B3 Communicable diseases

Pathogens are **microorganisms that cause infectious disease**.

Pathogens may be viruses, bacteria, protists or fungi.

They may infect plants or animals and can be **spread by direct contact, by water or by air**.

Bacteria and viruses may reproduce rapidly inside the body.

Viruses live and reproduce inside cells, causing cell damage.

Measles is a viral disease showing symptoms of fever and a red skin rash. Measles is a serious illness that can be fatal if complications arise. For this reason most young children are vaccinated against measles. The measles virus is spread by inhalation of droplets from sneezes and coughs.

HIV initially causes a flu-like illness. Unless successfully controlled with antiretroviral drugs the virus attacks the body's immune cells. Late stage HIV infection, or AIDS, occurs when the body's immune system becomes so badly damaged it can no longer deal with other infections or cancers. HIV is spread by sexual contact or exchange of body fluids such as blood which occurs when drug users share needles.

Tobacco mosaic virus (TMV) is a widespread plant pathogen affecting many species of plants including tomatoes. It gives a distinctive 'mosaic' pattern of discolouration on the leaves which affects the growth of the plant due to lack of photosynthesis.

Bacteria may produce poisons (toxins) that damage tissues and make us feel ill.

Salmonella food poisoning is spread by bacteria ingested in food, or on food prepared in unhygienic conditions. In the UK, poultry are vaccinated against Salmonella to control the spread. Fever, abdominal cramps, vomiting and diarrhoea are caused by the bacteria and the toxins they secrete.

Gonorrhoea is a sexually transmitted disease (STD) with symptoms of a thick yellow or green discharge from the vagina or penis and pain on urinating. It is caused by a bacterium and was easily treated with the antibiotic penicillin until many resistant strains appeared. Gonorrhoea is spread by sexual contact. The spread can be controlled by treatment with antibiotics or the use of a barrier method of contraception such as a condom.

Rose black spot is a fungal disease where purple or black spots develop on leaves, which often turn yellow and drop early. It affects the growth of the plant as photosynthesis is reduced. It is spread in the environment by water or wind. Rose black spot can be treated by using fungicides and/or removing and destroying the affected leaves.

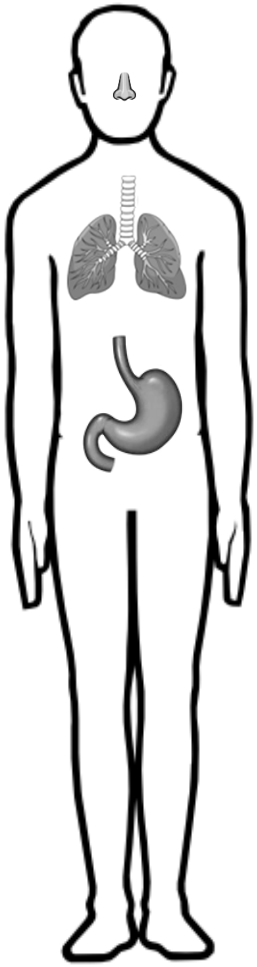
The pathogens that cause **malaria** are protists. The malarial protist has a life cycle that includes the mosquito. Malaria causes recurrent episodes of fever and can be fatal. The spread of malaria is controlled by preventing the vectors (mosquitos) from breeding and by using mosquito nets to avoid being bitten.

Note: **Vectors are animals which carry a disease**

B3 Human defence systems

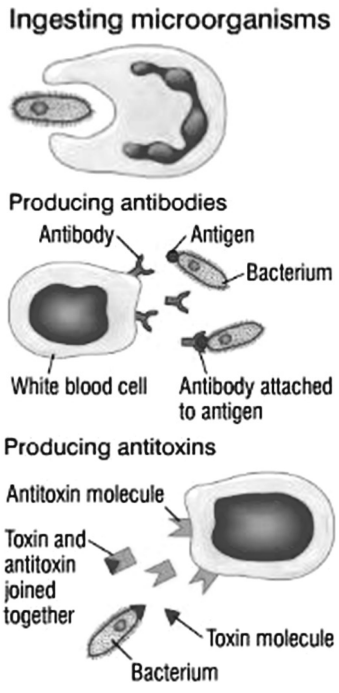
The non-specific defence systems of the human body against pathogens, including the:

- skin - acts as a barrier, produces antimicrobial secretions and healthy skin is covered in microorganisms as an extra barrier to pathogens.
- nose - full of hairs, produces a sticky liquid called mucus which trap particles containing pathogens.
- trachea and bronchi - secrete mucus, the lining of tubes are covered in cilia, cilia move mucus to back of throat where it is swallowed.
- Stomach. - produces acid which destroys microorganisms in mucus or in food and drink.



