
Year 12
Biology
Infectious Disease

Lesson 2:
Transmission of
disease
Sample resources

1. Transmission of disease

□ The chain of infection

- Infectious diseases result from the interaction of the **pathogen**, the **host** and the **environment**. This is referred to as the chain of infection.
- If the **chain is broken** at any point, the spread of disease can be prevented.



- **Infectious agents** are living and non-living things that cause disease.
 - What is the technical term for this?¹

 - Provide some examples.²

- A **reservoir** is a place where the pathogen can live grow and reproduce, within **people, water or food** for example.

- What are the reservoirs for the common cold and prion diseases?³

- To be infectious the pathogen must have a way of leaving the reservoir (portal of exit), such as through blood, other bodily fluid or skin.

- What is the portal of exit for a tape worm?⁴



Guinea worm exits through ulcers in the skin.

- **Modes of transmission** are the ways the pathogen **spreads** from the reservoir to the next susceptible host. This may be achieved through **physical contact, droplets or by airborne pathogens**.

- Can you identify a disease that is spread through droplets?⁵

- **Portals of entry** are the ways that the infectious agent can **gain entry** into the susceptible host. Common entry ways are **mucous membranes, the respiratory system or broken skin**.

- Can you identify a bacterial condition that infects the respiratory system?⁶

- To be a **susceptible host**, an organism usually has some traits that make them more vulnerable to disease. These include **immune deficiency, diabetes, injury or age**.

□ Direct contact transmission

- In **direct contact transmission** there is some **physical contact** between an infected person and a susceptible person.
 - This includes when an infected person **touches or exchanges body fluids** with a healthy person or **sprays them with droplets** at close proximity.
 - The pathogen can then infect through entryways such as **mucus membranes or open wounds**.

- Examples of direct contact transmission include:
 - Sexually transmitted infections
 - Coughing on someone
 - Sneezing on someone
 - Shaking hands



□ Indirect contact transmission

- In indirect contact transmission there is no direct human-to-human contact. Indirect contact transmission may occur through:
 - Airborne transmission e.g. the measles virus hangs in the air for a long time after an infected person walks past.
 - Contaminated objects e.g. doorknob, blood products, medical equipment.
 - Food and drinking water e.g. food poisoning
 - Animal to person e.g. handling animal waste

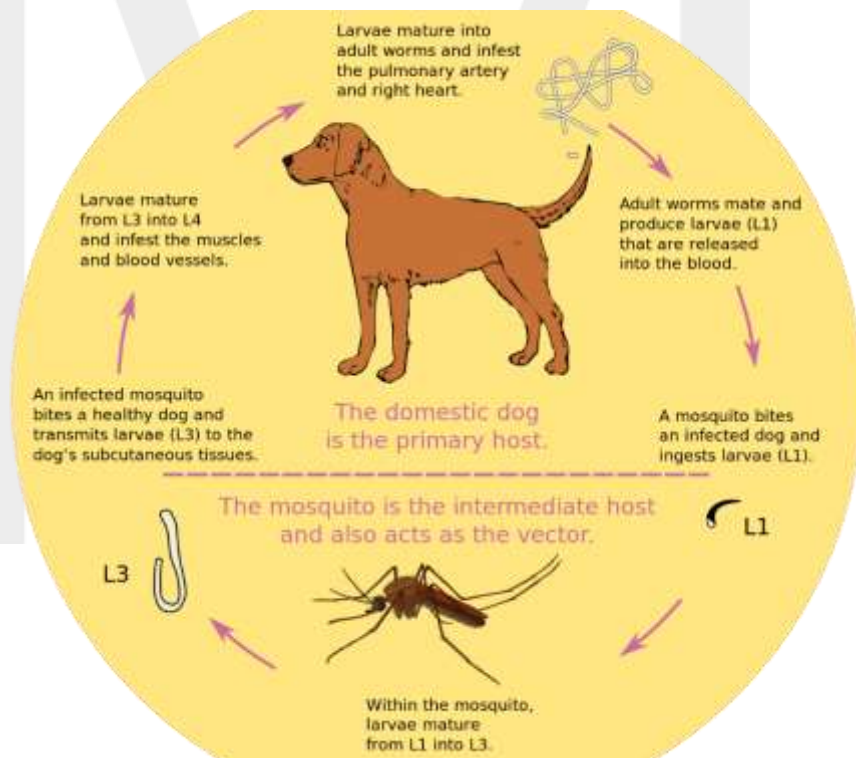


□ Vector transmission

- **Vector transmission** is a specific form of **indirect transmission** that usually involves a **bite** from an animal or insect.
 - **Lyme disease** is transmitted by a bite from a tick.
 - **Lyssavirus** is transmitted by a bite from a bat.
- **Heart worm** is a life-threatening disease found in dogs, the **life cycle** of heart worm is shown below.

