

HSC Biology

Core 3 - Search for Better Health

Focus 3

✚ During the second half of the nineteenth century, the work of Pasteur and Koch and other scientists stimulated the search for microbes as causes of disease.

Describe the contribution of Pasteur and Koch to our understanding of infectious diseases.

- Microbes as the cause of infectious disease:
 - Until mid 19thC, *spontaneous generation* believed origin of living things.
 - Derived from non-living matter.
 - 1680, Francesco Redi disproved spontaneous generation.
 - Scientists refused to accept his results.
 - Belief of spontaneous generation remained.
 - Prevented people understanding causes of disease & transmission.

- **Louis Pasteur:**

- His role in identifying cause of disease:
 - Disproved theory of ***spontaneous generation***.
 - It was believed maggots & fungi grew from non-living material.
 - Showed that micro-organisms come from pre-existing micro organisms.
- Discovered *germ theory of disease*:
 - Most infectious diseases caused by micro-organisms or germs.
- Examined fermented wines under microscope.
 - Described micro-organisms growing.
 - Demonstrations of living organisms existing in air destroy theory of s.g.
- Showed French wine industry that heating wine to 55°C destroyed micro organisms.
 - *Pasteurisation*
 - Now applied to;
 - Beer.

- Milk.
- Founded *vaccination*.
 - Inoculated 25 sheep with weakened *Bacillus anthracis* (anthrax bacteria).
 - Injected 50 sheep with strong dose of anthrax.
 - Predicted 25 would die.
 - 25 inoculated sheep survived.
- Developed vaccination for;
 - Anthrax.
 - Chicken cholera.
 - Swine erysipelas.
 - Developed rabies vaccination in 1885, saved life of infected boy.

- **Robert Koch:**

- Pasteur's work in identifying organism that causes fermentation.
 - Led to suggestion that infectious diseases caused by microscopic pathogens.
 - Others argued bacteria followed infection.
 - As opposed to causing it.
- **The work of Robert Koch (1843-1910).**
 - Proof of need to convince people that microscopic pathogens cause disease.
 - First experiment involved disease anthrax in sheep.
 - First found bacteria in anthrax infected sheep.
 - Isolated bacteria in blood of dying animals.
 - Identified active rod-shaped cells & resting spores.
 - Placed bacteria on plates with agar.
 - Bacteria reproduced.
 - Implanted bacteria in sheep.
 - Sheep became infected.
- **Koch's postulates.**
 - Series of steps to identify micro-organism for a particular disease.

- Step 1:
 - All infected hosts must contain the suspect organism.
 - Step 2:
 - Pure culture of suspect organism must be obtained.
 - Isolated from host's blood/cells.
 - Step 3:
 - Healthy organism infected with pure culture must develop same symptoms as original hosts.
 - Step 4:
 - Suspect organism isolated from second host, grown in pure culture, prove to be identical to first culture.
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- Koch's postulates used to identify organisms that cause infectious disease.
 - Symptoms carefully identified.
 - Blood of sufferer examined to determine causative organism.
 - Micro-organism suspected if it is present in the blood of another organism & transfer mechanism identified.
 - Identification in other organisms that are suffering will confirm causative organism.
 - A suspected causative organism can be confirmed by infecting a test organism.

 - Koch developed method for;
 - Fixing.
 - Staining.
 - Photographing bacteria.

 - The work of Pasteur & Koch paved the way for scientific study of micro-organisms, culture techniques & control procedures.

Distinguish between:

- Prions.
- Viruses.
- Bacteria.
- Protozoans.
- Fungi.
- Macro-parasites.

- **Prions:**

- Defective form of protein.
 - Chemically the same, develop abnormal shape.
 - Can alter other proteins.
 - Develop more prions.
 - Spread like a chain reaction.
- Does not contain DNA or RNA.
- Attacks brain / nerve cells of mammals.
- Infectious & heredity.

- All previous known pathogens contain nucleic acid.
 - Enables them to reproduce.

- Prion hypothesis states;
 - Certain diseases are caused not by known pathogens but a protein that has adopted an abnormal, disease producing form.