If a pathogen enters the body the immune system tries to destroy the pathogen. White blood cells help to defend against pathogens by:

- phagocytosis - phagocytes ingest and absorb the pathogens
- antibody production - lymphocytes produce antibodies (different antibodies are needed for different pathogens)
- antitoxin production - lymphocytes also release antitoxins which stick to toxins and prevent them damaging the body.



B3 Antibiotics and Painkillers

Antibiotics, such as penicillin, are medicines that help **to cure bacterial disease by killing infective bacteria** inside the body. It is important that **specific bacteria** should be **treated by specific antibiotics**. Antibiotics work by affecting things that bacterial cells have but human cells don't.
For example, human cells do not have cell walls, while many types of bacteria do. The antibiotic penicillin works by keeping a bacterium from building a cell wall.

The use of antibiotics has greatly reduced deaths from infectious bacterial diseases. However, the emergence of strains resistant to antibiotics is of great concern.
Both the NHS and health organisations across the world are trying to reduce the use of antibiotics because of this, especially for conditions that aren't serious.
The overuse of antibiotics in recent years means they're becoming less effective and has led to the emergence of "superbugs". These are strains of bacteria that have developed resistance to many different types of antibiotics, including:

- methicillin-resistant Staphylococcus aureus (MRSA)
- bacteria that cause multi-drug-resistant tuberculosis (MDR-TB)

The biggest worry is that new strains of bacteria may emerge that can't be effectively treated by any existing antibiotic.

Antibiotics cannot kill viral pathogens.
It is difficult to develop drugs that kill viruses without also damaging the body's tissues.

Painkillers and other medicines are used to treat the symptoms of disease but do not kill pathogens.

Vaccination

Vaccination will prevent illness in an individual, and the spread of pathogens can be reduced by immunising a large proportion of the population.

Vaccination involves introducing small quantities of dead or inactive forms of a pathogen into the body to stimulate the white blood cells to produce antibodies. If the same pathogen re-enters the body the **white blood cells respond quickly to produce the correct antibodies**, preventing infection.

Vaccinating a few people against a pathogen prevents them from becoming infected, but vaccinating the majority of a population prevents the spread of that pathogen, this can have a significant effect.

B3 Discovery and development of drugs

Traditionally drugs were extracted from plants and microorganisms.

