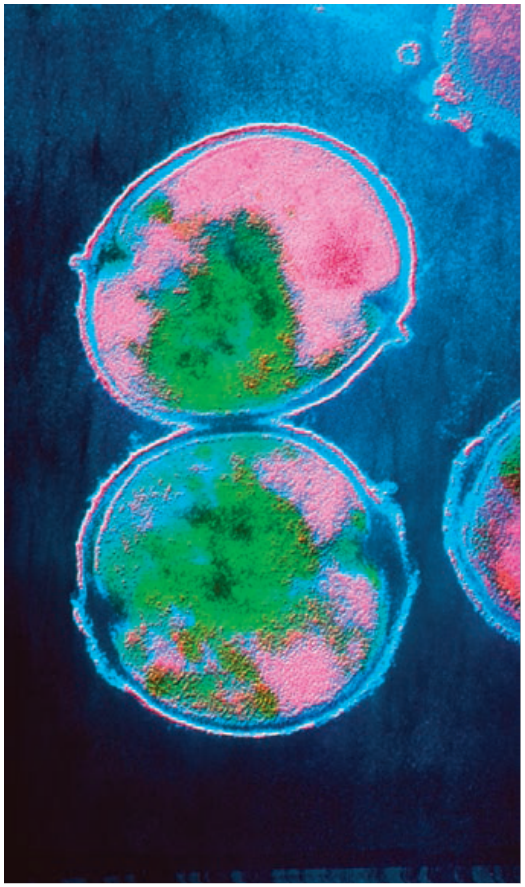
◀ spiral (plural spirilla)



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▲ spherical, known as coccus (plural cocci)

vibrio (not shown), like a comma.

