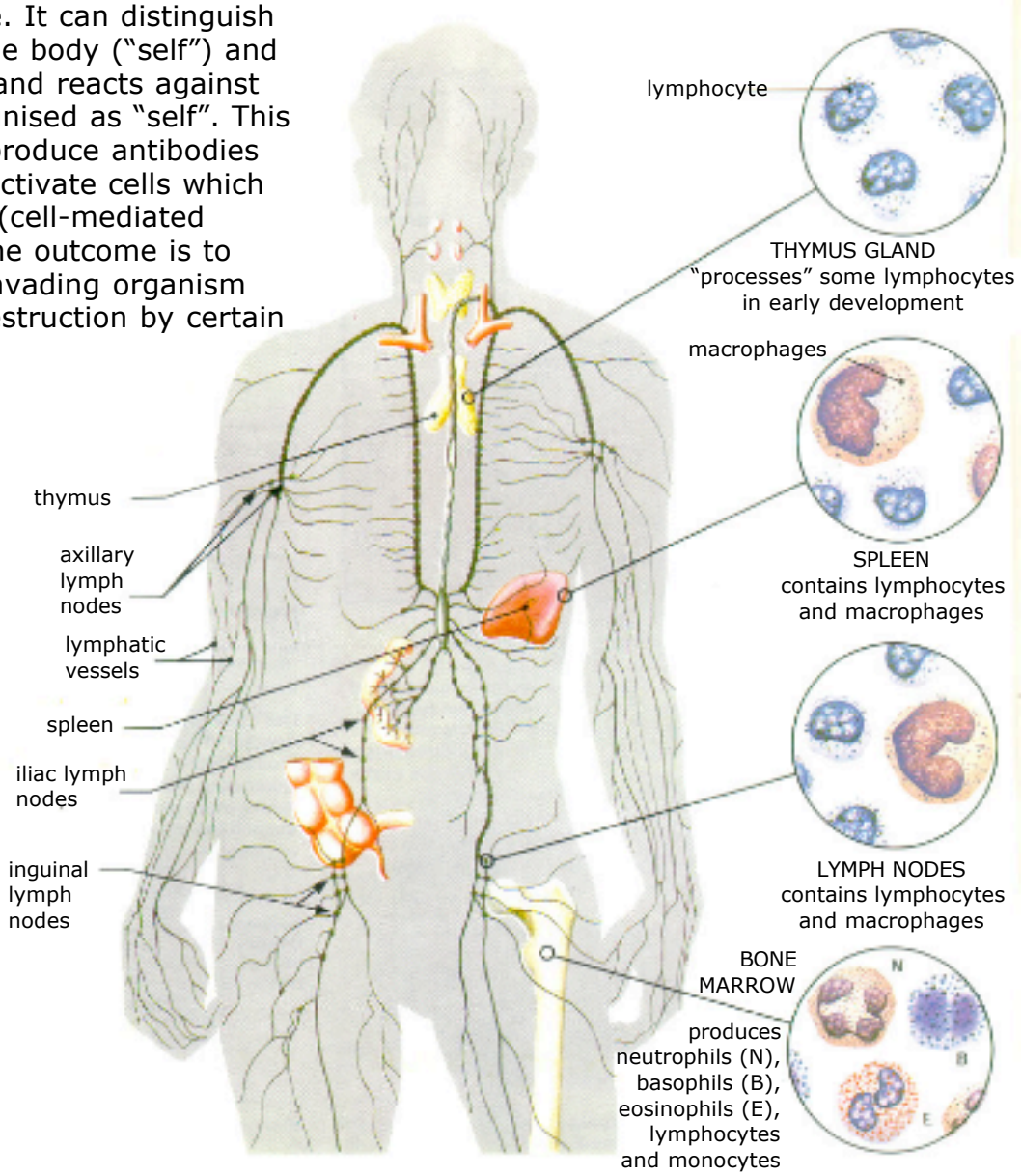
The Immune System 1

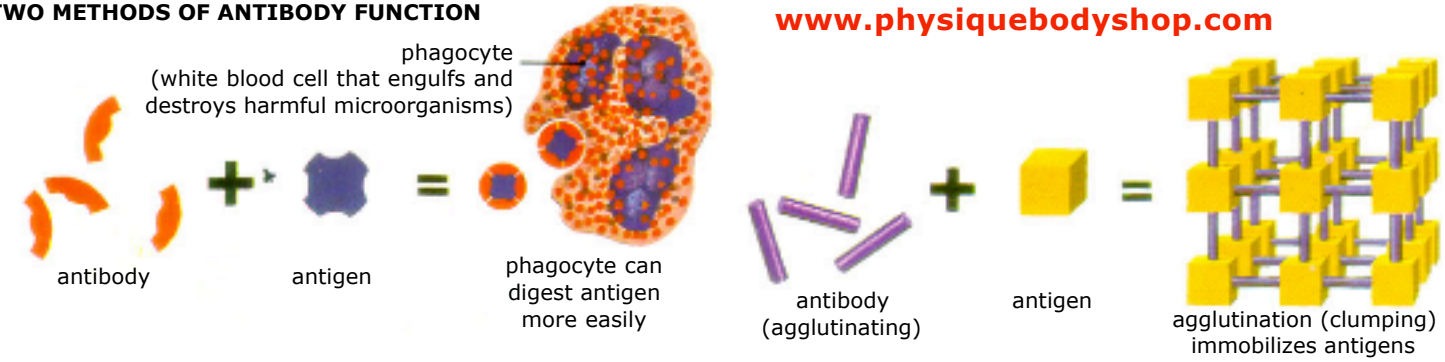
The immune system defends the body against invasion by disease-producing organisms and against toxins they produce. It can distinguish between what belongs in the body ("self") and what does not ("foreign"), and reacts against any cells that are not recognised as "self". This reaction may be either to produce antibodies (humoral immunity) or to activate cells which attack the invader directly (cell-mediated immunity). In both cases the outcome is to make the foreign cells or invading organism subject to phagocytosis; destruction by certain white blood cells.

Lymph nodes (above) are pea-sized structures situated in groups at strategic points in the lymphatic vessels; the network of channels which drain the tissues and return the excess fluid to the bloodstream. Foreign particles, such as bacteria, are trapped in the lymph nodes, which are inhabited by macrophages (white blood cells which can phagocytose. i.e. engulf and destroy foreign particles) and lymphocytes (white blood cells which mount immune reactions).



The main components of the body's immune system are shown above (right). The lymphatic system and lymphoid tissues represent the basic structural framework. The magnified cells shown are all different types of white blood cell. Lymphocytes are concentrated in the lymph nodes and spleen: they are of two types, "T-lymphocytes" and "B-lymphocytes", which inhabit different regions of the nodes and spleen and play different roles in the immune system response. In early development, the thymus gland "processes" some circulating lymphocytes before they reach the lymph nodes and spleen. These become "T-cells" able to mount a cell-mediated immune response. Others, called "B-cells," are not processed in this way, but are capable of responding to antigens by producing antibodies. The bone marrow manufactures a variety of white blood cells: monocytes, which eventually become phagocytic macrophages; neutrophils, which are also mainly phagocytic, basophils (called Mast cells outside the bloodstream), which produce histamine, and eosinophils, which limit the effects of histamine release.

