1. **Discuss the difficulties of defining the terms ‘health’ and ‘disease’**

Definitions from the World Health Organisation:

- **Health**: a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity
- **Disease**: any condition which prevents proper physical functioning by interfering with the structure of organs, tissues of cells or by altering normal metabolism

Difficulties with these definitions:

- The terms ‘health’ and ‘disease’ are used in day to day conversation and not necessarily with the same scientific meanings.
- It is possible for a person to be healthy and have a disease at the same time.
- The definition of disease is very broad. It could relate to anything, from a splinter in a finger to meningitis.
- The definition of health has many components and some of these are very subjective
- Health varies on a daily, even hourly basis and is not just the absence of disease.
- Health can vary with age or fitness level or susceptibility to disease
- Individuals can have the ability to be prone to certain diseases

2. **Outline how the function of genes, mitosis, cell differentiation and specialisation assist in the maintenance of health**

<table>
<thead>
<tr>
<th>Maintaining health depends on</th>
<th>Description</th>
</tr>
</thead>
</table>
| Functioning of genes | - Genes consist of DNA with the bases forming codons that relate to the production of specific amino acids.  
- Since amino acids are the functional unit of proteins such as enzymes, the gene message often translates into a particular enzyme that controls a specific reaction.  
- These proteins and enzymes are needed for growth and repair. They also regulating the cell cycle and limiting the growth and reproduction of cells.  
- E.g. diabetes, cystic fibrosis, albinism, lactose intolerance. |
| Mitosis | - Mitosis is a part of the cell cycle and is important in the maintenance, growth and repair of body tissues.  
- It replaces damaged cells with new healthy cells.  
- E.g. Red blood cells only last 3 months and skin cells are being constantly destroyed.  
- However the rate of mitosis needs to be carefully controlled to maintain the correct number of red blood cells and the correct skin thickness. |
| Cell differentiation and Specialisation | - Cell differentiation is the process where an unspecialised cell changes into a specialised cell with a particular structure and function (occurs after mitosis).  
- Multicellular organisms need specialised cells to carry out the specific functions required to allow the whole body to survive.  
- Each cell has the genetic information necessary to produce all types of cells. However, each cell normally differentiates to become a specialised cell, with a specialised structure aepidemiolnd function. Undifferentiated cells can combine to form tumours.  
- E.g. red blood cells, white blood cells, muscle cells, organ cells.  
- If a gene is switched on for a cell to divide uncontrollably, then it forms cancer. |

Normally however, you are able to maintain your optimal level of health due to a battery of biological mechanisms that fight disease and stabilise your basic body processes.
3. Use available evidence to analyse the links between gene expression and maintenance and repair of body tissues

Gene expression, maintenance and the repair of body tissues are intimately linked. For if one does not function properly, all the rest can also be affected thus resulting in sickness for the organism.

- **Gene Expression**: Genes are said to be expressed if they are able to produce a full functioning protein. Genes may be present but not expressed, e.g. if they are repressed by another gene.
- **Repair of Body Tissues**: When the body is damaged or injured, it is the expressed genes of the body that enable proteins to make their repairs on the damaged tissue. These genes provide the proteins, enzymes, and hormones necessary to heal the wound. However, as one ages, repressor genes inhibit the expression of genes necessary to repair body tissues - in other words, we heal faster and more completely when we are younger.
- **Genes that repair body tissue are also an essential part of the DNA replication cycle which maintains a healthy cycling of cells. However, repressors that inhibit these repair genes are also an essential part of the cycle - tumour suppressor genes and the like prevent uncontrolled cell division (which results in cancerous growth).**
- **Cancerous growths and the necessity of repressor genes:**
  - Cancerous growths (or tumours) result from uncontrolled division of cells which grow into one of the various kinds of tumours, malignant or benign.
  - Normal mitosis will automatically produce cancer because mitosis precipitates unchecked cell division.
  - The existence of repressor genes that prevent constant, unchecked cell division prevents human beings from becoming infected with cancerous growths.
  - Repressors are DNA-binding proteins that bind to the DNA segment known as the operator. By binding here, the repressor prevents the RNA polymerase from creating messenger RNA.
  - Repressors can be made ineffective by inducer molecules that force the repressor to "let go" of the operator of the DNA - hence the repressor/inducer system is essentially an example of a feedback mechanism.
- **How gene expression results in the repair of body tissues:**
  - In gene expression, a segment of DNA is "switched on" to produce a polypeptide.
  - The polypeptide is then manipulated into the required protein.
  - The protein is transported and manipulated so as to become either a component of cytoplasm or to function as an enzyme and control the production of other cellular molecules.
Chapter 3: Over 3000 years ago the Chinese and Hebrews were advocating cleanliness in food, water and personal hygiene

1. Distinguish between infectious and non-infectious disease
   - **Infectious disease**: pathogens causing disease to spread from one host to the next. E.g. flu virus.
   - **Non-infectious disease**: Disease not caused by a pathogen, can have genetic, environmental or nutritional causes. E.g. haemophilia, diabetes, cancer from tobacco smoking, cancer from radiation exposure.

2. Explain why cleanliness in food, water and personal hygiene practices assist in control of disease
   Cleanliness and hygiene are important to reduce the transmission of disease.

<table>
<thead>
<tr>
<th>Hygiene Practice</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washing hands after going to the toilet</td>
<td>Removal of bacteria to prevent transmission to others or to yourself</td>
</tr>
<tr>
<td>Cooking meat</td>
<td>Kills bacteria and flatworm cysts in the meat. Modern meat inspection practices ensure that the occurrence of parasites is far less common in meat</td>
</tr>
<tr>
<td>Bathing showering</td>
<td>Removes accumulated bacteria living in fats, oils and moisture on skin. Interestingly there is one school of thought that says that by not washing at all the bacteria on the skin eventually reach a natural balance that is not harmful to the body</td>
</tr>
<tr>
<td>Brushing teeth</td>
<td>Build up of plaque is food for bacteria</td>
</tr>
<tr>
<td>Boiling water when travelling</td>
<td>Kills micro-organisms in the water. Those local to an area often develop a resistance to microbes in the local water, but travellers are frequently susceptible to the new micro-organisms they encounter.</td>
</tr>
<tr>
<td>Covering mouth and nose when sneezing</td>
<td>Prevents spread of disease like air born bacteria that can affect others</td>
</tr>
<tr>
<td>Washing a wound and then covering</td>
<td>Removes bacteria by washing. Covering prevents airborne bacteria from entering.</td>
</tr>
</tbody>
</table>

3. Identify the conditions under which an organism is described as a pathogen
   A pathogen is any organism that can produce a disease. E.g. salmonella (common in raw chicken meat) can cause food poisoning.
   Pathogens cause contagious disease so the infectious diseases are the result of pathogens.
   They include:
   - Bacteria
     - Prions
   - Fungi
   - Viruses
     - Protozoans
     - Macro-parasites

   To be considered a pathogen, an organism must:
   » Be virulent- have a great enough effect to cause harm to its host.
   » Be able to enter the host’s body or live on its surface for long enough to cause harm before/without being killed by the immune system.
   » Have some way of passing from one organism to another. E.g. through air or fluid contact.

Pathogens harm the host by:
» Directly destroying host’s cells or tissues.
» Producing toxins that destroy the host’s cells or tissues.
» Multiplying to numbers that prevent normal functioning in the host.
» Producing/causing an excessive immune response which can cause damage even if the pathogen itself doesn’t directly harm the host.
4. Identify data sources, plan and choose equipment or resources to perform a first-hand investigation to identify microbes in food or in water

PRAC EXPERIMENT 1- Agar plates and the swabs from around the school.