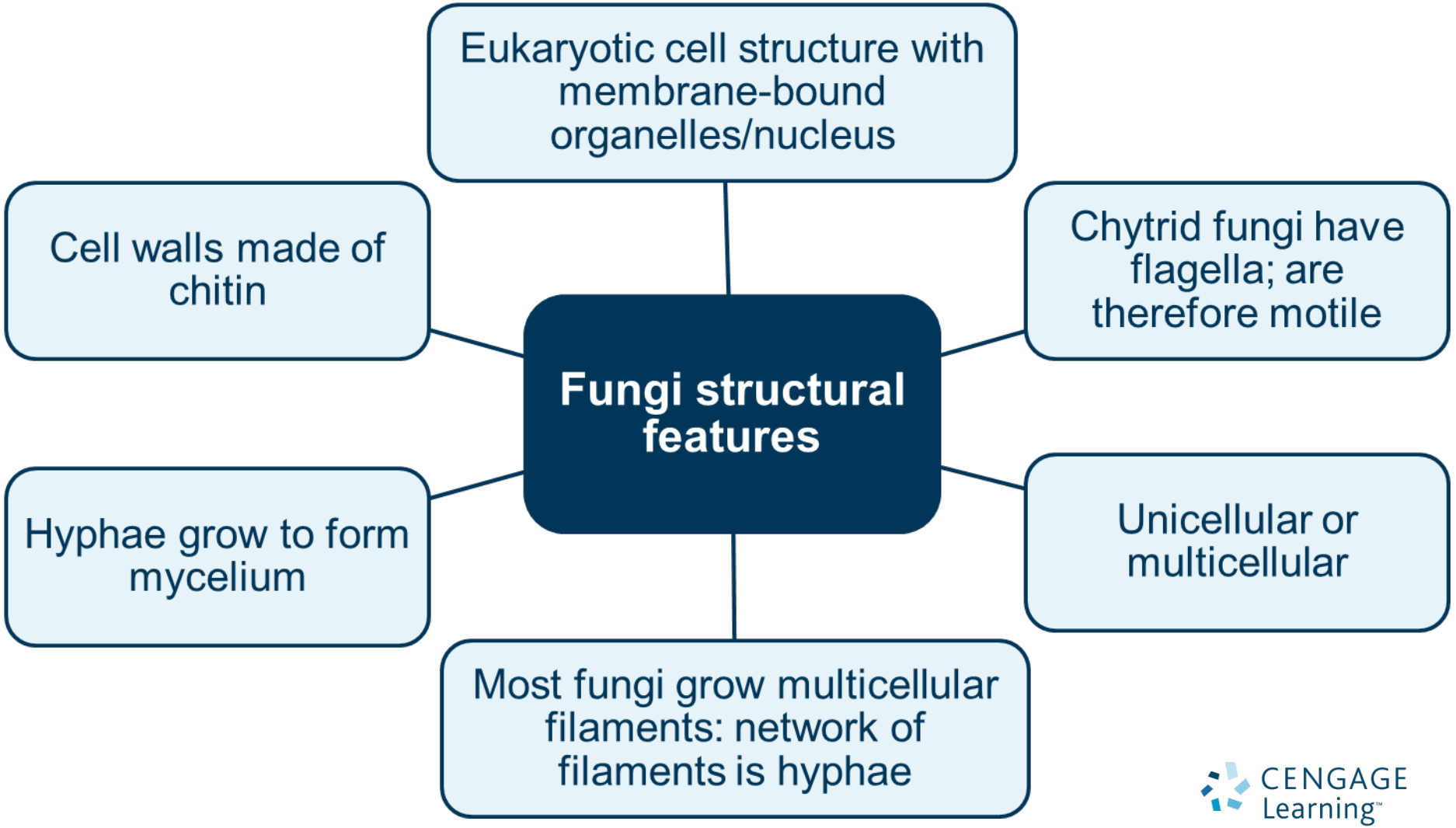
Fungi

The fungal world includes large organisms, such as mushrooms and toadstools, as well as minute forms that were only revealed with the invention of the microscope.

These microscopic fungi include **unicellular** yeasts and moulds.

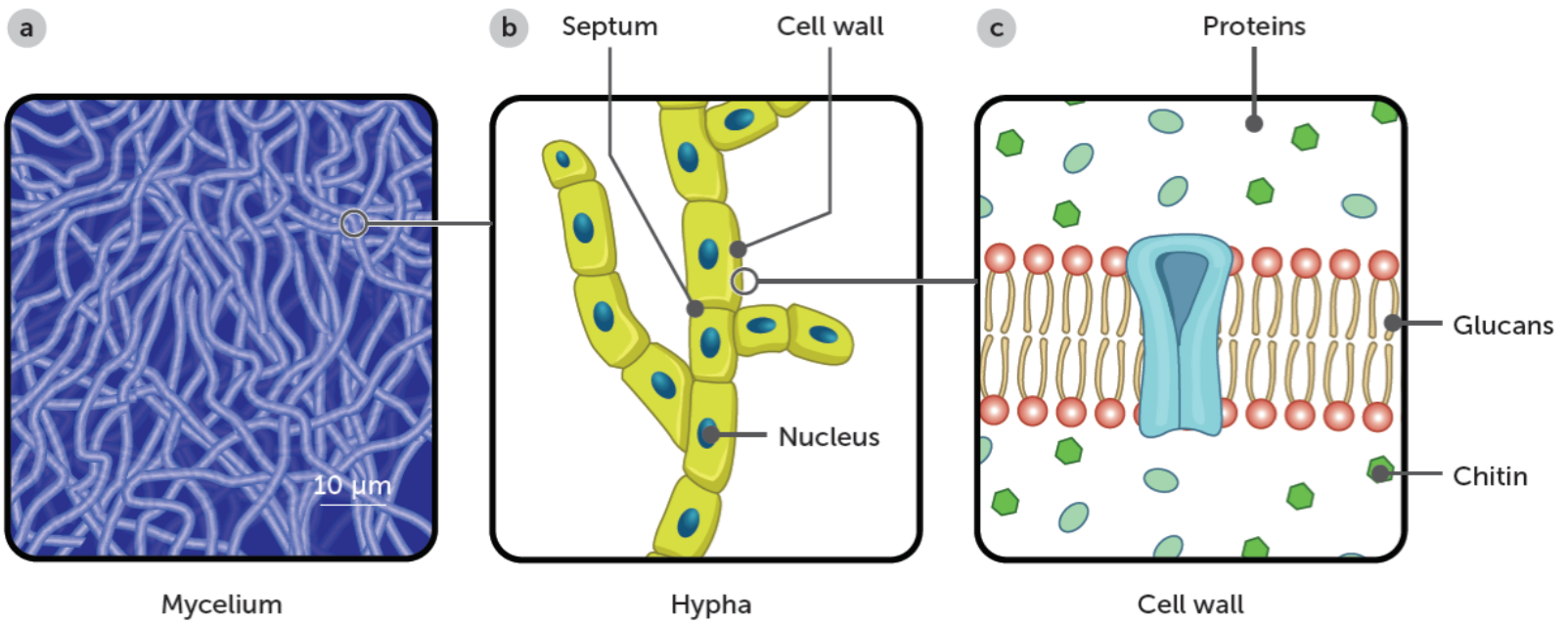
They are plant-like organisms with cell walls, but their cell walls are not made of cellulose and the cells do not contain chlorophyll.

