Higher Human Biology

Unit 4 Key Area 4 Pupil Notes

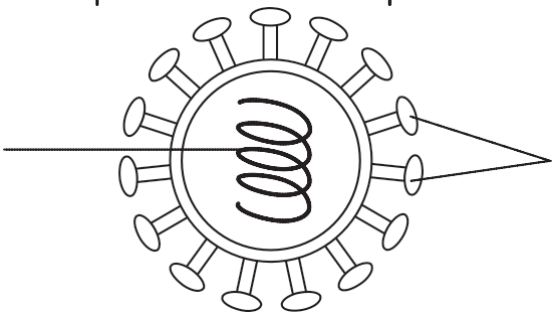
Vaccines – Vaccines allow the immune system to react much more quickly to a microbe by exposing it to all or part of the microbe involved.

Here are some examples of the various forms of pathogens used in vaccines and named diseases that we are protected from using each type:

Live vaccines	Live Attenuated vaccines	Killed Inactivated vaccines	Toxoids	Cellular fraction vaccines	Recombinant vaccines
•Small pox variola vaccine	•BCG •Typhoid oral •Plague •Oral polio •Yellow fever •Measles •Mumps	•Typhoid •Cholera •Pertussis •Plague •Rabies •Salk polio •Intra-muscular influenza	•Diphtheria •Tetanus	•Meningococcal polysaccharide vaccine •Pneumococcal polysaccharide vaccine •Hepatitis B polypeptide vaccine	•Hepatitis B vaccine

Example – How a pathogen can be used to make a vaccine

This virus shown can be used to prepare a flu vaccine. In order to do this the nucleic acid must be broken up but the surface proteins left intact.



Nucleic Acid

Proteins

This is necessary to break up the nucleic acid to prevent replication of the virus and to prevent individuals getting the disease (symptoms).

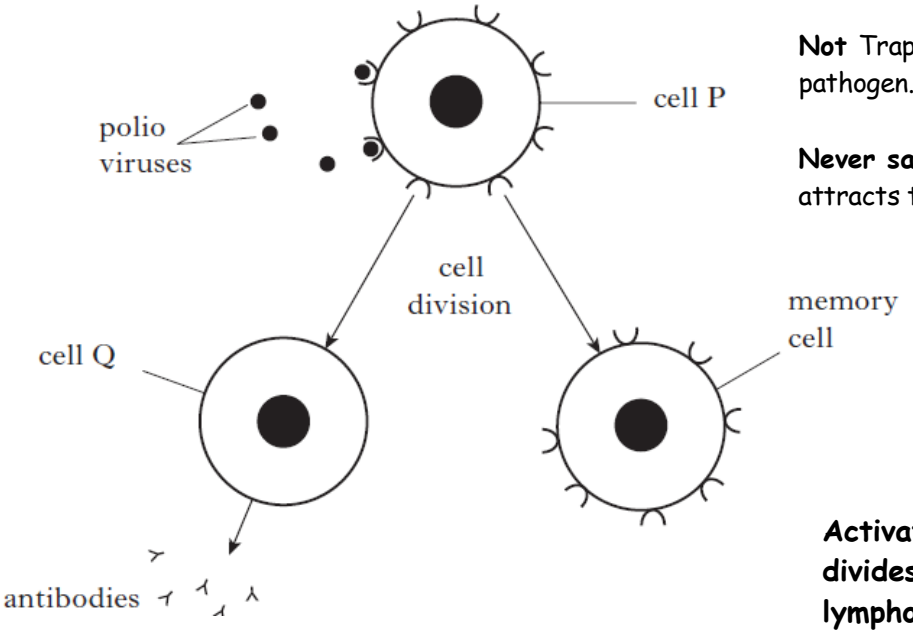
The surface proteins must be left intact to allow recognition by the immune system helper T lymphocytes and to ensure that the B-lymphocytes produce antibodies (see later). This also ensures memory cells are produced (see later).

Here is one example showing how the immune system responds to a polio virus in a vaccine.

Helper T Cell (P) recognises and attaches to virus.

Not Traps virus or Identifies pathogen.

Never say - Destroys virus or attracts the virus.



Activated helper T cell divides rapidly into B-lymphocytes and B-lymphocyte memory cells.

The response of a person to a vaccine is known as **active immunity** because the person produces their own antibodies (**not humeral**). It is artificially induced. The only way to get natural active immunity is to catch the disease and survive.