5. Gather, process and analyse information from secondary sources to describe ways in which drinking water can be treated and use available evidence to explain how these methods reduce the risk of infection from pathogens

Primary treatment:
- Screening – the filtering out of large debris by using bars and screens
- Degritting – the removal of relatively large grit particles
- Flocculation – the gentle mixing of water with chemicals to form suspended particles that contain many microbes
- Sedimentation – the settling of suspended particles in settling tanks
- Sludge Processing – the collection and processing of solids and liquids from the settling tanks

   These suspended particles containing microbes are removed so to prevent infections.

Secondary treatment:
- Filtration – the removal of nearly all remaining microbes and fine mud by passing the water through sand beds or charcoal

   Removes more microbes and other contaminants from the water.

Tertiary treatment:
- Chlorination – the addition of chlorine to kill off remaining harmful microbes, for example chlorine is more effective on bacteria than on viruses and protozoa
- Fluoridation – the addition of fluoride to reduce tooth decay
- Various other chemical treatments, depending on location

   Kills off all remaining harmful pathogens.
Chapter 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

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

It was scientific investigations by Louis Pasteur and Robert Koch in the 19th century that finally convinced scientists that microbes did cause disease.

**Louis Pasteur:**
- His work on fermentation of sugar-beet juice indicated that normal alcohol was produced, round yeast cells were present.
- However, when sour-tasting wine (containing lactic acid) was produced, small rod-shaped bacteria (bacilli) were present.
- He concluded that different micro-organisms were responsible for the various products.
- In this way, he was able to show that the souring of milk and spoiling of wine was caused by pre-existing bacteria, and that no microbes appear spontaneously, they occur in the environment naturally.
- However if it was heated for several minutes the microbes were killed in a process now called pasteurisation.

**But where did these microbes come from?**

**The Swan Neck Experiment:**
- He boiled broth to kill any existing micro-organisms
- He then poured it into two identical flasks where the necks of the flasks were bent in an S-shape
- One flask was left (did not have access to air currents) and the other has the swan neck broken off (had full access to air and air currents)
- The broth in the intact flask remained clear while the broth in the open flask turned cloudy.
- In this way Pasteur disproved spontaneous generation by proving that microbes are present in the air and transmitted by air currents.

**Vaccinations:**
- He also developed vaccinations which was a technique of inoculating animals with a weakened form of a disease so that they were protected against more virulent forms.
  - His experiments put medical science onto the track of finding the causes of many diseases that were cause by micro-organisms.
  - Some of his research led to later discoveries and adaptation by other scientists to identify and treat human and other diseases.

**Koch:**
- Robert Koch demonstrated which microbe caused a particular disease.
- He was the first to develop a way of growing pure cultures of bacteria on nutrient jelly in a petri dish.
- He isolated and identified the bacterium which caused anthrax in sheep and developed a set of rules which need to be followed before scientists can confidently declare a particular microbe as the cause of a disease.

**Koch’s Postulates (Koch’s Rules):**

1. The micro-organism believed to cause the disease must always be present when the disease occurs.
2. The micro-organism must be able to be isolated and grown in a pure (sterile) culture in a laboratory.
3. The micro-organisms from the pure culture must produce the disease when injected into a healthy host.
4. The same micro-organism that was isolated initially must be obtained from the organism in which the disease was induced.

Using his method, scientists were able to discover the causes of diphtheria, pneumonia and many more.
2. Distinguish between: prions, viruses, bacteria, protozoans, fungi, macro-parasites and name one example of a disease caused by each type of pathogen

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
</table>
| Prions         | • A prion is an infective prokaryotic protein that causes the degeneration of brain tissue.  
• Consist of only protein.  
• Non-cellular, have no DNA.  
• Not alive.  
• A defective prion begins to convert normal proteins into prion protein. This chain reaction continues, the prions bind together forming plaques that grow in nerve tissue and disrupt normal function by causing holes in the brain tissue. Leads to severe brain damage and death.  
Effect:  
– The bursting of nerve cells is what results in the large holes seen in infected brains.  
– No treatment is available for individuals with infected prions and prions are extremely resistant to heat and chemical agents. Very difficult to dispose of affected dead animals. | Known as “mad-cow disease” in cattle and “Creutzfeldt-Jakob disease” in humans.                                                                                                                                                                                                                                                                                                                                                   |
| Viruses        | • Considered non-cellular and non-living as they lack a cell membrane and do not perform cellular functions. They’re eukaryotic.  
• However they have a protein casing enclosing a single kind of nucleic acid (either DNA or RNA).  
• The protein coat may contain lipids, carbohydrates and sometimes enzymes which are involved in penetration of the host cell.  
• They contain their own genetic code which allows them to replicate through a host cell.  
• Viruses do not have their own enzyme system, but rather, rely upon and utilise the enzymes and metabolism of the host cell.  
• They can only multiply in a host cell and use the metabolism of the host cell to reproduce.  
• The host cell usually dies and the virus particles are released to infect other cells.  
• They contain their own genetic code which allows them to replicate through a host cell by “hacking” the host cell’s DNA (inserting their own DNA into the host cell). | Influenza  
Measles  
Warts  
Chicken Pox  
Hepatitis B  
Rabies                                                                                                                                                                                                                   |
| Bacteria       | • Bacteria are a type of prokaryote (unicellular life form) and have the same basic internal structure regardless of their varying shapes.  
• They have no membrane-bound organelles and no true nucleus. They’re eukaryotic.  
• They have a nucleoid, a region containing a single coiled strand of DNA and contain ribosomes and enzymes in the cytoplasm.  
• The cell membrane is surrounded by a cell wall.  
• When bacterial cells divide the total number doubles, thus, bacteria can rapidly multiply. | Tetanus  
Cholera  
Tonsillitis  
Tooth decay                                                                                                                                                                                                                   |
| Fungi          | • Includes yeasts, moulds and mushrooms.  
• Yeasts are unicellular, non-filamentous, oval or spherical cells. They’re eukaryotic.  
• Moulds are multicellular and filamentous.  
• They have no roots, stems, leaves or vascular systems and do not contain chlorophyll and hence are heterotrophic.  
• They obtain their nutrients by breaking down dead or decaying organic matter. | Tinea  
Ringworm  
Thrush                                                                                                                                                                                                                   |
Protozoa

- Protozoa are a type of prokaryote (unicellular life form)
- They have a cell membrane and are heterotrophic. They’re eukaryotic.
- Some protozoans have food vacuoles and contractile vacuoles which enable osmoregulation.
- Many can encyst and become dormant when conditions are unfavourable.
- Protozoans are typically motile, although some spore-formers are immotile.

Endoparasites:
- These are mainly flatworms such as flukes and tapeworms and round worms. They’re eukaryotic.
- Most endoparasites have adaptations to survive within their host. E.g. some flatworms with no eyes (not needed inside the darkness of the host’s body).
- They remain permanently inside the host, obtaining food and shelter.

Ectoparasites:
- These are mainly arthropods, especially insects, such as lice, fleas and arachnids such as ticks and mites. They’re eukaryotic.
- Some ectoparasites visit the host briefly just to feed (mosquitoes) while others bury into the skin for longer, obtaining shelter as well as food (mites).

Macroscopic organisms

- Liver Fluke Disease (fascioliasis)
- The mosquito that transmits malaria.

Prokaryotic: very simple cells that lack membrane bound nuclei.
Eukaryotic: More complex cells that have membrane bound nuclei.

Bacterial Replication
3. Identify the role of antibiotics in the management of infectious disease

Antibiotics are drugs that prevent bacterial growth.

They are usually secreted by other micro-organisms to destroy competing bacteria.

**They do not kill viruses.**

**Antibiotics work by:**
- Stopping the cell wall from forming in binary fission
- Stopping the cell membrane from working (breaks it down)
- Stopping or interfering with protein synthesis

Scientists have been able to synthesise new antibiotic chemicals, some of which are broad spectrum antibiotics that kill a wide range of bacteria.