- Believed prions caused by cellular protein PrP.
 - Consists of 250 a.as.
 - PrP exists in cytoplasm of cells.
 - In a stable state.

- Prions believed to be infectious.
 - Even after exposure to treatments that destroy nucleic acids.

Eg.

Scrapie in sheep.
BSE (bovine spongiform encephalopathy) - mad cow disease.
CJD (Creutzfeld-Jacob Disease) - in humans. <ul style="list-style-type: none">- A neurodegenerative disease.
GSS (Gersmann-Straussler-Scheinker syndrome) - in humans. <ul style="list-style-type: none">- A neurodegenerative disease.

- **Viruses:**

- Consist of a nucleic acid (DNA & RNA).
 - Surrounded by a protein coat.
- Technically unliving.
 - Have a genetic code.
 - Can replicate.
 - Only within the host cell.
- Invade cells.
 - Insert genetic code into host cell's genetic code.
- Extremely small.

Eg.

Example of virus	Disease caused
Hepatitis B	Viral liver infection.
Herpes	Cold sores.
Paramyxovirus	Measles, mumps.
Human Immuno Deficiency Virus (HIV)	Acquired Immuno Deficiency Syndrome (AIDS).
Pelargonium mosaic virus	Causes mottling of leaves on the Pelargonium plant.

- **Bacteria:**

- Prokaryotic cells.
 - Nucleic acid not contained in a nucleus.
 - No internal membrane.
- Most live freely.
 - Some are parasitic.
 - Others have helpful affects.
- Cause disease by;
 - Secreting toxins.
 - Invading cells.
 - Forming colonies.
 - Disrupt cell function.

Eg.

Tuberculosis.
Boils.
Legionnaire's disease.
Pneumonia.
Enterobacteria - salmonella diseases, gastroenteritis.
Bacterial leaf spot - rotting of leaves in snapdragons.

- **Protozoans:**
 - Unicellular organisms.
 - Larger than bacteria.
 - Eucaryotic.
 - DNA in nuclear membrane.
 - Many free living.
 - Some parasitic.
 - Cause disease.

Eg.

	Caused by:
Amoebic dysentery.	Entamoeba; an amoeba protozoan.
Diarrhoea.	Giardia; a flagellate protozoan.
Malaria.	Plasmodium; a sporozoan protozoan.

- **Fungi:**
 - Heterotrophic.
 - Eucaryotic.
 - Some unicellular.
 - Others long, branching threads (mycelium).

Eg.

Example of fungi	Disease caused
Candida	Thrush, mucous membrane infection.
Tinea	Ringworm, athlete's foot.
Botrytis cinerea	Furry growth on grapes.

- **Macro-parasites:**
 - Multicellular parasites.
 - Visible to naked eye.
 - External (ectoparasites).
 - Internal (endoparasites).

Eg.

Ticks.
Fleas.
Mites.
Lice.
Roundworm.
Tapeworm.
Aphids.

- Pathogens Summary:

Type of Pathogen	Distinguishing Features	Example
<i>Prion</i>	<ul style="list-style-type: none"> - Defective protein. - Not containing DNA or RNA. - Attacks brain/nerve cells. 	<ul style="list-style-type: none"> - PrP. - Forms abnormal protein.
<i>Virus</i>	<ul style="list-style-type: none"> - Non-cellular. - Contains DNA & RNA. <ul style="list-style-type: none"> - Protein coat. - Requires living host to replicate. 	<ul style="list-style-type: none"> - HIV.
<i>Bacteria</i>	<ul style="list-style-type: none"> - Prokaryotic cell. - Divides quickly. 	<ul style="list-style-type: none"> - Enterobacteria. - Salmonella.
<i>Protozoan</i>	<ul style="list-style-type: none"> - Eucaryotic cell. <ul style="list-style-type: none"> - Single celled organism. - May have complex life cycle. 	<ul style="list-style-type: none"> - Plasmodium. - Malaria.
<i>Fungi</i>	<ul style="list-style-type: none"> - Eucaryotic cell. <ul style="list-style-type: none"> - With cell wall. - Spreads via spores. <ul style="list-style-type: none"> - Rapid reproduction. - External. - Internal. 	<ul style="list-style-type: none"> - Unicellular. <ul style="list-style-type: none"> - Yeast. - Tinea. <ul style="list-style-type: none"> - Ringworm. - Athletes foot.
<i>Macro-parasites</i>	<ul style="list-style-type: none"> - Eucaryotic cells. - Multicellular organisms. 	<ul style="list-style-type: none"> - Most types of worms. <ul style="list-style-type: none"> - Roundworms. - Tapeworms.

