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AS Biology Unit 1

Health, Disease & Immunity

Key definitions:

- **Health** is a state of mental, physical and social wellbeing
- **Disease** is a departure from good health
- **Parasite** an organism which lives on another one causing harm
- **Pathogen** an organism which causes disease

Organisms which cause disease - PATHOGENS

Give examples of diseases caused by:

- **Viruses**
- **Bacteria**
- **Fungi**
- **protoctists**

Gaining entry to the host

- Skin
- Gas exchange system
- Digestive system
- Reproductive system

Pathogens cause disease by;

- Damaging host tissues
- Producing toxins

Disease and lifestyle

Risk = the probability that damage to health will occur as a result of a given hazard. It can be measured on a scale of 0% - 100%

Lifestyle and cancer

Cancer has many different and contributory causes, including genetic and age related but lifestyle choices can reduce the influence of environmental carcinogens. Life style factors include:

- Smoking
- Diet
- Obesity
- Physical activity
- Sunlight

Coronary heart disease risk factors

- Smoking
- High blood pressure
- Blood cholesterol levels
- Obesity
- Diet
- Physical activity

Evidence linking smoking to disease.

EPIDEMIOLOGY = the comparison of data on disease

Epidemiology analyses **correlation** between a particular disease and factors such as nationality, ethnicity, sex, age, lifestyle, pollution building up a series of interconnected data which can be used to form hypotheses about **causative** factors

The epidemiological evidence on smoking

General

- Regular smokers are three time more likely to die prematurely than non-smokers
- 50% of regular smokers are likely to die of a smoking related disease
- The more cigarettes smoked, the greater the risk

Lung cancer

- 25% of smokers die from lung cancer
- Smokers are 18 times more likely to die from lung cancer than non-smokers
- Heavy smokers (25+ per day) are 25 times more likely to die of lung cancer than non-smokers

Lung disease

- COPD is rare in non-smokers
- 98% of people with emphysema are smokers
- 20% of smokers have emphysema

CHD

- There are too many contributory risk factors with CHD (diet, lifestyle, genetics etc. etc. for the effects of smoking to be identified and measured separately but the information makes smoking the single most important contributory factor.

Cholera

Caused by: *Vibrio cholerae* parasitic pathogen in small intestine

Transmission:

- Un-purified drinking water with faecal contamination
- unwashed hands in food preparation
- filter feeding shellfish exposed to sewage

Effects on body:

- V. Cholerae use flagellum to propel themselves into the mucus lining of the small intestine
- They secrete a protein which binds to specific receptors on the epithelial cell membrane which injects a toxin into the cell.
- The toxin causes chloride ion channels to open so Cl^- ions flood out of the epithelial cells into the lumen of the intestine
- This raises the water potential of the epithelial cells so water flows out by osmosis into the gut
- Causing severe dehydration and diarrhoea.