However many bacteria have developed resistance to antibiotics because of the overuse of antibiotics and disinfectants:
- When an antibiotic kills bacteria, there may be one or two individual bacteria that have a natural resistance, from natural selection or mutation, to the antibiotic.
- These individuals will be able to multiply without competing with other bacteria that have been killed by the antibiotic.
- The result is strains of bacteria that are resistant to antibiotics.
- A strain resistant to practically all antibiotics is called a ‘super-bug’.

The strongest antibiotic is called **vancomycin**.  
**Staphylococcus aurea (Golden staph)** now has a strain that is resistant to vancomycin.

The resistant genes to an antibiotic are located in the bacteria’s DNA, this resistance is subsequently capable of being passed on to other bacterial species via plasmid transfer.
Overuse of Antibiotics and Disinfectants:

**Livestock:**
- Another overuse of antibiotics is in feed in livestock. This is used to reduce death by infection and increase yield and profits.
- Any resistant bacterial strains that develop may be passed on to humans through the consumption of uncooked meat, the use of utensils that have been in contact with meat juices and from farm waste run off into lakes, rives and ground water.
- Genetically modifies crops that have antibiotic-resistant genes also increase the risk of other microbes acquiring this resistance.

**Misuse of antibiotics:**
- Misuse of antibiotics by medical practitioners and patients are also responsible for the rapid increase in antibiotic-resistant strains of bacteria.
- Doctors often prescribe antibiotics for patients with illnesses that cannot be treated or cured by antibiotics (such as viral infections like the common cold).
- Patients often request antibiotics when they are not needed or do not complete the entire course prescribed for them. This kills off the susceptible bacteria and leaves the more resistant bacteria to reproduce.

**Resistance happen when an infection is treated with antibiotics but all the bacteria are not killed – the ones that remain learn how to outlive that antibiotic and are now resistant.**

**This happen from:**
- Not finishing the whole prescription
- Not taking the proper dosage or at the proper times
- Taking someone else’s prescription
- Taking antibiotics when not needed

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

PRAC EXPERIMENT 2
5. Gather and process information to trace the historical development of our understanding of the cause and prevention of malaria

- **1820** Quinine first purified from tree bark. For many years prior, the ground bark had been used to treat malaria.
- **1880** Charles Louis Alphonse Laveran first identifies the malaria parasite. He is awarded the 1907 Nobel Prize for the discovery.
- **1898** Sir Ronald Ross demonstrates that mosquitoes transmit malaria. He wins the 1902 Nobel Prize for this work.
- **1934** Hans Andersag in Germany discovers the **Anti-malarial drug Chloroquine**, which is not widely used until after World War II.
- **1952** Malaria is eliminated in the United States.
- **1957** First documented case of resistance to Chloroquine is reported.
- **1976** William Trager and JB Jensen grow parasite in culture for the first time, opening the way for drug discovery and vaccine research.
- **1989** The U.S. Food and Drug Administration approve the use of the anti-malaria drug Mefloquine hydrochloride, registered as Lariam® by Hoffman-La Roche.
- **1992** Malaria vaccine candidate RTS,S, developed by GlaxoSmithKline and the Walter Reed Army Institute of Research, enters clinical trials.
- **1996** Insecticide-treated bed nets are proven to reduce overall childhood mortality by 20 percent in large, multi-country African study.
- **1998** WHO adopts home management strategy for malaria whereby trained community volunteers provide antimalarials in remote African communities.
- **2001** WHO prequalifies first fixed-dose Artemisinin combination therapy (ACT), sold by Novartis as Coartem® and recommends ACT as first-line malaria treatment.
- **2002** Genome sequencing of Anopheles gambiae (mosquito) and Plasmodium falciparum (parasite) completed.
- **2007** UCSF study shows combination malaria therapy effective in treating African children.
- **2008** The Global Health Group at UCSF comes forward with the first high-level strategy for the eventual achievement of malaria eradication. This strategy has since been widely adopted.
- **2008** United Nations adopt April 25 as World Malaria Day.
- **2008** Rectal application of the inexpensive **antimalarial drug artesunate** proven to save the lives of young children with severe malaria.
- **2010** UCSF experts outline new strategy to eliminate malaria.
6. 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

<table>
<thead>
<tr>
<th>Name</th>
<th>Malaria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cause</strong></td>
<td>The parasitic protozoan, <em>Plasmodium</em></td>
</tr>
<tr>
<td><strong>Vector</strong></td>
<td>Anopheles female mosquito</td>
</tr>
<tr>
<td><strong>Area</strong></td>
<td>Mainly in tropical climates</td>
</tr>
</tbody>
</table>

| **Transmission** | Blood from a malaria victim contains Plasmodium sex cells. These form zygotes in cysts in the stomach wall of the mosquito and mature into sporozoites. When a cyst bursts, the sporozoites travel to the mosquito salivary glands, from where they are transferred to the victim of the mosquito bite. The sporozoites travel to the liver, multiply and then enter the red blood cells, where they also multiply. When the infected cells burst, they cause the malarial fever. Male and female gametes are produced from these sporozoites, which are then taken in the blood the next time a mosquito bites. |
| **Major Symptoms** | When the merozoites burst out of the red blood cells, toxins are released. These toxins cause: |
| | • Fever that may reach 41°C |
| | • Shivering fits |
| | • Headaches |
| | • Nausea |
| | • Profuse sweating |
| | • Attacks lasting two or more hours occurring in cycles every 48 hours |
| | • Anaemic symptoms from loss of red blood cells and haemoglobin. |
| **Host Response** | • While in the liver, the plasmodium is isolated from the host’s immune system. |
| | • When the plasmodium is in the red blood cells, the host produces antibodies. |
| | • The surface antigen of the cell membrane of Plasmodium changes periodically which means the new surface antigen is not recognised by the antibodies. |
| **Treatment** | • Medicines including quinine such as chloroquine which prevents malaria, can be taken. |
| | • Other drugs reduce temperature and may cure the infection. |
| **Control** | • Wear protective clothing. |
| | • Use insect repellent. |
| | • Use mosquito nets over beds. |
| | • The adult mosquito can be destroyed but spraying insecticides. |
| | • Swamps and standing water can be drained, covered with a lid or a layer of oil to destroy the larvae and pupa. |
| | • Ships, planes and vehicles should be sprayed before arrival in malaria-free locations. |

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

-------------------------------See point 3-------------------------------
Chapter 4: Often we recognise an infection by the symptoms it causes. The immune response is not so obvious, until we recover

1. Identify defence barriers to prevent entry of pathogens in humans: skin, mucous membranes, cilia, chemical barriers, other body secretions

   To produce disease, pathogens must enter the body in sufficient numbers, or enter the body and reproduce in the body.