Identify the role of antibiotics in the management of infectious disease.

- Antibiotics:
 - Compounds that kill or inhibit pathogens.
 - **Eg.** *Penicillin* from mould '*Penicillium*'.
 - Discovered by Alexander Fleming.
 - 1928.
 - Have an important role in management of infectious diseases.
 - Naturally occurring compounds.
 - Produced by one organism.
 - Prevent growth of bacteria.
 - Prior to antibiotics, many died from 'simple' infections.

Perform an investigation to model Pasteur's experiment to identify the role of microbes in decay.

Aim: To identify the role of microbes in decay.

Materials: - Swan neck stopper.

- Stopper.
- 3x test tubes.
- Broth.
- Test tube rack.

Method: - Add equal amounts of broth to each test tube.

- Boil the broth for several minutes.
- Place 1 test tube in test tube rack.
- Place swan neck stopper on other test tube and place it in the test tube rack.
- Stopper the third test tube to seal it off from the air and place it in the test tube rack.
- Place on a shelf and leave for a year, observing and recording the developments frequently.

Results: Open test tube: bacteria.

Swan neck: no bacteria.

Stoppered: no bacteria.

Conclusion: The open test tube allowed for air to enter, carrying microbes that cause disease. The bend in the swan neck stopper prevented dirt and bacteria carried in the air from entering the test tube, preventing infection. The control; the stoppered test tube was completely sealed off from the external environment, preventing infection.

Gather and Process information to trace the historical development of our understanding of the cause and prevention of malaria.

- **Malaria:**
 - Caused by protozoan parasites.
 - Genus Plasmodium.
 - Vector (carrier):
 - Female *Anopheles* mosquito.
 - Only females feed on mammalian blood.
 - Requires blood meal to complete reproduction cycle of mosquito.
 - During meal, Plasmodium (sporozoites) transferred from salivary glands of mosquito to bloodstream of host.
 - Sporozoites travel to liver.
 - Merozoites (new form of protozoan) form, released into blood after 12 days.
 - Toxins also released.
 - Cause characteristic sweats & fevers.
 - Some merozoites form gametocytes, sucked up by another mosquito, enter gut & become fertilised gametes.
 - Form sporozoites, travel to salivary glands.
 - Involves a complex life cycle.
 - Asexual & sexual multiplication in mosquito & human.
 - Humans suffer fevers when red cells containing parasites burst.
 - Release merozoites into blood stream.
- **Historical Development of Malaria:**
 - Ancient Times:
Man attributed fevers to evil spirits & black magic.
 - Several thousand years ago:
Malaria attributed to god, depicted as mosquito-like creature.
 - 800BC:
Indian wrote mosquitoes could cause diseases, fevers.
 - 400BC:

Hippocrates distinguished between malaria fevers & other fevers.

300BC:

Charaka (Indian) categorises 5 types of fever.

100BC:

Susruta (Indian) associates fevers with insect bites.

1st Century BC:

Romans suggested diseases caused by animals in marshes.

1696AD:

Morton presented 1st description of clinical picture of malaria & treatment with cinchona.

1712AD:

Francesco Torti accurately described intricate course of disease curable by cinchona.

1716-1717AD:

Lancisi described characteristic black pigmentation of brain & spleen in malaria victims. Linked malaria with swamp vapours & stagnant water. His book echoed view that malaria was caused by minute 'bugs' / 'worms' which enter blood stream, revived idea of mosquito playing a role.

1796AD:

American physician suggested mosquitos lay eggs during biting which hatch in the wound & migrate through the hosts body.