Oral rehydration therapy

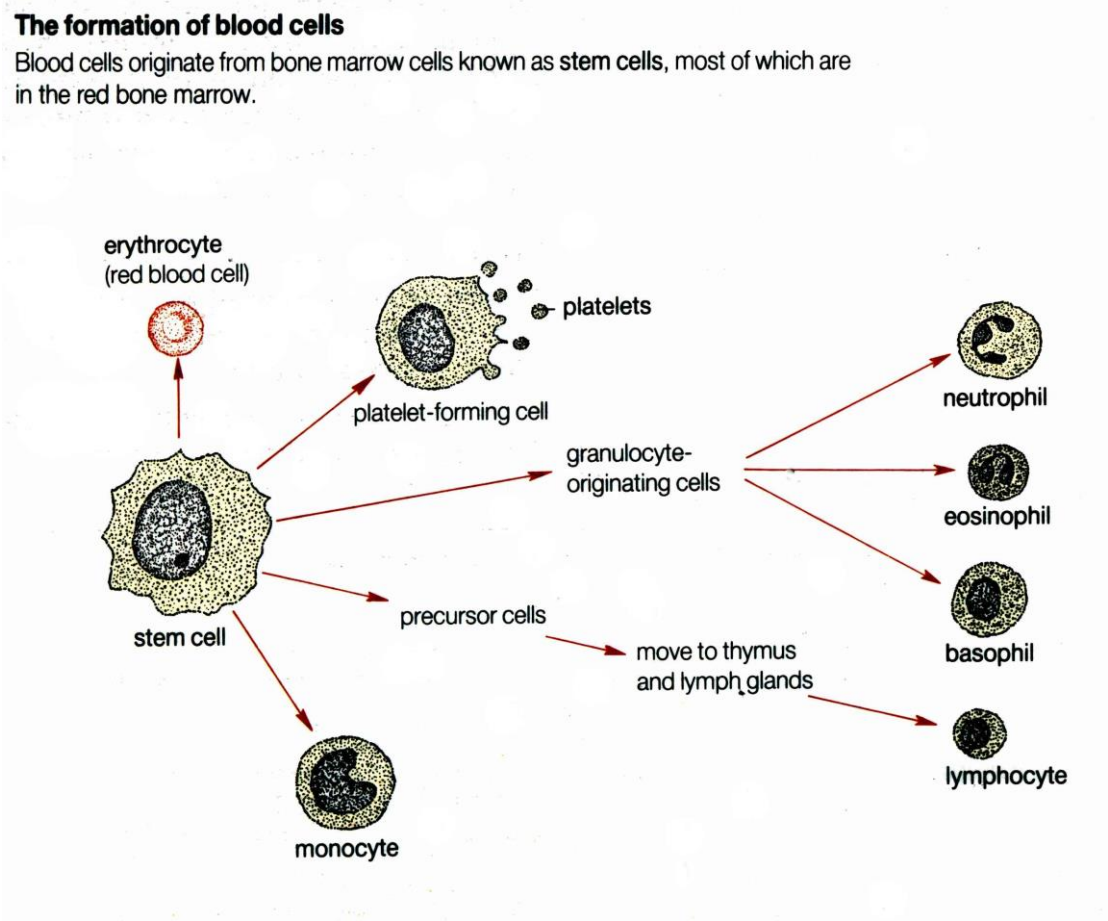
Rehydration must contain

- Water
- Sodium
- Glucose
- Potassium
- Other electrolytes

Problems with ORT?

DEFENCE AGAINST DISEASE

In this section it is easy to become confused about the different types of blood cell. Red blood cells (erythrocytes) have already been described in module 1. The defence system involves white blood cells (leucocytes) The diagram below illustrates some of the major types of white blood cell. Use it as a reference as you work through this unit.



Blood Cell	Main Function
Platelet forming cell	Produce cell fragments called platelets, necessary for blood clotting
neutrophil	Phagocytic cells which engulf and digest microorganisms in the blood and tissue fluids
monocyte	Develop into macrophages, large phagocytic cells which operate in tissues destroying pathogens, cancer cells and other debris
Basophils and eosinophils	Involved in the histamine response to allergens
B lymphocytes	Produce antibodies
T lymphocytes	Cell mediated responses to specific infections

Non-specific responses to infection

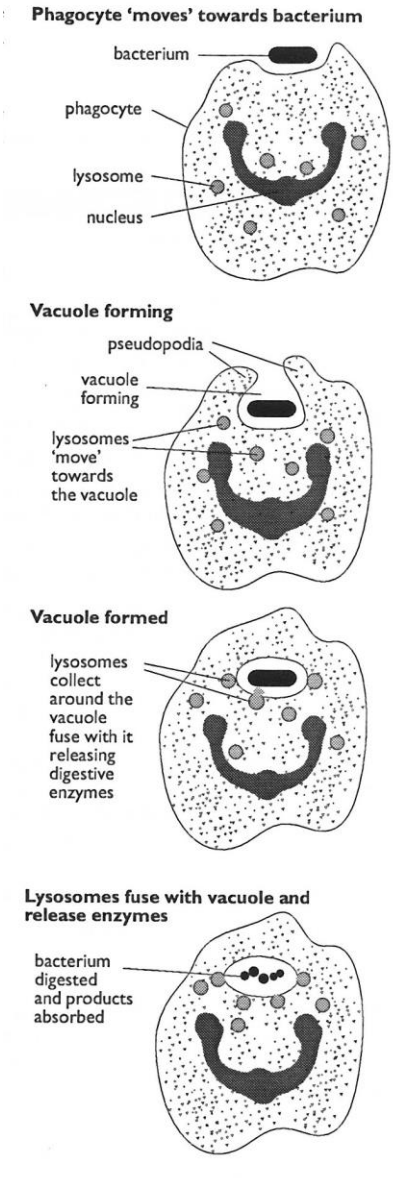
Non-specific =

1. Primary responses prevent pathogen entering body cells
e.g.

notes

- Skin
- Mucous membranes
- Acidity
- Wax

2. Secondary responses involves **PHAGOCYTES** and **HISTAMINE**



Phagocytes (neutrophils and macrophages)