   Therefore, pathogens must have certain points of entry and these points of entry form a non-specific response in the first line of defence.

| Skin | • Covers whole body  
|      | • The outer layers contain a protein called keratin. This is impenetrable by pathogens unless broken.  
|      | • Skin is naturally acidic which discourages growth of many microbes.  
|      | • Oil glands secrete fatty acids which inhibit the growth of bacteria and fungi.  
|      | • Quite dry and the growth of microbes is practically impossible without water.  
|      | • Skin has its own population of normally harmless bacteria which discourages and destroys invading pathogens. |

| Mucous Membranes | • Line the digestive, respiratory and urinary tracts with a slimy mucous.  
|                  | • This traps the pathogen and carries it out of the body in the mucus.  
|                  | • Contains the antibody IgA which reacts with potentially risky pathogens, preventing them from invading the surface  
|                  | • Also contains natural microbes which secrete substances to inhibit pathogen growth |

| Cilia | • Tiny hair-like structures that projects from the cells lining respirator surfaces life nose, trachea and bronchial tubes, all over the body.  
|       | • Cilia beat and sweep (in a wave-like motion) the mucous containing pathogens out of the body through the nose opening or to the pharynx (throat) then coughed out or swallowed.  
|       | • Cilia in the nose filter the inhaled air.  
|       | • Reflex actions such as coughing and sneezing help to remove pathogens as well. |

| Chemical Barriers | • Provided by conditions that make the surface inhospitable for potential pathogens  
|                  | • Most pathogens entering body in food or drink and destroyed by the strong acidity of the stomach or the alkalinity of the small intestine (destroys acid resistant pathogens).  
|                  | • Lysozyme dissolves the cell membranes of bacteria. |

| Body Secretions | • Urine is sterile and acidic. It flushes the ureters, bladders and urethra and prevents the growth of most microbes.  
|                 | • Saliva washes microbes off teeth and into the stomach where they are killed by acid  
|                 | • Fluids, nasal secretions, saliva, tears and perspiration contain the enzyme lysozyme which is designed to lyse’ or break down the cell wall of certain types of bacteria.  
|                 | • Harmless microbes in the vagina create acidic conditions which inhibit the growth of bacteria and fungi. |

2. Identify antigens as molecules that trigger the immune response

   See Point 4

   If both the first line of defence and the second line of defence fail to destroy a pathogen, then the third line of defence comes into operation.

   This is the immune system and depends upon distinguishing between parts of the body and foreign particles; otherwise it would destroy body cells.
• **Antigen**: Any molecule that the body recognises as being foreign.
• Antigens are molecules that activate the immune response.
• These are foreign molecules and chemicals that are in or on foreign organisms.
• Two examples of foreign molecules are substances in the outer coating of microbes and protein debris from other organisms.
• The third line of defence (B cells) recognises antigens and begins to make antibodies.
• An **antibody** is a protein (made by B cells – lymphocytes) that binds with and antigen to destroy it.

3. **Explain why organ transplants should trigger an immune response**

The body has unique methods of recognising and acting against invaders, including transplanted organs.

**Identification:**
- Each cell in the body has a marker or Major Histocompatibility Complex molecule (MHC) which signals that it belongs to the same body as the rest of the cells.
- These are glycoproteins which form marker molecules on the surface of body cells.
- They protrude from cell membranes and play a role in the recognition of **self** and **non self** and in the communication between cells in the immune system.
- These markers are unique to each person, except for identical twins whose markers are identical.
- Class 1 MHC – present on the surfaces of almost all body cells (not red blood cells) and T lymphocytes
- Class 2 MHC – present on the surface of macrophages and B lymphocytes
- **In most cases transplanted donor tissue will not match that of the recipient perfectly and the recipient will react against the non-self material.**
- For this reason transplant organs it is given to a recipient whose cell marker proteins match those of the donor as closely as possible

**Organs:**
- Before an organ is transplanted from one person to another, the donor and the potential recipient have their tissues ‘typed’ to find out the major antigens that are present in each.
- The amount of foreign or non-self material introduced into a recipient is minimised by matching the tissues as closely as possible.
- The closer the match of MHC markers between the donor and recipient, the higher the chance that the transplant will be successful.
- Transplant rejection can occur days, months or even years after surgery.

**Bone Marrow:**
- Bone marrow is a tissue that can be transplanted from a living donor, unlike heart and liver transplants that require the death of the donor.
- Recipient tissues must be matched as closely as possible so the chance of rejection of the transplant by the recipient is reduced.
- A specific problem may occur with bone marrow transplants.
- As bone marrow contains T cells, the donor T cells may recognise and react against the antigen on the host cells.
- If this occurs, donor T cells reproduce and produce cytokines (lymphokines) in an attempt to remove host cells.
- To prevent rejection of recipient cells by donor bone marrow cells, a recipient is treated with immunosuppressive drugs.
- In addition, some of the T cells are removed from the donor bone marrow to reduce the intensity of any reaction.
Immunosuppression:

- In order to ensure success after transplant surgery, the body’s own immune system must be dampened to minimise the chances of any cells reacting to the graft/donation and causing rejection.
- This is known as immunosuppression.

Drugs available that inhibit the immune response:

- Cyclosporine is a drug derived from a fungus that acts specifically against T cells and so the remainder of the immune system is available to act against disease-causing organisms.
- One side effect of Cyclosporine is that it may increase the risk of cancer.
- A range of other drugs can also be used in association with cyclosporine.

4. Identify defence adaptations, including: inflammation response, phagocytosis, lymph system, cell death to seal off pathogen

*Once pathogens have successfully entered the body, the body responds, non-specifically in the second line of defence*

**Inflammation response:**

Any tissue damage from a pathogen or a foreign object such as a metal or wooden splinter will initiate a localised inflammatory response.

Damaged tissue releases **histamines** that:
- increase the dilation of blood vessels (so to increase circulation and amount of blood supplied to the area)
- allow leakage of blood vessel walls (so that white blood cells, such as phagocytes can penetrate the affected area to kill the pathogen or contain the foreign object)
Phagocytosis:

Some white blood cells, called macrophages and neutrophils, can very easily change their shape so that they flow around particles and completely enclose them within their cell, where they are broken up by cell enzymes. This is called phagocytosis.

- Phagocytes are white blood cells that attack foreign substances by engulfing and destroying them.
- They move through blood capillary walls to the affected site and release more histamines, which encourage other phagocytes to travel to this area.
- Phagocytes will actively engulf or surround the invader pathogens.
- Often white blood cells will accumulate later as dead phagocytic cells and bacteria and fluid at the site, which becomes obvious as pus.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td>Material to be phagocytised becomes attached to cell membranes at phagocyte.</td>
</tr>
<tr>
<td>2)</td>
<td>Cell membrane of phagocyte flows around the material to be ingested – until it is enclosed within a vacuole within the phagocyte.</td>
</tr>
<tr>
<td>3)</td>
<td>Lysosomes in cell approach the vacuole.</td>
</tr>
<tr>
<td>4)</td>
<td>Lysosomes fuse with vacuole and discharge their contents (including lysozyme) into it.</td>
</tr>
<tr>
<td>5)</td>
<td>Lysosome enzymes break down the particles and render them harmless – these products are used by the phagocyte or are released into its surroundings.</td>
</tr>
</tbody>
</table>

Blood cells that complete Phagocytosis
(All blood cells are produced by stem cells in the bone marrow)

Neutrophils
- First to access infection scene to kill pathogens by completing phagocytosis (to a lesser extent than macrophages)

Monocytes
- Circulate in the blood stream and phagocytise foreign material.
- When an infection occurs, they travel to the infected site and mature into macrophages.
Macrophages
- Mature from monocytes
- Travel to infected area and complete a higher pathogen engulfing form of phagocytosis.
- After cut or inflammation is cleared of infection it also engulfs all the dead cells after infection.
- After engulfing pathogen, processes the pathogen’s antigen and secretes cytokines for antigen presentation on the macrophage surface at a MHC marker site to a Helper T-cell in a lymph node.

Eosinophils
- Mainly used in attacking parasites and in allergy responses

Basophils
- Mainly used in allergy responses

This line of defence is sometimes limited because:
- Pathogens may repel phagocytosis
- Pathogens may escape from the phagocyte before they are completely destroyed
- In severe infection, many phagocytes are destroyed.