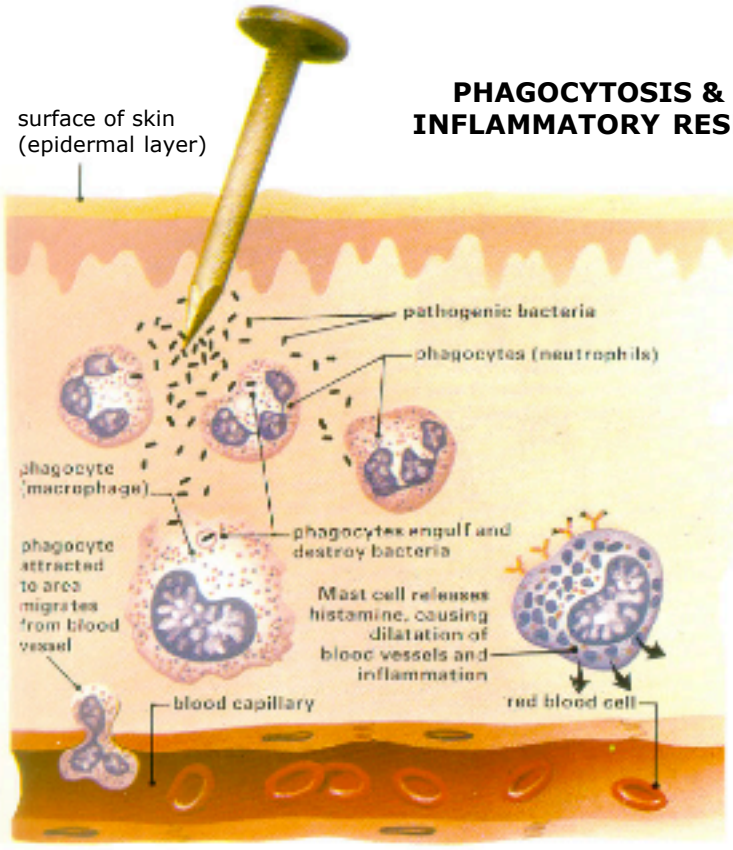
TWO METHODS OF ANTIBODY FUNCTION

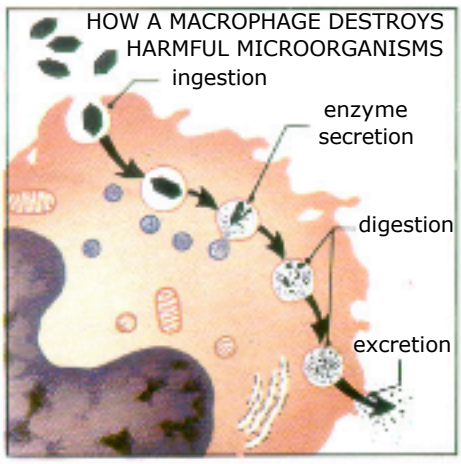


The above diagrams illustrate two ways in which antibodies act to render the corresponding antigen harmless. Left: antibodies coat the surface of the antigen. As a result of this process, certain other enzymes in the blood are activated which, if the antigen is a cell or micro-organism, damage the cell wall, killing the cell. In addition, coating makes the antigen more readily destroyed by phagocytic cells: specific sites on the phagocytes attract the antibody molecules. Right: the antibody can combine with two molecules of antigen, thereby binding the antigen into two clumps. This process of agglutination immobilises the antigens, which can again be ingested by the phagocytes.