Histamine reaction

When cells are infected by a pathogen, they release histamines which cause…

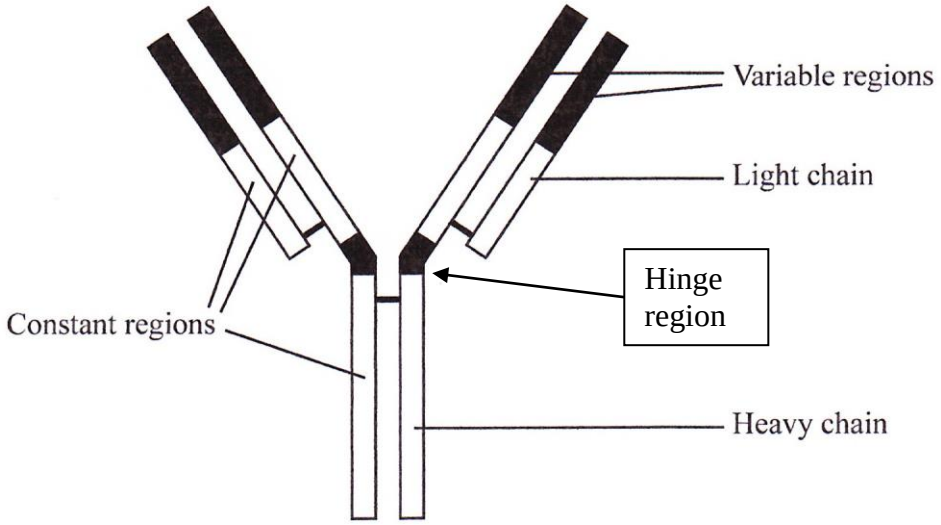
- Neutrophils to be attracted to the site of infection
- Capillaries to become leaky releasing more tissue fluid
- Localised swelling and increased lymph drainage
- Pathogens and damaged fragments pass into the lymph nodes triggering macrophages to activate the specific immune response

Specific immune responses

Antigens and antibodies

Antigen =

Antibody =



Name a) the monomers that make up the heavy and light chains

b) the chemical bonds which join these monomers

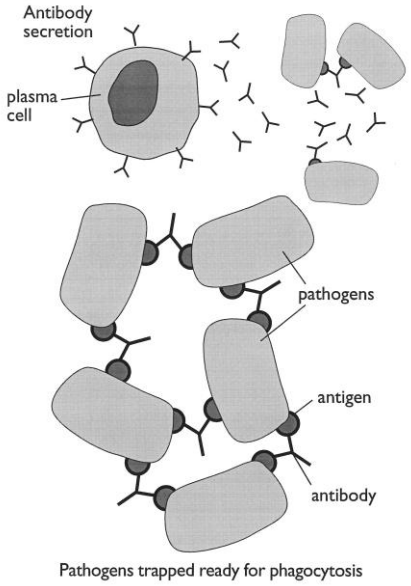
c) the chemical bonds which join the polymers