Lymphatic system:
- The lymph system returns intercellular fluid to the blood system, filters cell debris and produces white blood cells responsible for the immune response.
  - Lymphatic vessels run throughout the body and collect a fluid called lymph from the body’s tissues. Lymph carries wastes and certain nutrients, especially proteins.
  - Lymph capillaries (lymphatic vessel): The lymph capillaries collect the intercellular fluid from the cells and pass it to the lymph veins.
  - Lymph veins (lymphatic vessel): These pass the fluid to a larger set of lymph veins and eventually into two large lymph ducts which empty into veins of the blood circulatory system near the heart.
  - Lymph nodes: Small, bean-shaped organs found at certain points along the lymphatic vessels and are clustered in such places as the neck, the armpits and the groin. They remove antigens from the lymph and are storage and maturation sites for antigen-fighting cells such as B-cells and T-cells (that are called lymphocytes)

Cell death to seal off pathogens:
For some pathogens, macrophages and lymphocytes completely surround a pathogen so that it is enclosed in a cyst. The white cells involved die, so that the pathogen is isolated from its food supply and also dies.
- Granulomas are a cluster of cells that produce a covering to seal off a pathogen from the rest of the body.
- The internal cells die and are surrounded by layers of macrophages, lymphocytes and a hard outer covering.
- The cells die to seal off the pathogens and protect the rest of the body from infection.
- These are also classified as cysts.

5. Gather, process and present information from secondary sources to show how a named disease results from an imbalance of microflora in humans

Tissues such as skin, mucous membranes and intestines are constantly exposed to, and usually colonised by micro-organisms.
- Microflora: The mixture of micro-organisms, usually bacteria, that is regularly present in humans
- The association between the host and the microflora is of mutual benefit.
- The microflora gains a supply of nutrients, a stable environment, a constant temperature, protection and transport from the host.
- In return the presence of the normal microflora makes it difficult for micro-organisms, which could cause disease to the host, to establish themselves and multiply.
- However, fluctuations in the numbers of microflora that are present in humans can cause disease.
When the microflora is suddenly changed, other organisms can grow and cause change or infection.

Use of antibiotics is a common way to cause an imbalance in microflora.

This is because these drugs usually kill a range of micro-organisms, which often includes the microflora that is needed by the body.

<table>
<thead>
<tr>
<th>Name</th>
<th>Vaginal Thrush</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cause</td>
<td>An overgrowth of a fungus called Candida that lives naturally in warm, moist places.</td>
</tr>
</tbody>
</table>

**Symptoms**

- Stinging pain when passing urine
- Itchy and swollen genitals
- White and cheesy-looking discharge, often thick with a yeasty smell

**Obtained**

Taking antibiotics that kill the microflora in that area

Once the microflora in the vagina die, previously competing more successfully for the nutrients and space there, fungi can take over and when they do, it results in thrush.

Taking the contraceptive pill that can cause hormones to vary and therefore imbalances in microflora

**Treatment**

Creams and pessaries can restore the natural microflora balance and remove thrush

---

**Figure 1 - White Blood Cell Drawing**

- granules in cytoplasm
- lobed nucleus

---

**Figure 2 - Red Blood Cell Drawing**

- Copyright © 2001, Benjamin Cummings, an imprint of Addison-Wesley Longman, Inc.
Chapter 5: MacFarlane Burnet’s work in the middle of the twentieth century contributed to a better understanding of the immune response and the effectiveness of immunisation programs.

MacFarlane Burnet was one of the key scientists associated with the understanding of immunology. He proposed the idea that the body recognises its own tissue and will not destroy it. This is crucial to the treatment of transplant patients that have new tissue needing to be kept and not destroyed as foreign material. This has resulted in the use of immunosuppressant drugs in transplant patients to prevent tissue rejection. His work also dealt with the study of viruses and in particular, influenza A, resulting in the development of a vaccine saving countless lives, preventing the spread of virulent strains of disease and dramatically reducing the incidence of some diseases. Burnet concluded that a human immune system contained inactivated B cells that could be activated and produce an immune response following their exposure to a microbe. This led to the development of the understanding of mechanisms underlying previous vaccination technologies and led to the exploration of further vaccination technologies such as subunit vaccines.

1. Identify the components of the immune response: antibodies, T cells, B cells

*Specific immunity is the ability of a host to defend the body against particular pathogens by using responses specific to those pathogens.*

This is the third line of defence.

All blood cells are produced by stem cells in the bone marrow (and foetal liver).

The lymphocytes involved in the third line of defence leave the bone marrow either as T-cells or B-cells and so the immune system is made up of two parts, due to the different responses of the B and T cells to antigens. **Antibody:** a blood protein produced in response to and counteracting a specific antigen. Antibodies combine chemically with substances which the body recognizes as foreign, such as bacteria, viruses, and foreign substances in the blood.

**T-cells:** (Cell Mediated Response or Cellular Response)

- They are created in the bone marrow and mature in the thymus – that is why they are called T-cells
- Macrophages engulf and process a pathogen and present the antigen through cytokines to a Helper T-cell.
- T-cells do not respond to free antigens, but only to antigens that have been processed and presented by infected cells or phagocytic cells.
- The information provided by the macrophage causes the T-cells to differentiate into helper T-cells, cytotoxic (killer) T-cells, memory T-cells and suppressor T-cells are also produced (see diagram).

**Helper T-cells:**

- Cause macrophages to phagocytise more quickly and stimulate the production of cytotoxic T cells (killer).
- They become activated when they recognise a specific antigen on the surface of a phagocyte (such as a macrophage) that has just engulfed the associated pathogen.
- When activated, helper T cells release cytokines, chemicals that stimulate B cells to divide and differentiate into plasma cells (these secrete antibodies) and memory B cells.

**Cytotoxic (killer) T cells**

- Attach to a body cell infected with viruses and destroy the cell by breaking its cell membrane or by poisoning it with chemicals. Killing the cell prevents the virus from reproducing. Phagocytes such as macrophages then engulf these cells.
- Bacteria, protozoa, fungi, worms, transplanted tissues and cancer cells are also recognised as foreign antigens and are similarly dispatched.

**Suppressor T cells**

- Will turn off the immune response when no more antigens are present.
**Memory T cells**
- Circulate in the lymph to be used when the host in reinfected with the same pathogen at a later time.

  T-cells destroy invading pathogens directly. They act against bacteria, viruses within cells, protozoa, fungi, worms, transplanted foreign tissue and cancer cells.

**B-cells:** *(Humoral Response- immune responses involving antibodies in body fluids as opposed to in cells)*
- Are created in the bone marrow and mature in the bone marrow – that is why they are called B-cells.
- B-cells are activated by the cytokines produced by helper T cells (presenting the antigen from the macrophage) to rapidly divide and differentiate into plasma cells (to make antibodies) and memory B-cells.

These lymphocytes circulate in the blood and lymph and are stored in the lymph nodes and in lymphatic tissue along the lymph system.

**Plasma cells**
- The plasma cells resident in lymph nodes, produce Y-shaped antibodies which is a specific antibody (immunoglobulin) to attack and destroy a specific antigen (usually a protein).
- These antibodies are then released to circulate freely in the blood and lymph.
- **Antibodies act in several ways:**
  » They bind to viral antigens to prevent viruses from entering host cells.
  » They deactivate toxins and they coat pathogens outside of cell causing them to clump, making it easier for phagocytes such as macrophages to find and destroy them.

**Memory B cells**
- Circulate in the lymph to be used when reinfection occurs.
- When the pathogen reinvades, memory B cells will quickly divide into more plasma and memory B cells. Although this may happen many years later it is a much more rapid response than what occurs at initial infection.
- Some B cells differentiate into long-lived memory cells so years or decades after a previous infection, these cells rapidly differentiate into antibody and produce plasma cells when they encounter the same antigen in another infection.