Fungi structural features

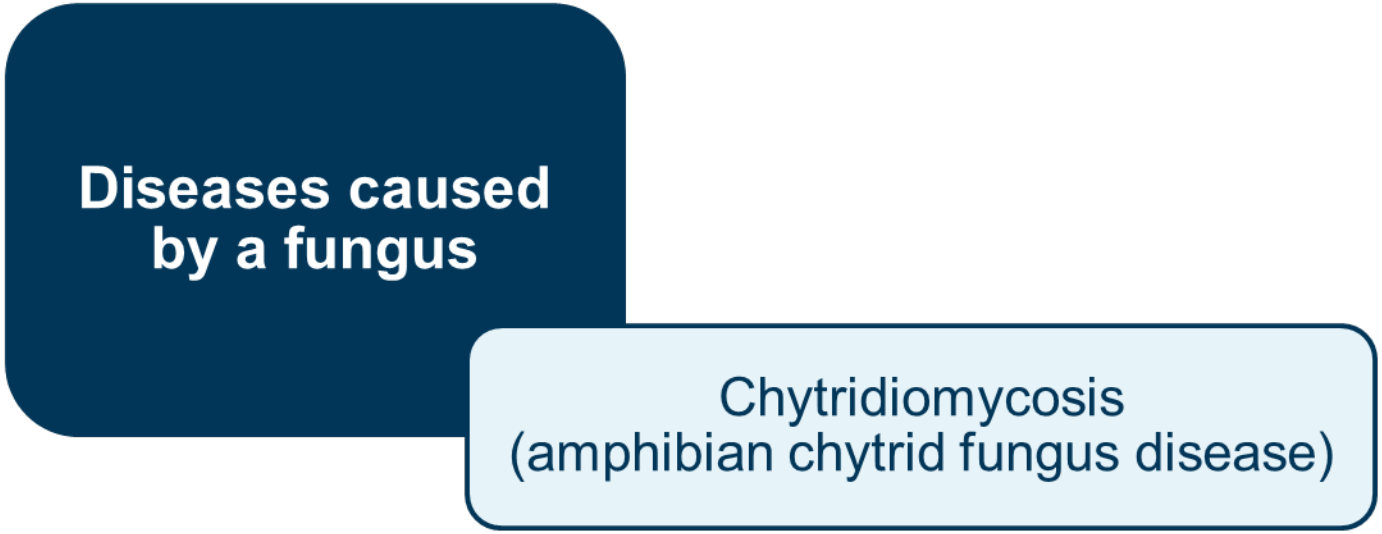


Fungi structural features

This diagram shows the basic structural features of fungi: **a** optical microscope image of a mycelium film showing a branched network of microfilaments (hyphae); **b** schematic representation of a hypha composed of cells separated by cross walls (septa), all enclosed within a cell wall; **c** schematic representation of the cell wall – a layer of chitin that surrounds the cell