d) suggest how the specificity of an antibody depends on the variable regions

How antibodies work

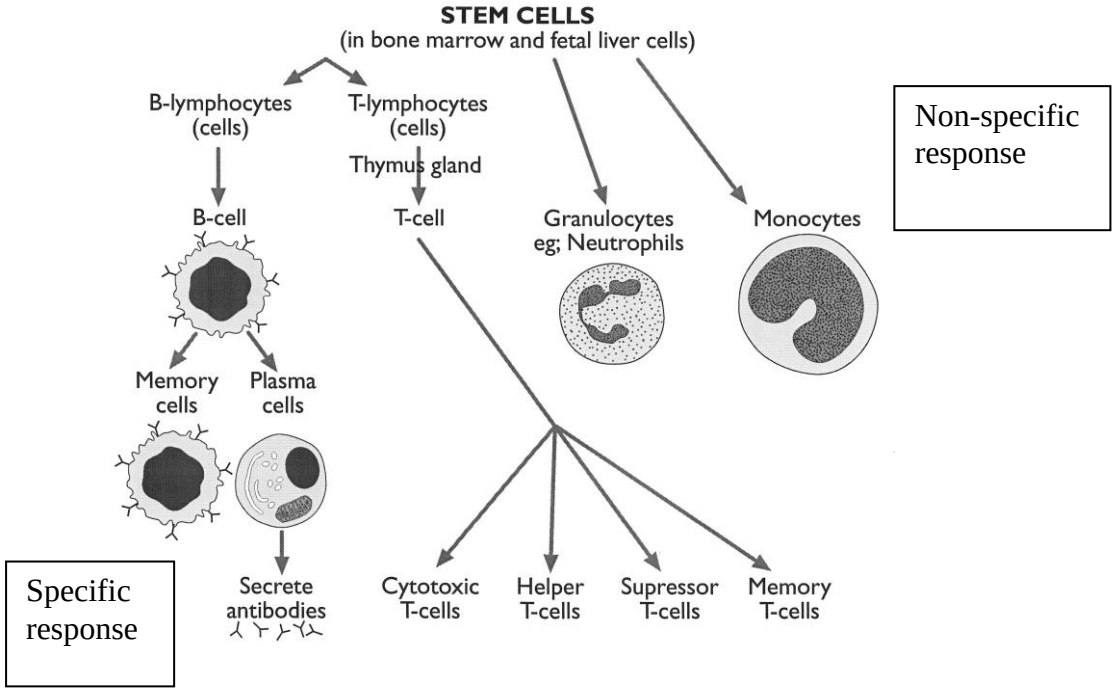
Neutralization

Agglutination



Pathogens trapped ready for phagocytosis

Two types of lymphocyte –



B cells **T cells**

Produced:

Functions:

Stages of immune response to an infection

1. Antigen presentation

Antigens are displayed on the surface of the pathogens and also on the Surface membranes of infected cells and macrophages . (phagocytosis results in bits of the pathogen Remaining on the surface)

2. B cell response (clonal expansion)

B cell receptors bind to antigens With complementary shapes They become activated and start To divide (**cloning**)

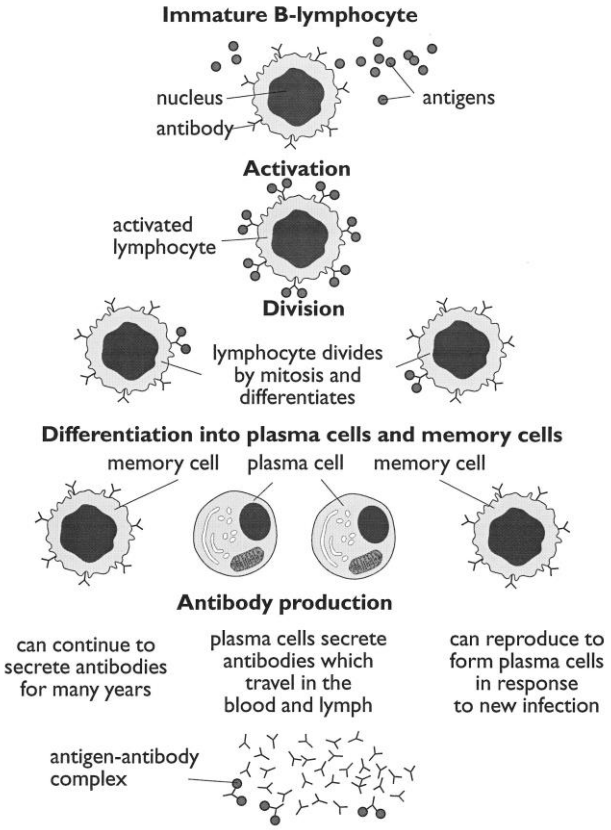
3. Differentiation

The cloned cells
Differentiate in two different ways

- **Plasma cells**. These produce Antibodies

- **Memory cells**. These remain In the blood for a number of Years

Summary diagram:



T cell response

Antibodies can only attack antigens in the tissues fluids and blood (**humoral**) but some pathogens e.g.viruses are inside their host cells and can't be reached. The receptors of T cells are activated by contact with antigens presented on the surface of B cells, macrophages and infected cells (**cell mediated**)

In exactly the same way as B celss, once triggered into action, they undergo a period of clonal expansion followed y differentiation to three main kinds of T cell.