This can occur because the immune system:
- Is able to distinguish host cells ("self") from invading cells ("non-self") so can recognise invading substances.
- Is able to produce numerous antibodies to react with a wide variety of invading antigens.
- Has a memory and so can recognise and react to substances that have previously entered the body.
2. Describe and explain the immune response in the human body in terms of: interaction between B and T lymphocytes, the mechanisms that allow interaction between B and T lymphocytes, the range of T lymphocyte types and the difference in their roles

----------------------------------------See Point 1 and Diagram----------------------------------------

3. Outline the way in which vaccinations prevent infection

Vaccination is a method of providing artificial acquired immunity without the need for a person to have suffered the disease initially.

- It involves the injection or swallowing of a substance that triggers the immune response so that memory B and T cells are produced and stored in the lymphatic system so that the immune response can be fast and effective if a later infection by the same antigen occurs.
- The memory B cells and T cells will rapidly detect and respond to a subsequent infection by producing antibodies in large numbers so that the infection is dealt with quickly and effectively.
- Vaccines not only protect the individual but reduce the incidence of the disease as there are less people to pass it on.
  - E.g. tetanus, polio vaccines.

Passive immunisation:

- This involves the injecting one person with antibodies produced by another person. This only produces only short-term immunity as although the antibodies can give temporary, immediate immunity, they do not provoke an immune response so no new antibodies or memory cells are produced by the injected person.
- Passive immunity is sometimes used to help a seriously ill person to fight a disease by receiving antibodies made by someone else in an immunoglobulin injection (blood serum, which contains already formed antibodies from someone who has had the disease).
- Passive immunity can also be used when a person has come in contact with a disease and has not been vaccinated (insufficient time to develop active immunity).
- Passive immunity also occurs when antibodies present in a mother’s placenta cross over to the blood of the foetus, or when the baby takes antibodies present in its mother’s milk.

Active immunisation:

- This stimulates a person to make his or her own antibodies through the introduction of killed/dead bacteria or viruses, weakened live pathogens or modified toxins into the body.
- This activates the immune response producing antibodies against these specific antigens. The antibodies thus produced remain in the blood and protect the body should a virulent strain of the same microbe invade the body at a later date.
- Memory cells also form and circulate in the blood so that the attack against the invading microbe is immediate. When the body recognises these substances as antigens, and B cells are stimulated to produce plasma cells and memory cells.

<table>
<thead>
<tr>
<th>Genetic</th>
<th>Natural</th>
<th>Acquired</th>
</tr>
</thead>
</table>
| An individual is born with a high immunity to a disease (pathogen) so never catches the disease memory cells are present from birth. | **Active:**
  - an individual catches the disease, fights off the pathogen and develops immunity (memory cells remain in the system) | **Active:**
  - a vaccine of dead or weakened pathogen is injected; it is not strong enough to cause the production of antibodies and the build-up of immunity |
| Passive:
  - antibodies pass across the placental membrane from mother to foetus (also milk) | **Passive:**
  - a sample of antibodies (e.g. gammaglobulin) from an immune individual is injected the recipient’s immune system may act later but the administered antibodies provide the immunity |

4. Outline the reasons for the suppression of the immune response in organ transplant patients

----------------------------------------See Chapter 4 Point 3----------------------------------------
5. Process, analyse and present information from secondary sources to evaluate the effectiveness of vaccination programs in preventing the spread and occurrence of once common diseases, including smallpox, diphtheria and polio

<table>
<thead>
<tr>
<th>Details</th>
<th>Smallpox</th>
<th>Diphtheria</th>
<th>Polio</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>An infectious disease that caused many epidemics across the planet.</strong></td>
<td><strong>An infectious disease that is spread by coughing &amp; sneezing by respiratory droplets from the throat. The disease normally breaks out two to five days after infection.</strong></td>
<td><strong>An infectious disease that mainly affects children under five years of age. It was originally highly common in 1988 with an estimated 350 000 cases in more than 125 endemic countries however since then Polio cases have decreased over 99%.</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Symptoms</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Influenza-like symptoms:</strong></td>
<td><strong>Range from a moderately sore throat and fever to swelling in the muscles and tissues of the upper and lower respiratory tracts.</strong></td>
<td><strong>There is no cure for polio. It can be prevented by a polio vaccine given multiple times to children.</strong></td>
<td></td>
</tr>
<tr>
<td>» Fever</td>
<td>» Inflammation to heart muscles and peripheral nerves may occur</td>
<td>» Fever</td>
<td></td>
</tr>
<tr>
<td>» Headache</td>
<td>» Small skin sores that form larger ulcers normally found on the legs can occur</td>
<td>» Fatigue</td>
<td></td>
</tr>
<tr>
<td>» Severe back pain and abdominal pain and vomiting</td>
<td>»</td>
<td>» Headache</td>
<td></td>
</tr>
<tr>
<td>» Two to three days later, the temperature falls and the patient feels better.</td>
<td>»</td>
<td>» Vomiting</td>
<td></td>
</tr>
<tr>
<td>» Following this, a rash of cysts filled with pus appears over the whole body leaving deep scars upon healing</td>
<td>»</td>
<td>» Stiffness in the neck</td>
<td></td>
</tr>
<tr>
<td>» Sores also develop in the nose and mouth and quickly become ulcers spreading around the mouth and throat.</td>
<td>»</td>
<td>» Pain in limbs</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatment and Prevention of disease</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>People who contract this disease are immediately isolated in hospital or at home and although there is no complete cure, symptoms can be treated accordingly.</strong></td>
<td><strong>Immediate dosages of diphtheria antitoxin &amp; antibiotics. Immunization of the population controls this disease</strong></td>
<td><strong>A number of strategies have been in place to attempt to eradicate the disease polio. There is high infant immunization coverage with</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vaccination program</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>In 1967, the World Health Organisation launched an intensified plan to eradicate smallpox.</strong></td>
<td><strong>In the 1940s Diphtheria was the most common cause of death in children in Australia. Since then, vaccination programs to vaccinate the entire</strong></td>
<td><strong>A number of strategies have been in place to attempt to eradicate the disease polio. There is high infant immunization coverage with</strong></td>
<td></td>
</tr>
</tbody>
</table>

![Diagram of immune system response to infected cell](image-url)
<table>
<thead>
<tr>
<th><strong>Population</strong></th>
<th><strong>Australia</strong> against this disease have effectively almost eliminated the disease in this country</th>
<th><strong>Four doses of vaccine in the first year of life. Then supplementary doses of vaccine are given to all children under five years of age.</strong></th>
</tr>
</thead>
</table>

**Evaluation**

This program of worldwide vaccination and elimination of the disease, smallpox has proved effective as there have been no epidemics of this disease since. However, there is only a vaccine available for this disease, not an immunization. This means that the vaccine can wear down over an extended period of time & make the vaccinated person once more susceptible to the smallpox disease.

However, as this disease has been eradicated worldwide and there are effective action plans in place to avoid an epidemic forming as a result of this disease, when the vaccine wears down people are still protected from this disease as it is non-existent in the community.

This program of immunizing the population of Australia against diphtheria has been effective as it has prevented the expansion of this disease therefore preventing an epidemic and as a result decreased the amount of deaths that have occurred from this disease.

However regardless of this mass immunization, there is a possible chance that a strand of diphtheria may mutate as a result of one person not completing the full course of the antibiotics or antitoxins for treating their diphtheria. This may result in a new strand of diphtheria that can overcome the immunisation & result in an epidemic.

This program of worldwide immunisation and eradication of the disease, polio has proved effective as there has been a great decrease in the amount of cases of polio since. In 2008, only parts of four countries in the world remain epidemic for the disease. However, there are still places that have not been affectively treated and so the disease has not been completely annihilated and therefore there are still children at risk.

At the same time there are effective action plans in place to totally eliminate the disease & avoid an epidemic forming.