Examples of diseases caused by a fungus

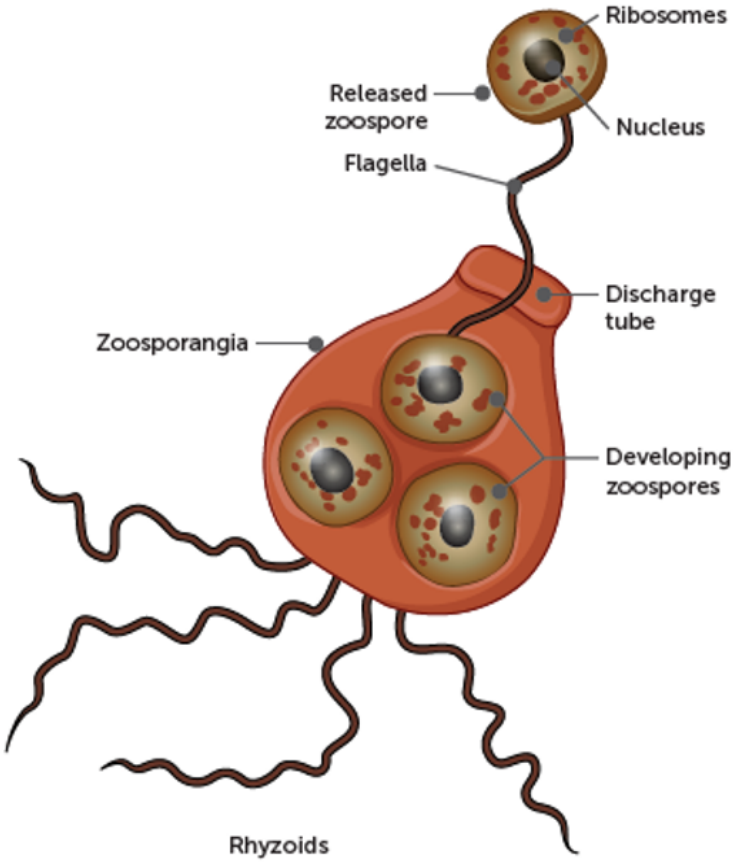


Cellular pathogens

Fungal disease example:

Batrachochytrium dendrobatidis live in water or soil. They produce spores that are motile in water, which means they can swim through water. Individual amphibians contract the disease when their skin comes into contact with water containing spores that have travelled from infected amphibians.

The amphibian's skin gets thickened and hardens. Respiration becomes difficult because significant gas exchange usually occurs across the moist skin under normal conditions. The amphibian can become lethargic. Hind legs extend, and the amphibian becomes sluggish and has no appetite. These symptoms can lead to death.



Protists

Protists are a diverse and mostly unicellular group of eukaryotic organisms.

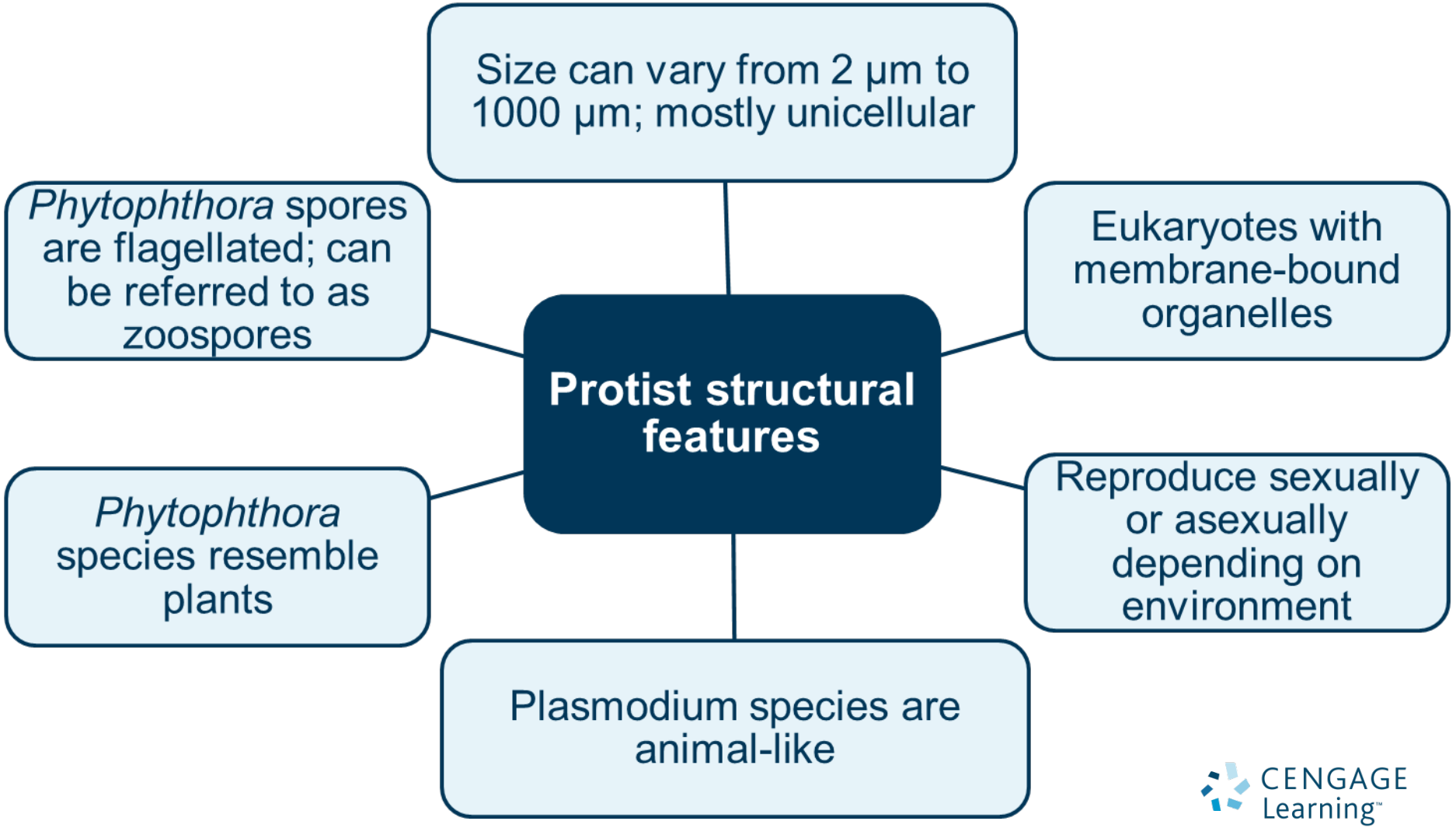
Of the 65 000 known species of protists, less than 24 species cause diseases in humans, but these few infect hundreds of millions of people each year.