1816AD:

Giovanni Rasori suggested malaria caused by micro-organism.

1820:

Quinine used to prevent disease.

1847AD:

German physician viewed malaria parasites in blood but did not recognise what they were.

Nov 6, 1880:

Charles Laveran found moving object in fresh blood sample of malaria patient. Named it *Oscillaria malariae*.

1882:

Albert King, America suggested mosquito real source of malaria.

1884:

Russian physiologist identified malaria parasites in blood of wild birds.

Marchiafava & Celli demonstrated active amoeboid in unstained blood, named it *Plasmodium*.

1886:

Pasteur, Osler & Golgi confirm Laveran's findings.

Golgi observed asexual reproduction of Plasmodium, identified 2 species.

Aug 20, 1897:

Ronald Ross demonstrated oocysts in gut of anopheline mosquito in India, proved mosquito was vector of malaria.

July 1898:

Ross demonstrated sporozoites in salivary glands of mosquito. Giovanni Grassi named Anopheles as vector.

1940:

Chloroquine first synthetic anti-malarial drug used.]

1987:

Dr. Patarroyo, Columbian biochemist developed 1st synthetic Spf66 vaccine against Plasmodium falciparum.

2002:

Genome of anopheles gambiae & Plasmodium falciparum sequenced.

Identify Data Sources, Gather, Process and Analyse information from secondary sources to Describe one named infectious disease in terms of its:

- **cause**
- **transmission**
- **host response**
- **major symptoms**
- **treatment**
- **prevention**
- **control**

- **Hepatitis B**

Medical name: Serum hepatitis.

Causes:

- Hepatitis B virus (HBV).
- Circular DNA molecule.
- Surrounded by envelope of lipid, protein, CHO.

Transmission:

- Close contact in which blood / bodily fluids exchanged.
 - Most common = needle-stick injuries, homosexual activity.
- Infects baby of infected mother during birth.
- Baby then carries virus.

Host Response:

- Long incubation period (6-8 weeks).
 - No symptoms.
- Acute disease occurs, lasts weeks/months.
- 3 possible outcomes of disease:
 - 90% ppl recover completely.
 - 1% follow fatal course, *fulminating hepatitis*.
 - 3% chronic hepatitis. → cirrhosis of the liver, liver cancer.
 - 1% of cirrhosis/cancer fatal.

Major Symptoms:

- Fever.
- Painful joints.
- Jaundice.
- Nausea.
- Tender liver.

Treatment:

- Rest @ home.
- Rest liver, avoid;
 - Fatty foods.
 - Alcohol.

- Other drugs toxic to liver.
- Chronic sufferers;
 - Interferon; antiviral drug.
- Liver failure:
 - Transplant.

Prevention:

- Avoid contact with blood/bodily fluids of known/suspected carriers.
- No cure available.
- Vaccination.
 - Provides protection in 90% of people.

Process information from secondary sources to discuss problems relating to antibiotic resistance.

- Overuse of antibiotics led to selection of more virulent bacteria that are resistant to antibiotics.
 - Had a dramatic effect on pathogens when first introduced.
 - Effect gradually lessened as pathogens developed resistance.
 - Whenever antibiotic used, individual pathogens with natural resistance selected.
 - Resistant pathogens breed, pass on genetic information.
 - Forming more resistant pathogens.
 - Drug no longer has an effect.
 - Formation of 'superbugs' has occurred.
 - Eg.** Golden staph (*staphylococcus aureus*).
 - Not destroyed by even the strongest antibiotics.
- Scientists working on development of new antibiotics.
 - Zyvox.
 - Otherwise common infections will cause death once again.
- Many household products contain antibiotics.
 - Kill non-resistant bacteria.
 - Resistant microbes can breed with no competition.
- Antibiotic use in farms has led to selection of resistant bacteria.
 - Human antibiotics prevent infections in meat.
 - May remain in animals when put on the table.
 - Leads to resistant strains being selected.
 - Able to reproduce.
- Completing antibiotic courses even though symptoms are gone is important.
 - Ensures all microbes are destroyed.
 - Not finishing course leads to selection of some bacteria.