**Polio:**

There is surveillance of wild polio strands which are reported and laboratory tested. Children under fifteen years of age are tested for acute paralysis. Targeted campaigns once a wild polio strand is detected so it is limited to a focal area
Chapter 6: Epidemiological studies involve the collection and careful statistical analysis of large quantities of data. Such studies assist the causal identification of non-infectious diseases

1. Identify and describe the main features of epidemiology using lung cancer as an example

   - **Epidemiology:** is the study of the incidence of diseases or risk factors involved in its occurrence, prevalence and spread within a population.

   The main features of epidemiology include:
   - The cause of the disease
   - How it is transmitted
   - Who is at risk
   - Method of treatment and control

   To study these issues, scientists need to collect and analyse data for whole populations and only then can suitable procedures be set in place. This often involves the government and administrative departments which deal with relevant areas (e.g. construction of sewage treatment works, freshwater supplies and immunisation programs).

   A general decline in the incidence and mortality rates in males as a result of lung cancer is attributed to decreased tobacco smoking among men.

<table>
<thead>
<tr>
<th>Epidemiology</th>
<th>Lung Cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>The cause of the disease</td>
<td>Cancer is an uncontrollable division of abnormal cells that have that ability to spread. They differ from normal cells in that they are less differentiated, lack contact inhibition and have uncontrolled reproduction rates. Carcinogens damage DNA and cause the cells to mutate randomly.</td>
</tr>
<tr>
<td>How it is transmitted</td>
<td>There is not clear transition but instead is caused by a variety of “risk factors” that depend on lifestyles, environmental factors and the genetic history of people who have suffered from lung cancer</td>
</tr>
<tr>
<td>Who is at risk</td>
<td>High risk factors include tobacco smoking and passive smoking, exposure to certain chemicals such as asbestos, etc.</td>
</tr>
<tr>
<td>Method of treatment and control</td>
<td>Law enforced smoke free zones in public areas.</td>
</tr>
<tr>
<td>Long-term measures of prevention</td>
<td>Advertising campaigns encouraging people not to smoke tobacco.</td>
</tr>
</tbody>
</table>

2. Identify causes of non-infectious disease using an example from each of the following categories:
   - inherited diseases, nutritional deficiencies, environmental diseases

   a) **Inherited diseases** – Inherited diseases result from mutations that lead to the production of different or faulty enzymes, resulting in impaired body function.

      » **Down syndrome** is an inherited disease that is caused by the non-disjunction of chromosome 21. This results in three chromosomes and not the usual two (trisomy 21). People with Down syndrome have a characteristic appearance and may have a shortened life span. Mothers who have children later in life are more prone to produce Down syndrome children.

   b) **Nutritional diseases/deficiencies** - The effect of nutritional deficiencies depends on the kind of deficiency. In some parts of the world diets may be deficient in certain elements, such as iodine, copper, iron or zinc.

      » **Scurvy** is caused by a deficiency in vitamin C. Symptoms include bleeding gums and tooth loss. It is treated by increasing the intake of food and drinks containing vitamin C, such as citrus fruit.

   c) **Environmental diseases** – Environmentally caused diseases include those due to lifestyle, such as smoking-related diseases, as well as those caused by something in the environment, such as lead or substances that cause allergies.

      » **Mesothelioma** is caused by exposure to asbestos and patients don't get any symptoms until 20 to 30 years after exposure. There is no cure and treatment can only slow down the progression of the disease.
3. Gather, process and analyse information to identify the cause and effect relationship of smoking and lung cancer

--- See Point 1 ---

4. Identify data sources, plan and perform a first-hand investigation or gather information from secondary sources to analyse and present information about the occurrence, symptoms, cause, treatment/management of a named non-infectious disease

<table>
<thead>
<tr>
<th>Non-Infectious Disease</th>
<th>• Obesity.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Disease</td>
<td>• Mainly lifestyle however also social and environmental.</td>
</tr>
<tr>
<td>Occurrence</td>
<td>• More than five million Australians are obese (BMI ≥ 30 kg/m²)</td>
</tr>
<tr>
<td></td>
<td>• Just over 2 million Australian men are obese.</td>
</tr>
<tr>
<td></td>
<td>• Close to 2 million Australian women are obese.</td>
</tr>
<tr>
<td></td>
<td>• Compared to 1995, the proportion of Australians that are obese in 2012 has increased by 47%.</td>
</tr>
<tr>
<td>Symptoms</td>
<td>• Breathing disorders (e.g., sleep apnoea, chronic obstructive pulmonary disease)</td>
</tr>
<tr>
<td></td>
<td>• Certain types of cancers (e.g., prostate and bowel cancer in men, breast and uterine cancer in women)</td>
</tr>
<tr>
<td></td>
<td>• Coronary artery (heart) disease</td>
</tr>
<tr>
<td></td>
<td>• Depression</td>
</tr>
<tr>
<td></td>
<td>• Diabetes</td>
</tr>
<tr>
<td></td>
<td>• Gallbladder or liver disease</td>
</tr>
<tr>
<td></td>
<td>• Gastroesophageal reflux disease (GERD)</td>
</tr>
<tr>
<td></td>
<td>• High blood pressure</td>
</tr>
<tr>
<td></td>
<td>• High cholesterol</td>
</tr>
<tr>
<td></td>
<td>• Joint disease (e.g., osteoarthritis)</td>
</tr>
<tr>
<td></td>
<td>• Stroke</td>
</tr>
<tr>
<td></td>
<td>• <strong>Body shape and weight.</strong></td>
</tr>
<tr>
<td>Cause</td>
<td>• When the body consumes more calories than it burns.</td>
</tr>
<tr>
<td></td>
<td>• Overeating and under-exercising.</td>
</tr>
<tr>
<td>Treatment and Management</td>
<td>• Focusing on balancing energy IN (calories from food and drinks) with energy OUT (physical activity)</td>
</tr>
<tr>
<td></td>
<td>• Following a healthy eating plan</td>
</tr>
<tr>
<td></td>
<td>• Learning how to adopt healthy lifestyle habits</td>
</tr>
<tr>
<td></td>
<td>• Following a healthy eating plan will lower your risk for heart disease and other conditions. A healthy eating plan is low in saturated fat, Trans fat, cholesterol, sodium (salt), and added sugar.</td>
</tr>
<tr>
<td></td>
<td>• Being physically active and eating fewer calories will help you lose weight and keep weight off over time.</td>
</tr>
<tr>
<td></td>
<td>• Change your surroundings. You might be more likely to overeat when watching TV, when treats are available at work, or when you're with a certain friend. You also might find it hard to motivate yourself to be physically active. However, you can change these habits.</td>
</tr>
<tr>
<td></td>
<td>• Weight-loss surgery might be an option for people who have extreme obesity (BMI of 40 or more) when other treatments have failed.</td>
</tr>
</tbody>
</table>
Chapter 7: Increased understanding has led to the development of a wide range of strategies to prevent and control disease

1. Discuss the role of quarantine in preventing the spread of disease and plants and animals into Australia or across regions of Australia

- Quarantine manages exotic pests and disease risks to protect Australia’s agricultural industries and environment. This means that all international passengers, cargo, mail, animals, plants and animal or plant products that arrive in Australia are inspected.
- Many countries have pests and diseases that could have disastrous effects on Australia’s animals and plants.
- These pests and diseases could be carried by people, by animals, in animal products such as meat, in plants or in plant products such as timber or in soil on machinery.
- All of these must undergo quarantine inspection and many plants and animals must be isolated at quarantine stations so any pest or disease risks can be identified and prevented from entering the community.
- These diseases cause huge financial losses to farmers in other countries. Australia is able to sell its products to overseas markets because of the absence of diseases, like mad cow disease and foot-and-mouth disease.
- Australia has generally been fortunate in preventing the spread of plant and animal disease from other parts of the world because of its geographical isolation.
- Australia also has declared fruit-fly free areas where the produce is sold with a guarantee of no fruit fly. This can be done by having inspections and bins to put fruit in when entering particular fruit growing areas.