- Identify the **vector** of the disease.⁷

- Can you list any human diseases that are transmitted by this vector?⁸

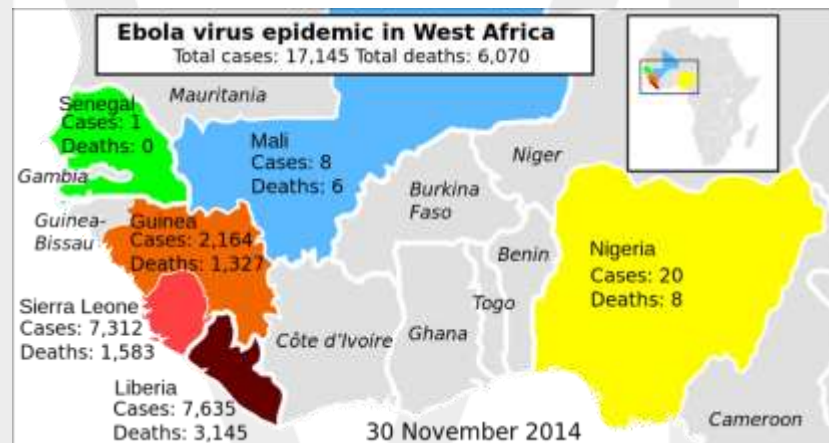


By Cú Faoil (text), Anka FriedrichDirecoes_anatomicas.svg: RhcastilhosMosquito gender en.svg: LadyofHatsderivative work: Anka Friedrich - Own workThis file was derived from:Dog tan.svg:Direcoes anatomicas.svg: Mosquito female.svg: Mosquito gender en.svg;. CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=27495265>

- Vectors can also transmit diseases to **plants**. For example, Banana bunchy top virus is transmitted by a sap sucking insect (Aphid).

□ Epidemic transmission

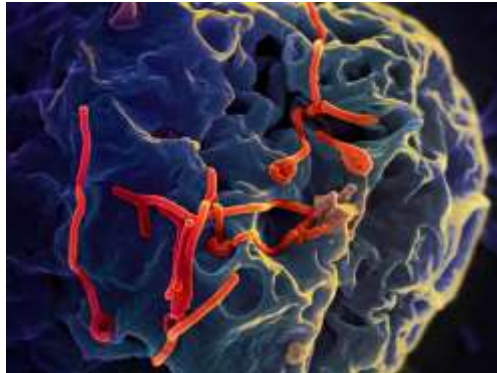
- An **epidemic** is a **sudden increase** in the occurrence of a particular disease **within a certain area**.
 - The **normal base level** of occurrence of the disease is the **endemic** level.
 - When epidemics occur across a wider area (e.g. multiple countries or continents) it becomes a **pandemic**. These affect a high percentage of the population.
- An example of an epidemic is the outbreak of the **Ebola** that occurred in **2014**. Ebola is a **virus** that has a **mortality rate of 50%**.
 - Historically there have been occasional outbreaks of the Ebola virus, but in 2014 there was an **epidemic**, with **major outbreaks in West Africa**.



By Mikael Häggström. Also updated by BrianGroen. Esperanto version included in separate layer by Piet-c. - Own work, CC0, <https://commons.wikimedia.org/w/index.php?curid=35199728>

- Ebola is transmitted between people through **close or direct contact with bodily fluids** (mainly blood, faeces and vomit).
 - It has also been detected in breast milk, urine and semen.
 - Direct contact transmission is common, but indirect transmission through contact with contaminated objects is also possible.
 - The virus is not spread through airborne droplets.
- What are some ways that transmission could be prevented?⁹

- A variety of factors contributed to the epidemic spread of the disease in 2014.
 - Poor public health infrastructure.
 - High population mobility.
 - A shortage of health care workers.
 - Traditional funeral practices that involve washing the dead and touching the body.



Ebola virus (red) emerging from a cell.

