- thin - for a short diffusion distance
- large area - achieved by being long and thin, flat, or folded
- moist - so that substances can be dissolved for diffusion to happen
- Common features of transport systems:
  - tubes or ‘vessels’ that carry materials from one part of the organism to another
  - close contact with cells, such as those of exchange surfaces

The *circulatory system* in humans has a pump, the heart. However, the transport systems in plants - the xylem and phloem - do not have pumps.

**LYMPhOCYTES**

About 25 per cent of the white blood cells are *lymPhocytes*. They are part of the body’s *immune system* and produce soluble proteins called *antibodies*.

**Antibodies**

Antibodies attach to *antigens*. Antigens are substances found on the surface of cells, including *bacteria* and other *pathogens*. Different antibodies attach to different antigens. In this way, the body’s immune system can recognise *foreign antigens* – antigens that are not normally produced by the body, but by pathogens instead.

Antibodies can neutralise toxins produced by pathogens. They can also cause the destruction of pathogens by:

- causing bacteria to burst open and die
- labelling the pathogen so that it is recognised more easily by phagocytes
- sticking pathogens together in clumps so that they can be engulfed by phagocytes more easily

**PHAGOCYTES**

About 70 per cent of the white blood cells are *phagocytes*. They are part of the body’s *immune system*, but they do not produce *antibodies*. Instead, they ingest and destroy *pathogens* such as bacteria.

This is what happens:

1. the phagocyte surrounds the bacterial cell, enclosing it in a *vacuole*
2. enzymes are secreted into the vacuole to destroy the bacterial cell

The process of ingesting the pathogen is called *phagocytosis*.

**VACCINATION**

People can be *immunised* against a *pathogen* through *vaccination*. Different vaccines are needed for different pathogens. For example, the MMR vaccine is used to protect children against measles, mumps and rubella (German measles). Vaccination involves putting a small amount of an inactive form of a pathogen into the body. Vaccines can contain:

- live pathogens treated to make them harmless
- *toxins* produced by pathogens
- harmless fragments of the pathogen
- dead pathogens

These all contain *antigens*. When injected into the body, they stimulate *lymPhocytes* to produce *antibodies* that can recognise the pathogen. Some lymPhocytes develop into *memory cells*. If the vaccinated person later becomes infected with the same pathogen, the *immune system* is prepared, and the required lymPhocytes are able to reproduce rapidly and destroy it. This means that the person is unlikely to become ill.