2. Explain how one of the following strategies has controlled and/or prevented disease: public health programs, pesticides, genetic engineering to produce disease-resistant plants and animals

Public Health Programs:
- Public health programs have helped to control and prevent disease by assisting in protecting people from disease.
- Laws define some measures. Some diseases are classified as ‘notifiable’ (such as AIDS, cholera and whooping cough) while other diseases such a rubella and chicken box are governed by laws that require a quarantine period. There are also laws that relate to the health conditions of workers such as the Occupational Health and Safety Laws and pollution laws.
- Immunisation programs include childhood triple antigen and Poliomyelitis, and the influenza program for the elderly. There are education programs such as the ‘Quit’ campaign for smoking, the ‘Slip, Slop, Slap’ campaign for skin cancer and the drink driving campaign.
- Screening programs have been introduced in the form of pap smears for cervical cancer, chest X-rays for breast cancer and bone density tests for osteoporosis.
- Public programs that help keep the environment clean also reduce the incidence of disease. This includes sewage treatment works, clean water supply, garbage collection, pollution monitoring programs, public hospitals, food inspections and quarantine controls.

Genetic Engineering:
- Genetically engineered plants can now kill their own pests because of the insertion of a gene from a soil bacterium, Bacillus thuringiensis (Bt).
- Bt cotton was the first genetically engineered crop grown in Australia. The bacteria contain a gene that produces chemicals that kill certain insects.
- By taking that gene from the bacteria and inserting into the genome of plants, the plants now produce the chemical that will kill insect pests.

3. Perform an investigation to examine plant shoots and leaves and gather first-hand information of evidence of pathogens and insect pests

PRAC EXPERIMENT 3
4. Process and analyse information from secondary sources to evaluate the effectiveness of quarantine in preventing the spread of plant and animal disease into Australia or across regions of Australia

- Quarantine has prevented Australia from being affected by fire blight, a bacterial disease which affects pears, apples and some ornamental plants.
  - Strict quarantine has prevented plant material possibly carrying the disease from entering the country, and thus has effectively prevented the disease from impacting upon Australia’s fruit industry.

- Quarantine across regions of Australia has assisted in controlling the further spread of the fruit fly.
  - Fruit flies lay their eggs under the skin of fruits, which then hatch in to larvae which destroy the fruit, making it inedible.
  - Fruit fly damage has a major financial impact on Australia’s fruit industry.
  - Quarantine is helping to prevent the spread of fruit fly across Australia. There are regulations in place which forbid travellers from taking fruit from one state in to another, and signs and fruit disposal bins at state borders remind travellers of the rules.
  - Currently fruit fly is found only in parts of Western Australia and Eastern Australia. Quarantine has effectively controlled the pest from spreading further throughout Australia.

- Another example of how quarantine across areas of Australia has been successful in preventing the spread of infectious diseases is the plant disease Grape Phylloxera.
  - The disease has spread through people carrying infested wines and now infests most wine-growing regions, including the eastern states of Australia.
  - Quarantine laws have effectively prevented the introduction of any part of a grape vine in South Australia since 1899, thus South Australian and Western Australian vines remain free of Grape Phylloxera.

- An animal disease which has been effectively controlled by quarantine is foot and mouth disease.
  - It is a highly contagious virus that affects pigs, cattle, sheep, goats and deer.
  - Foot and mouth disease is currently not present in Australia at all, due to strict quarantine monitoring.
  - Incoming agricultural equipment is stringently checked, and the shoes of travellers who have visited agricultural areas are checked and cleaned to prevent diseases such as foot and mouth from entering Australia.

- These regulations and precautions protect Australia’s fauna and flora against most transmittable diseases; however it is not a foolproof system. Diseases can still be transmitted through natural processes, such as the movement of migratory birds and wind-borne organisms.
- Also, with the massive numbers of people, aircraft, boats and mail that enter Australia each day it is impossible to stop all the things that may carry diseases or pests from entering, despite AQIS’s best efforts to prevent this. Thus quarantine is not entirely effective in preventing the spread of plant and animal disease into, and around, Australia.

5. Gather and process information and use available evidence to discuss the changing methods of dealing with plant and animal diseases, including the shift in emphasis from treatment and control to management or prevention of disease

Treatment and Control:
- Only focused on curing the individual who requested treatment therefore;
  - Other victims may be left vulnerable as not everyone is treated.
  - Nothing is done towards stopping the reoccurrence of the disease.
  - No emphasis is placed on the eradication of disease.
  - It was effective at minimising impact on an individual however, diseases could still affect many others.
Special methods used in hospitals to prevent the spread of disease:

- Standard Precautions and Transmission-based Precautions were designed to reduce the risk of transmission of blood borne and other pathogens, both recognised and unrecognised and causes of infection in hospitals.
- A variety of infection control measures are used for decreasing the risk of the spread or the transmission of micro-organisms in hospitals. These measures include:
  - Hand washing – hands must be washed before and after patient contact.
  - Gloves – Gloves must be worn when in contact with blood or body substances. Gloves must be changed before and between patient contacts and hands must be washed after removal of gloves.
  - Protective aprons or gowns are worn when there is a likelihood of splashes or splattering of blood or body substances.
  - Masks, protective eyewear and face shields are worn when there is a likelihood of splashes or splattering of blood or body substances.
  - Safe handling and disposal of needles and other sharp objects is important. Sharps containers should be placed as close as practicable to the point of use to limit the distances between use and disposal.

Additional precautions are used for patients known to or suspected to be infected or colonised with epidemiologically important or highly transmissible pathogens that can cause infection. These include:

Airborne Precautions

- Apply to patients known or suspected to hold pathogens that can be transmitted by an airborne route.
- Airborne transmission occurs by dissemination of either airborne droplets or dust particles containing the infectious agent.
- Examples: Mycobacterium tuberculosis, measles virus, Varicella (chicken pox) and Haemorrhagic fever (e.g. ebola)

Droplet Precautions

- Apply to patients known or suspected to hold pathogens that can be transmitted by infectious droplets
- Droplet transmission involves contact of the conjunctivae or the mucous membranes of the mouth or nose of a susceptible person with large particle droplets containing micro-organisms.
- Examples: Mumps, rubella, pertussis, influenza, diphtheria and Pneumonic plague

Contact Precautions

- Designed to reduce the risk of transmission of micro-organisms by direct or indirect contact
- Direct contact transmission involves skin-to-skin contact and physical transfer of micro-organisms to a susceptible host from an infected or colonised person, can occur when health care workers turn patients, bathe patients or perform other patient-care activities that require physical contact
- Examples: Colonisation of Multi Resistant Staphylococcus Aureus (MRSA), Vancomycin Resistant Enterococcus (VRE), Respiratory syncytial Virus (RSV) Highly contagious skin infections such as scabies, lice and impetigo, hepatitis A, Shigella and other gastroenteritis.

Management or Prevention:

- Focus of elimination of factors (such as vector mosquito in malaria)
- Emphasis on education of public about disease and its prevention so disease is not spread (such as having protected sex to avoid HIV or Aids)
- Management and prevention is holistic. It not only treats individuals but stops spread and eliminates the disease (such as through vaccines, quarantine etc.)

Examples:

Success in the vaccination campaigns such as in the eradication of small pox. The prevention of disease has become a main focus rather that the treatment and control of its symptoms. However with illnesses that cannot be treated, control, management and treatment is of high priority. Examples of these diseases include HIV/Aids and skin cancers. As a result, public education programs such as Slip, Slap, Slap and Quit Smoking campaigns are also aiming at preventing these diseases.

Quarantine: Animal and plant diseases have been managed by quarantine restrictions in Australia.