The Immune System 2

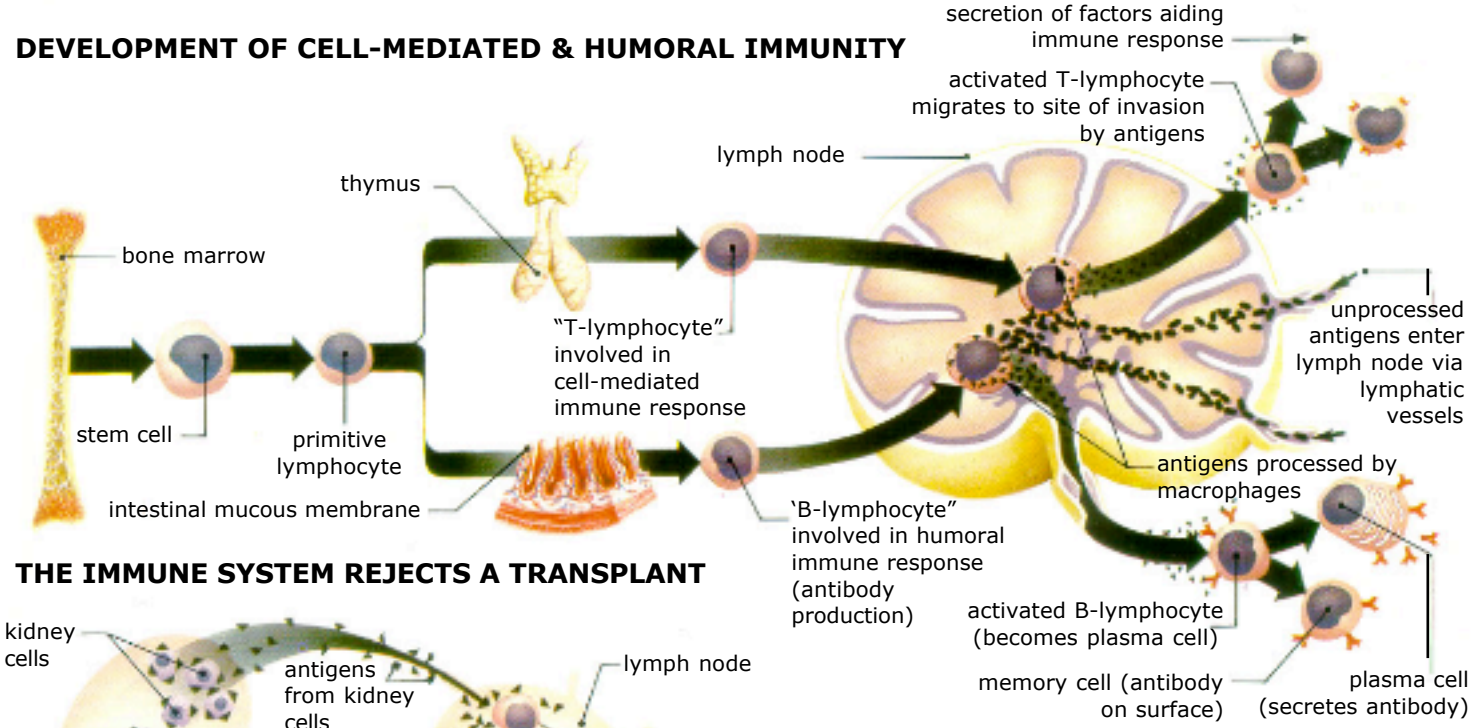
PHAGOCYTOSIS & THE INFLAMMATORY RESPONSE



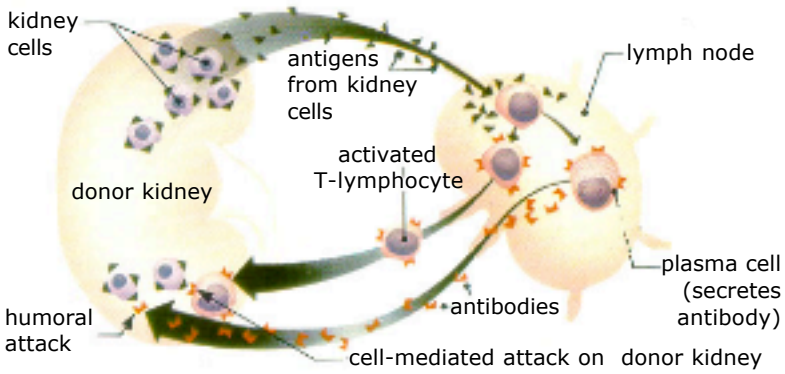


Left: a rusty nail has broken the skin, carrying in with it pathogenic bacteria. Some of these are ingested by phagocytic neutrophils and by a macrophage. Antigens from the organism will reach the local lymph node, either directly or carried within the macrophage, and "antigen processing" takes place (see below). Lymphocytes are stimulated to become plasma cells which make appropriate antibodies; this then circulates to the tissue and combines with the antigen on the surface of the organism at the site of the wound. This reaction causes activation of enzymes in the blood, causing damage to the cell walls of the invaders. Various chemical substances are released; these attract phagocytes and cause secretion of histamine by mast cells. Histamine causes dilation of local blood vessels and increased migration of fluid and cells into the area, leading to the familiar features of inflammation.

DEVELOPMENT OF CELL-MEDIATED & HUMORAL IMMUNITY



THE IMMUNE SYSTEM REJECTS A TRANSPLANT



The immune system can recognise the cells of a transplanted organ as "foreign" and attacks the organ. Both types of immune response are involved, though cell-mediated immunity plays the greater part. The rejection process can be countered by immunosuppressive drugs, or by closely matching the tissue types of donor and recipient (e.g family member).

Above: in early development some of the stem cells in the bone marrow develop into primitive lymphocytes. Some pass through the thymus and become "T-lymphocytes"Others become "B-Lymphocytes" Both types of lymphocytes are stimulated by antigens: activated T-Lymphocytes migrate to the point where the antigen has arisen and may destroy foreign cells themselves or activate local macrophages to do so. These lymphocytes secrete factors which "arm" macrophages and attract other white blood cells. Activated B-Lymphocytes divide, and some become plasma cells. Plasma cells make large quantities of antibodies; they are found in lymph nodes and bone marrow and may continue to produce low levels of antibodies for many years. In addition some activated T- and B-Lymphocytes become "memory-cells", able to respond again if the same antigen presents itself.