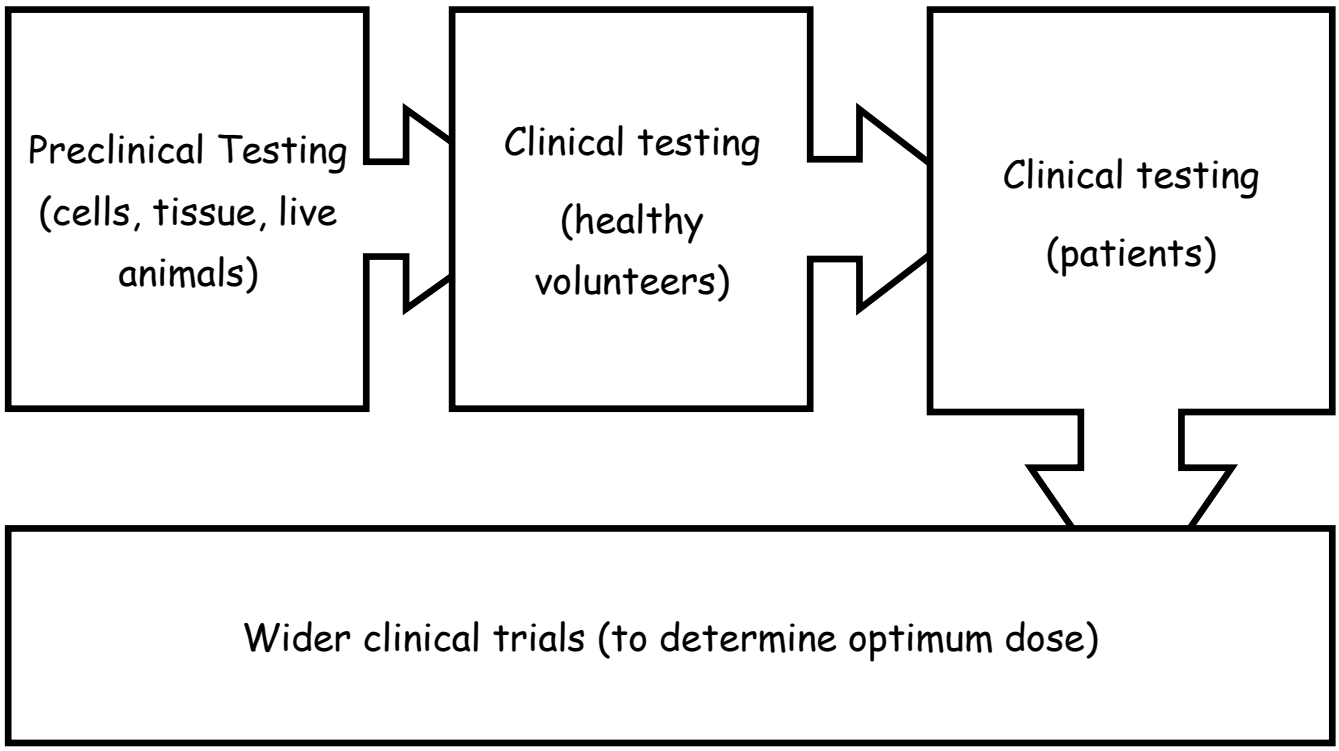
- The heart drug digitalis originates from foxgloves.
- The painkiller aspirin originates from willow.
- Penicillin was discovered by Alexander Fleming from the Penicillium mould.

Most new drugs are synthesised by chemists in the pharmaceutical industry. However, the starting point may still be a chemical extracted from a plant.

New medical drugs have to be tested and trialled before being used to check that they are safe and effective. New drugs are extensively tested for **toxicity, efficacy and dose**.

Preclinical testing is done in a laboratory using **cells, tissues and live animals**.

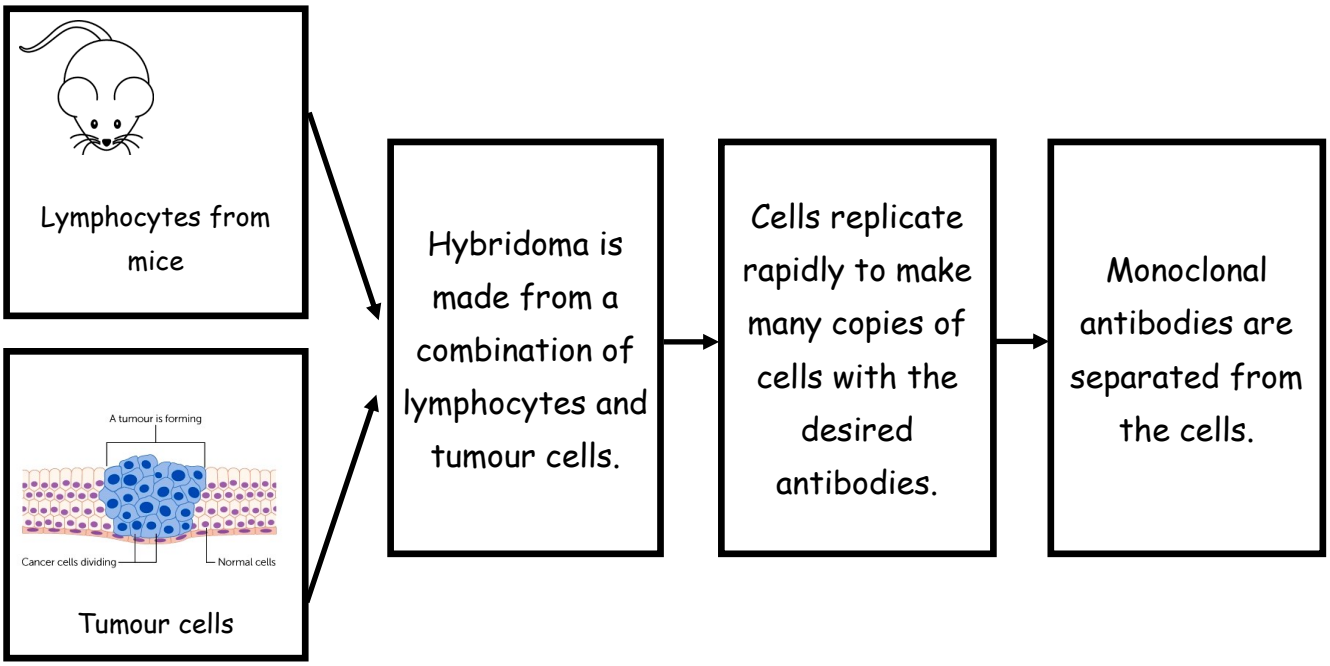
Clinical trials use **healthy volunteers and patients**. Very **low doses** of the drug are given at the start of the clinical trial. If the drug is found to be **safe**, further clinical trials are carried out to find the **optimum dose** for the drug. In **double blind** trials, some patients are given a **placebo**.