In response to the vaccine, cell P (a helper T cell) with the correct surface antigenic markers binds to the virus and starts to divide to form two types of cell;

a) **B - lymphocytes** (shown as cell Q) which start to produce antibodies against the virus (not just lymphocyte of B-cell)

b) **Memory cells** – these cells allow the immune system to respond <u>quickly</u> to <u>another/a second</u> invasion of a virus /bacterium / pathogen / toxin / antigen NOT DISEASE

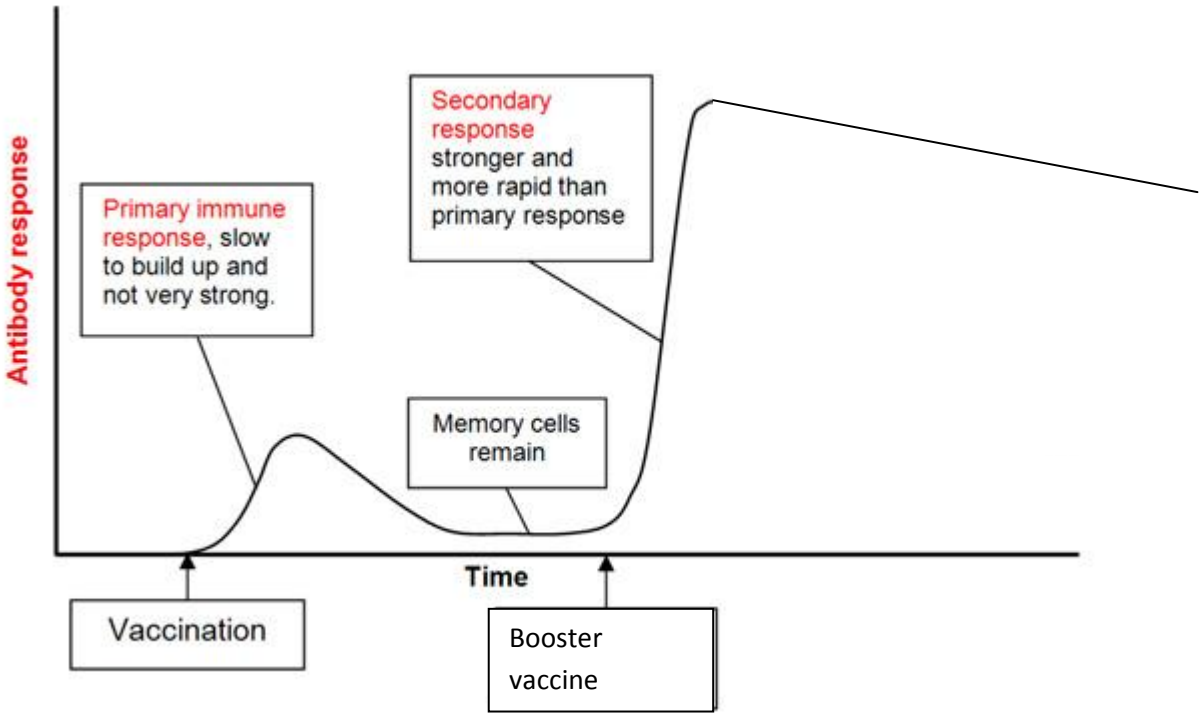
Vaccines produce antibodies which are specific to one microbe e.g. in this case one virus.

The vaccine may not work again for a very rapidly mutating microbe as the antigenic markers on their surface change and are not recognized by the immune system. This is called **antigenic variation.**

The <u>receptor</u> on the B-lymphocyte memory cell does not match the measles virus antigen.

Did you know? - Vaccines are often mixed with chemicals known as **adjuvants** which increase the efficiency of the vaccine.

The response of the immune system to a vaccine



Following vaccination the B lymphocytes produce antibodies specific to the antigenic markers on the surface of the microbe.

Over time the antibody concentration decreases in the blood.

Memory cells are also produced which allow a much more rapid response in case of re-exposure to the microbe.

A booster vaccine tricks the immune system into thinking there has been exposure to the microbe and the memory cells cause a stronger response where antibody production:-

- Increases more rapidly
- Reaches a much higher concentration
- Declines more slowly

This secondary response produced by the booster provides much more effective, longer lasting protection against a microbe.

Herd Immunity

Vaccines give immunity to individuals who take them but also provide some protection to individuals who have not been vaccinated. This is called herd Immunity.

Herd immunity is provided only if vaccination levels are above a threshold as non-vaccinated people are less likely to encounter an infected person.

How can we be sure vaccines work?

Before any new drug can be marketed the drug companies who produce them must test them using strict rules (protocols).

These trials involve the key protocols of randomisation, use of placebo drugs and are double blind.

Placebo

- This takes the same form as the treatment but lacks the active ingredient being tested
- The procedure is carried out to assess the 'placebo effect'
- The effect from receiving the treatment that does not depend on the active ingredient
- Some patients on the placebo show an improvement in their condition, why?

This could be the result of the psychological effect of –

- Thinking they were getting the 'real' treatment
- Getting expert attention from health care staff
- Expecting the treatment to be efficacious

Double-Blind trial

- This is one in which neither the subjects nor the doctors know who is receiving the vaccine or a placebo

Randomisation

- Age, gender and other details are entered into a computer
- This then puts each person into one or other of the two groups at random
- This further eliminates bias

Only on completion of a trial and analysis of the results do independent researchers find out if an improvement was found only in the group which had received the drug and not the placebo.

This system has saved more lives than any other discovery in medicine.