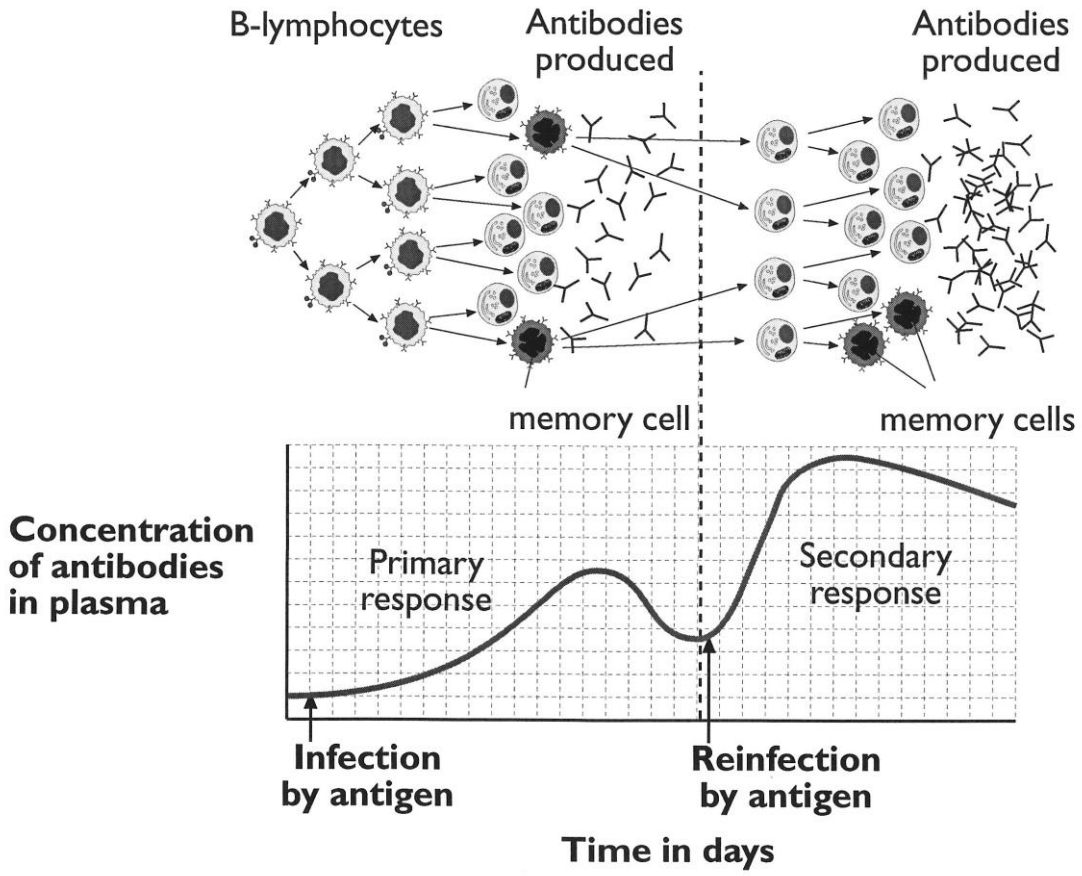
- **T killer cells** attack and destroy infected cells

- **T helper cells** secrete cytokines which stimulate B cells to clone

- **T memory cells** remain for many years in the blood.

Primary and secondary immune response.

Study the diagram below and explain what is meant by the terms 'primary' and 'secondary' immune response.



In a pregnant woman, some antibodies pass across the placenta from mother to fetus. These antibodies provide only short term immunity for newborn babies. Explain why these antibodies do not give more lasting protection against infections.

Vaccination (immunization)

Vaccination is a deliberate exposure to antigenic material which activates the immune system to make an immune response and provide immunity.

Source of antigenic material

- Whole live microorgaisms (live vaccine) with similar but less harmful antigens (e.g. smallpox)
- Attenuated (made harmless) form of the pathogen (e.g. measles, TB)
- Dead pathogen (e.g. typhoid, cholera)
- A preparation of antigens from a pathogen (e.g. hepatitis B)
- A harmless toxin (toxoid) (e.g. tetanus)

Herd vaccination vaccinate sufficient numbers of a population to avoid possibility of infection (up to 95% in case of measles)

Ring vaccination vaccinate all individuals within a 'safe' radius of infection site

Natural and artificial immunity

- **Natural** immunity is gained in the normal event of catching a disease.
- **Artificial** immunity is provided by vaccinations

Active and passive immunity

When your body responds to an antigen (either by catching a disease of being vaccinated) your immune system manufactures antibodies and memory cells. This is an **active** process and gives lasting protection.

If you are provided with antibodies from an external source, then you have **passive** protection, no memory cells and no lasting immunity. E.g. the acquisition of antibodies by a fetus across the placenta or a baby through its mother's milk.

Antigenic drift random mutations in the DNA or RNA of pathogens results in new antigens e.g. type A influenza

Antigenic shift Mutant forms may shift the target host to different species, e.g. birds to humans (bird flu) or pigs to humans (swine fever)

Problems with vaccination programmes

- Economic
- Side effects
- Producing, storing and transporting vaccine
- Administration

Why vaccination is not always successful

- Some people have defective immune systems
- Disease is caught immediately after vaccination
- The pathogen mutates (antigenic drift /shift)
- Many varieties of the pathogen (malarial parasite)
- Pathogen 'hides' inside body cells (cholera)
- Religious ethical objections to vaccination

TB and Cholera are difficult to control

- Cholera is intestinal and difficult to reach by immune system. Oral treatments are quickly flushed our with diarrhoea
- Cholera antigens change rapidly
- Mobility of populations spreads the disease globally
- HIV leads to impaired immune system (TB)
- Elderly people have weaker immune systems
- TB has mutated to resistant types