There are two major aspects to our defence system – general and specific.

**General Defence System**

- Barriers
- Non-specific protective cells

**Barriers:**
- Skin (inc. sweat)
- Breathing System (mucus, cilia)
- Digestive System (acid in stomach)
- Tear Glands - lysozyme in tears keeps the surface of the eye free of bacterial infection.

**Non-specific Protective Cells**

**Phagocytes**
- Phagocytes are white blood cells.
- They ‘feed’ like *Amoeba* on bacteria, viruses and dead body cells.
- Free phagocytes wander throughout tissues ‘searching’ for ‘foreign invaders’.
- Fixed phagocytes reside in a particular area destroying pathogens that enter their space.

**Specific Defence System (Immune System)**

This defence strategy uses very precise unique defensive proteins against a particular pathogen.
- The defence proteins are called **antibodies**, if the target is a pathogen,
- An **antitoxin** if the target is a poisonous chemical.

The **pathogen** is identified as its surface has a chemical that is ‘foreign’ – i.e. a ‘non-self’ chemical.
- This non-self chemical is called an **antigen**.
- **Antigen**: a chemical that causes the immune system to produce specific antibodies.
- **Antibody**: a specific protein produced by the immune system on detection of an antigen.

**Induced Immunity:**
This is protection gained by the production of specific antibodies **after** the antigens on the pathogen have been detected.

**Passive Induced Immunity** *(i.e. immunity gained by antibodies made other than in the host)*
- **Natural**: mother’s antibodies passed to the foetus in the womb and antibodies supplied in mother’s milk during lactation.
- **Artificial**: injection of specific antibodies against a particular pathogen –
  - Passive induced immunity is short-lived.

**Active Induced Immunity** *(i.e. immunity gained following infection)*
- The patient produces the antibodies in response to antigen detection by phagocytes
- **Natural**: normal infection.
- **Artificial**: vaccination
- Active induced immunity is long-term protection because of the long life of memory B cells.
Sequence of events following exposure to an antigen

This requires lymphocytes: T-cells originate in the Thymus; B-cells in the Bone marrow.

- A phagocyte ‘eats’ the antigen and attaches parts of it to its surface
- It then ‘presents’ them to a T-helper cell (found mainly in lymph nodes and the spleen)
- The T-helper cell secretes large quantities of lymphokines, which cause inflammation and cause B lymphocytes to multiply (‘plasma cells’) and secrete antibody
- Each B-lymphocyte can only produce one specific antibody
- Once exposed to the antigen and lymphokines, it multiplies, forming a clone
  - Each clone produces vast quantities of one antibody – ‘monoclonal antibodies’
  - These bind to the antigen, and cause the phagocytes to attack and kill it
  - The whole process (‘primary response’) takes 7-10 days.
  - T-helper cells are infected by HIV, thus weakening the host’s immune system
  - Other types of T-cells (T-killer cells) attack cancer cells and those infected by a virus

After recovery, the plasma cells rapidly die, but some mature into B-Memory cells, which remain in the body for many years.

- When exposed a second time to the same antigen, the response is
  - Faster
  - More powerful
- Since the B-Memory cells multiply rapidly and antibody is produced almost at once
- So powerful is the response that disease symptoms do not develop
- This is known as the ‘secondary response’,
- This is why you need 2 injections to provide long-term immunity against each disease.
- RNA viruses (colds, ‘flu, HIV) mutate so rapidly that you can become infected repeatedly...
Immune Memory

Vaccination
A vaccine is specially prepared material that carries the antigen and is given to induce active immunity against a specific pathogen. Suitable vaccines may cause some discomfort but give faster and greater antibody production against infection such that no symptoms occur when subsequently infected.

Types of Vaccines
- Preparation of the dead pathogen.
- Preparation of the live but weakened pathogen (cannot reproduce).
- Preparation of a close but relatively harmless relative of the pathogen.
- Preparation of parts of the pathogen that carry the antigen.

Examples of Vaccines
- MMR: defence against measles, mumps and rubella.
- 3 in 1: defence against diphtheria, whooping cough and tetanus.

Immunisation
Immunisation is the protection against disease by vaccination or administration of antibodies.
ABO Blood Groups

- There are 4 different blood groups: A, B, AB, and O.
- They are named after the antigens on the surface of the RBC’s.
- ‘O’ - type blood is the most common (43%) and has no antigens.
- ‘AB’ - type blood is the least common (3%), and has both A and B antigens.
- Each blood group has the opposite antibody in the plasma, so:
  - A- blood people have anti-B antibodies in their plasma
  - B- blood people have anti-A antibodies in their plasma
  - AB – blood people have no antibodies (or they would attack themselves)
  - O- blood people have both anti-A and anti-B antibodies

These antibodies cause the RBC’s of the ‘wrong’ blood to clump together = ‘agglutination’

Transfusions

Normally, donor blood of the same blood group is given to the recipient.
But AQA like to ask questions based on mixing!
So…..

- It is vital that the donor RBC’s are compatible with the recipient’s plasma
  (the other way round does not matter!)
- AB is the ‘universal recipient’ and can accept any blood group
- O is the ‘universal donor’ and can be given to anyone

When blood testing is carried out:
- A-type blood agglutinates with anti-A
- B-type blood agglutinates with anti-B
- AB-type blood agglutinates with both
- O-type blood agglutinates with neither

<table>
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<tr>
<th>Blood type</th>
<th>Genotype</th>
<th>Antibodies made</th>
<th>Reaction to added antibodies</th>
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<tbody>
<tr>
<td>A</td>
<td>A(^+/+) or A(^+/-)</td>
<td>Anti-B</td>
<td>Anti-A Anti-B</td>
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<tr>
<td>B</td>
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