To date, we still do not have effective preventatives against many of them, and the treatment drugs we have are limited in their effectiveness.

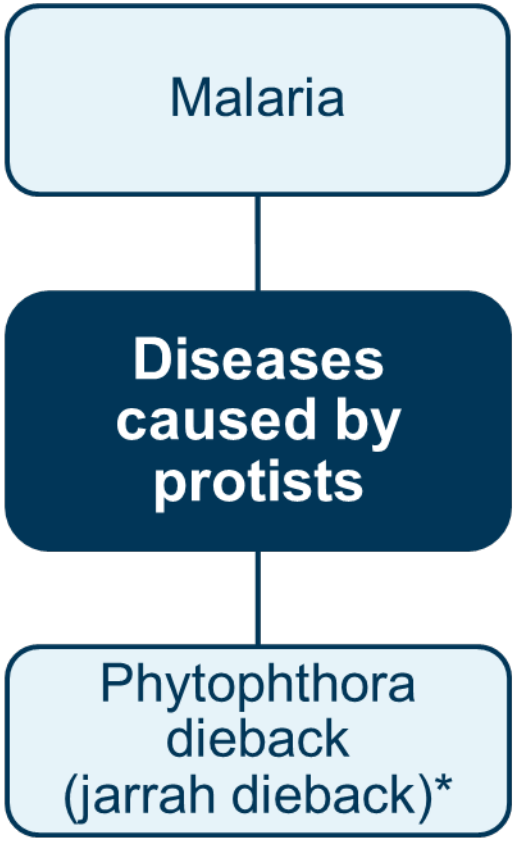
Some protists resemble animal cells, some resemble plant cells and some resemble fungi cells.

A variety of specific, unique features set them apart.

Protists structural features



Examples of diseases caused by protists



*The Phylum Oomycota containing Phytophthora dieback has been removed from the Fungi Kingdom and placed in the Protista Kingdom

Cellular pathogens

Protist disease examples:

Five species of *Plasmodium* cause malaria. The symptoms are fever, headache, chills (shaking), sweating and vomiting. If left untreated and a host is susceptible, complications such as anaemia and liver failure can develop, and may lead to death.

Giardia lamblia is a relatively common parasite that infects travellers. This flagellated protist can cause mild intestinal upsets, such as diarrhoea, but may also have more severe effects in the young or the elderly. People become infected if they drink contaminated water. It is a major problem in many developing countries, where travellers are advised never to drink water that is not bottled or boiled.