Ebola Virus by NIAID <https://www.flickr.com/photos/niaid/14712446017> CC BY 2.0

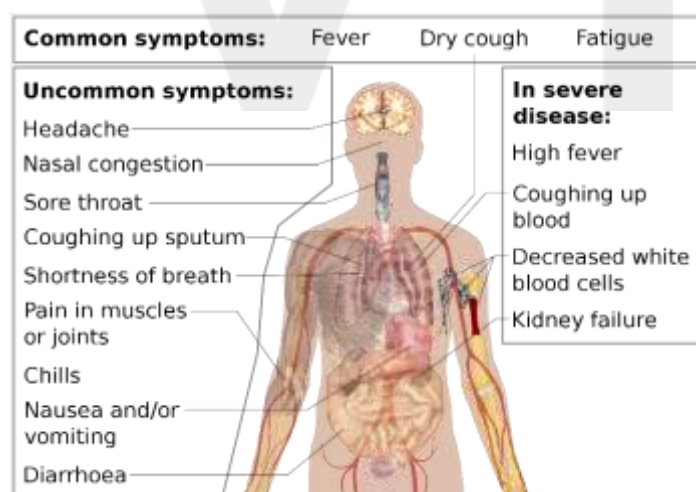
- Testing of **vaccines and antiviral drugs** are still ongoing, as is development of **diagnostic tests** that can function outside of a lab.
 - Can you recall a method you learned last term that can be used to diagnose a disease?¹⁰
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- **Zika virus** was first discovered in 1947 in a rhesus monkey in the Zika forest in Uganda. It is spread from human to human by the *Aedes africanus* mosquito, mother to baby or through sexual transmission
 - Symptoms include skin rash, fever, joint pain and conjunctivitis. Symptoms are mild and rarely require hospitalisation or cause death.
 - There are no vaccines or drugs that can treat it.
 - The first outbreak occurred in Micronesia in 2007.
 - From 2013-2014 further outbreaks occurred in the Pacific Islands.
 - From 2015-2016 the disease spread across Central and South America.

- The most concerning effect of Zika virus is that if a pregnant woman is infected her baby is likely to be born with **microcephaly** where the skull is smaller than normal.
 - The child may also have developmental delays, dwarfism, trouble with coordination and seizures.
 - At least 3700 children were born with birth defects due to Zika virus.
 - This is a lifetime disability. The long term social and economic impact of this is an example of **disease burden**.



By Brar_j- CC BY 2.0, <https://commons.wikimedia.org/w/index.php?curid=63278345>

- **Coronavirus (COVID-19)** started as an epidemic in the Wuhan region of china but quickly became a pandemic spreading to all continents.
 - It is difficult to tell the difference between COVID-19 and seasonal flu.
 - COVID-19 often leads to secondary pneumonia.
 - The disease is spread through direct or indirect contact transmission.
 - The mortality rate is around 3.4% which is higher than seasonal flu (<1%).



- We will examine the methods used to control epidemics and pandemics in lesson 7.

Concept Check 1.1

Read the information below and answer the following questions.

Hendra virus is a potentially fatal virus found in large fruit bats (flying foxes). Horses may contract the virus by consuming water or food contaminated with saliva, droppings or placenta of infected fruit bats. Humans don't usually contract the disease from flying foxes or their waste, but horses can pass the infection on to humans.

A small number of people such as horse owners and veterinarians have contracted Hendra virus after very close contact with infected horses. The virus spreads between horses, and from horses to humans, through direct contact with body fluids of sick horses, such as nasal secretions or blood products. There is no record of human to human transmission.

(a) Identify the infectious agent.¹¹ 1

(b) Identify the reservoir.¹² 1

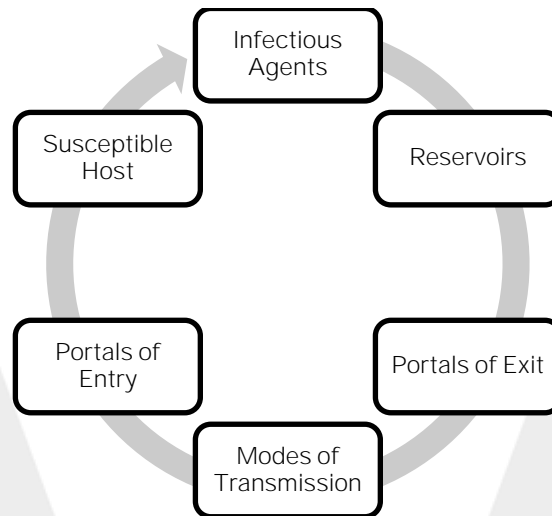
(c) Describe the portals of exit and mode of transmission to humans.¹³ 2

(d) Are the horse or bat acting as a vector? Explain why.¹⁴ 2



Concept Check 1.2 [2019 HSC Sample Q2]

The diagram shows a model of disease transmission.



A pathogen was identified as being unadapted to dry conditions and as having the gastrointestinal tract as the 'route of entry' and the 'route of exit'.