B3 Monoclonal antibodies (Triple only)

Monoclonal antibodies are produced from a **single clone of cells**.

The **antibodies are specific** to one binding site on one protein antigen and so are able to target a specific chemical or specific cells in the body. They are produced by **stimulating mouse lymphocytes to make a particular antibody**. The lymphocytes are **combined with a particular kind of tumour cell** to make a cell called a **hybridoma** cell. The **hybridoma cell can both divide and make the antibody.** Single hybridoma cells are cloned to produce **many identical cells that all produce the same antibody.** A large amount of the **antibody can be collected and purified**.



Some examples of the uses of monoclonal antibodies include:

- for diagnosis such as in pregnancy tests
- in laboratories to measure the levels of hormones and other chemicals in blood, or to detect pathogens
- in research to locate or identify specific molecules in a cell or tissue by binding to them with a fluorescent dye
- to treat some diseases: for cancer the monoclonal antibody can be bound to a radioactive substance, a toxic drug or a chemical which stops cells growing and dividing. It delivers the substance to the cancer cells without harming other cells in the body.

There are **ethical issues** with monoclonal antibodies (for example: use of mice).
Monoclonal antibodies create **more side effects than expected**.
They are not yet as widely used as everyone hoped when they were first developed.

B3 Plant disease (Triple only)

Plant diseases can be detected by:

- stunted growth
- spots on leaves
- areas of decay (rot)
- growths
- malformed stems or leaves
- discolouration
- the presence of pests.

Identification can be made by:

- reference to a gardening manual or website
- taking infected plants to a laboratory to identify the pathogen
- using testing kits that contain monoclonal antibodies.

Plants can be infected by a range of viral, bacterial and fungal pathogens as well as by insects.

Examples of plant diseases is restricted to **tobacco mosaic virus** as a viral disease, **black spot** as a fungal disease and **aphids** as insects.

Plants can be damaged by a range of ion deficiency conditions:

- stunted growth caused by nitrate deficiency (**nitrates are needed for protein synthesis**)
- chlorosis caused by magnesium deficiency (**magnesium ions needed to make chlorophyll**)

Plants may have physical and chemical defence responses.
Physical defence responses to resist invasion of microorganisms.

- Cellulose cell walls.
- Tough waxy cuticle on leaves.
- Layers of dead cells around stems (bark on trees) which fall off.

Chemical plant defence responses.

- Antibacterial chemicals.
- Poisons to deter herbivores.

Mechanical adaptations.

- Thorns and hairs deter animals.
- Leaves which droop or curl when touched.
- Mimicry to trick animals.