Using this information, what is the most likely mode of transmission? ¹⁵

- (a) Skin to skin contact
- (b) Coughing or sneezing
- (c) Contaminated water supplies
- (d) Transmission of infected blood products

Concept Check 1.3 [2019 HSC Sample Q3]

An epidemiologist suspected that bats were acting as a reservoir for an infectious disease in humans.

Which condition would need to be met to confirm the epidemiologist's suspicion? ¹⁶

- (a) The infectious agent would need to have a mode of entry into humans
- (b) The infectious agent would need a mode of transmission from bats to humans.
- (c) The bats would have to be able to transmit the infectious agent between each other.
- (d) The susceptible human host must be able to transmit the infectious agent to the reservoir of bats.

2. Microbes in food or water

□ Investigation into microbes

- Microbes are extremely **small** and **not visible to the naked human eye**. Thus, to be able to see and study them, we need to grow LOTS of them.
 - The following method, called **microbiological culture**, is often used to multiply microbes under controlled conditions:
 1. Smear the source of microbes e.g. contaminated water, onto nutrient-filled jelly plates (usually agar jelly in Petri dishes).
 2. Quickly replace lid on petri dish and seal tightly with sticky tape.
 3. Warm the plates in an incubator/oven for several days – the microbes use the nutrients and warm conditions to multiply.
 4. Count the number of colonies that form and distinguish different species or strains by their size, shape, texture and colour.



By Bill Branson, National Cancer Institute, Public Domain

- Watch this video (Length 4:02) on various **microbial cultures** produced from various household and personal items.
 - Why is it important to **seal** the Petri dishes after inoculation?¹⁷

- Bottled water is often said to be 'better' than tap water. Design an experiment to determine whether this is true.¹⁸

Note to students

For questions that ask you to 'design an experiment', you must think about the various components of an experimental report.

Check that your answer includes an identification of the independent and dependent variables, a control, controlled variables, repetition and a data collection method.

Independent variable: _____

Dependent variable: _____

Controlled variables: _____

Method:

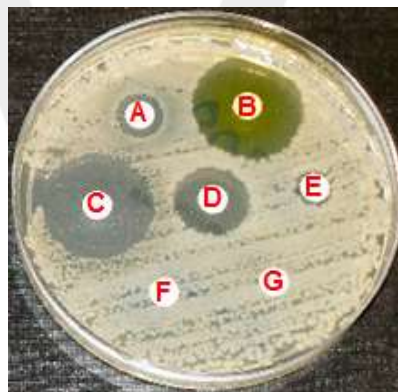
- What **sterile techniques** should be used when culturing microbes (i.e. how can we make sure that you are culturing the microbes from food or water samples, and not, say, from the air)?¹⁹

- What are the **safety considerations** of working with microbes?²⁰

- In another example, papers soaked in different **antibiotic solutions** were placed on the plate shown below.

- Which type of pathogen are antibiotics effective against?²¹

- The clear area around the discs show the **areas of inhibition** (where bacteria couldn't grow due to the antibiotics).



Dr Graham Beards at en.wikipedia CC BY-SA 4.0 <http://creativecommons.org/licenses/by-sa/4.0>
<https://commons.wikimedia.org/w/index.php?curid=25206097>





- Which disc(s) had antibiotics that the bacteria were resistant to?²²

Did you know?

Microbes of different colours can be used to create microbial art!

Concept Check 2.1

A student collected water from different sources and performed a first-hand investigation to identify the presence of microbes. The student's lab notes are shown in the table below.

	Control	Bottled water	Tap water	Tank water
Inoculation of agar plate	X	✓	✓	X
Incubation at 37°C	✓	✓	X	X
Appearance of agar plate				

What can be concluded from these results?²³

- The inoculation loop was contaminated before use.
- The same microbe was found in every water source.
- All sources of water are unsafe for consumption.
- Prior to the experiment all agar plates were contaminated.

Concept Check 2.2

You are a NSW Food Authority supervisor monitoring food service at a food court. You have identified the following types of microbes in a cheese burger produced from Oporto.

Microbe	Description
<i>Saccharomyces cerevisiae</i>	Baker's yeast
<i>Lactobacillus bulgari</i>	Commonly found in milk and dairy as well as fermented products
<i>Bifidobacterium longus</i>	Present in the human gastrointestinal tract

Would you consider this burger to be safe for general consumption?²⁴

- No, organisms that are found in the human body are pathogenic.
- No, Bifidobacterium and Saccharomyces cause disease.
- No, food should not contain microbes.
- Yes, the food we eat often contains microbes.

Concept Check 2.3

A student aims to identify microbes in food or water. Complete the following table to plan the first-hand investigation.²⁵

5

Dependent variable	
Independent variable	
Control	
Safe work practices to be followed	