Health and disease

*(a) discuss what is meant by the terms health and disease;*

*Health*

**A state of mental, physical and social wellbeing, not just the absence of disease.**

**Free from disease or illness**

**Good nutrition ;**

**Suitably housed ;**

*Disease*

**A departure from good health caused by a malfunction of the mind or body**

*(b) define and discuss the meanings of the terms parasite and pathogen;*

*Parasite*

**An organism that lives on or in another living thing causing harm to its host**

**It feeds on the host, receives warmth and protection and the host allows for the transmission of the parasite to a new host**

*Pathogen*

**An organism that causes disease**

*(c) describe the causes and means of transmission of malaria, AIDS/HIV and TB (knowledge of the symptoms*

*of these diseases is not required);*

*Malaria*

**Infective agent is *Plasmodium falciparum* which is carried by a vector, the female Anopheles mosquito. The parasite has to live in the mosquito and another animal such as a human during its life cycle. If the human already has malaria, the female Anopheles mosquito will take the parasite gametes into its own stomach when it bites and sucks blood**

**The gametes fuse and the zygotes develop in the mosquito’s stomach**

**Infective stages are formed and these move to the mosquito’s salivary glands**

**When the mosquito bites another person, it injects a little saliva as an anticoagulant**

**The saliva contains the infective stages of the parasite**

**In the human host, the infective stages enter the liver where they reproduce before passing into the blood again**

**In the blood they enter red blood cells, where the gametes are produced**

*HIV/AIDS*

**Infective agent is *Human Immunodeficiency Virus***

**The virus enters the body by**

**Exchange of bodily fluids such as blood**

**Unprotected sexual intercourse**

**Unscreened blood transfusions**

**Use of unsterilised surgical equipment**

**Sharing hypodermic needles**

**Accidents such as ‘needlestick’**

**Across the placenta or during childbirth**

**From mother to baby during breastfeeding**

**HIV is a retrovirus and inserts its RNA into a T lymphocyte. The enzyme reverse transcriptase produces a DNA copy of the viral RNA and the DNA is inserted into the chromosome of the T lymphocyte. Viral mRNA is produced and makes viral proteins which then form many copies of the virus which are released from the T lymphocyte**

**HIV can remain inactive in the body for many years. Once the virus becomes active as above it destroys T helper cells, effectively rendering the immune system useless**

*Tuberculosis*

**Infective agent is *Mycobacterium tuberculosis***

**The bacteria are contained in the tiny droplets of liquids which are released when an**

**infected person coughs, sneezes or talks. But it takes close contact with an infected person**

**over a long period of time to contract the disease. There are a number of conditions which**

**make contraction and spread more likely**

**Overcrowding- many people eating and sleeping together in one house**

**Poor ventilation**

**Poor health- particularly if a person has HIV/AIDS**

**Poor diet**

**Homelessness**

**Living or working with people who are migrated from areas where TB is more common**

**TB can also be contracted from the milk or meat of cattle.**

*(d) discuss the global impact of malaria, AIDS/HIV and TB;*

*Malaria*

**Kills about 3 million people annually**

**Affects about 300 million people**

**Currently limited to areas where the Anopheles mosquito can survive, which is currently**

**the tropical regions.**

**But, with global warming, the Anopheles mosquito may be able to survive further north,**

**even into parts of Europe.**

*HIV/AIDS*

**Spreading into pandemic proportions all over the world**

**Approximately 45 million people living with HIV/AIDS at the end of 2005**

**More than half of these are in Sub-Saharan Africa**

**About 5 million people infected each year**

**By the end of 2005, nearly 30 million people had died from HIV/AIDS related illnesses**

**It is thought that the number of people living with HIV/AIDS in China will soon exceed the**

**number in any other country**

*Tuberculosis*

**Approximately 1% of the population is infected every year, and 10-15% of those will go on**

**to develop the disease**

**In 2005 there were 8.8 million new cases of Tuberculosis and 1.6 million people died.**

**Up to 30% of the world’s population may be infected with TB**

*(e) define the terms*

*immune response*

**The specific response to a pathogen, which involves the action of lymphocytes and the**

**production of antibodies**

*antigen*

**Molecules that stimulate an immune response**

*antibody;*

**Protein molecules that can identify and neutralise antigens**

*(f) describe the primary defences against pathogens and parasites (including skin and mucus membranes) and*

*outline their importance. (No details of skin structure are required)*

**The skin an mucus membranes are a physical barrier to prevent entry of microorganisms**

**Mucous membranes have goblet cells which produce mucus to trap pathogens**

**The ciliated epithelia remove the mucus full of trapped pathogens**

**Blood clotting prevents pathogens entering bloodstream**

**Ear wax and nasal hairs trap the pathogens**

**Lysozyme is found in tears and saliva which kills bacteria**

**Stomach acid kills bacteria in food**

*(f) describe, with the aid of diagrams and photographs, the structure and mode of action of phagocytes;*

**Phagocyte receptor recognises the antigen on plasma membrane of bacterium**

**Phagocyte binds to bacterium**

**Pathogen is engulfed by infolding of phagocyte membrane forming a phagosome**

**Lysosomes fuse with the phagosome and release lysins (enzymes) it**

**Bacterium is digested to amino acids, sugars, glucose, fatty acids, and glycerol**

**These are absorbed into the cytoplasm by diffusion**

*(g) describe, with the aid of diagrams, the structure of antibodies;*

**Antibodies are Y-shaped molecules made up of 4 polypeptide chains, 2 light and 2 heavy chains held together by disulfide bonds**

**There is a constant region which is a marker allowing the binding of phagocytes**

**The variable region allows for antibody specificity and has a complementary shape to the antigen on the pathogen. The fact that there is more than one variable region allows agglutination and the attachment to more than one pathogen**

**The hinge region allows flexibility when more than one pathogen is attached**

**Four polypeptide chains held together by disulfide bridges**

*(h) outline the mode of action of antibodies, with reference to the neutralisation and agglutination of pathogens;*

**They attach to the specific antigens on a pathogen. The pathogen may use these antigens as a binding site, for example, which would bind to the host cell.**

**If the antibody blocks this binding site, the pathogen cannot bind to its host cells – this is neutralisation.**

**Some antibodies will attach to more than one pathogen at a time causing agglutination.**

**Pathogens are unable to infect cells and are easier for phagocytes to find and engulf**

*(i) describe the structure and mode of action of T lymphocytes and B lymphocytes, including the significance*

*of cell signalling and the role of memory cells;*

*Cell signalling*

**The immune response involves a coordinated response between a wide range of cells. To**

**work effectively, these cells need to communicate.**

**A body cell is infected by a pathogen and antigens from the pathogens may be**

**presented on the plasma membrane of the infected cell**

**This can have two effects**

**Act as a distress signal and can be detected by cells from the**

**immune system**

**Act as markers to indicate that the host cell is infected- T killer**

**cells recognise that the cell is infected and must de destroyed**

**The pathogen may be engulfed by macrophage cells which remove antigens and presented them on the plasma membrane**

**This allows for the selection of correct T killer cells and T helper cells (clonal selection)**

*Cell mediated response (T cells)*

**Multiplication of correct killer T cells (clonal expansion)**

**Killer T cells search for infected cells**

**Killer T cells attach to infected cells**

**Killer T cells secrete toxic substances (hydrogen peroxide) into infected cells to kill the cell and the pathogens it contains**

*Humoral response (B cells)*

**T helper cells release a cytokine called interleukin which binds to a receptor on (cell surface) membrane of a B lymphocyte as they have complementary shapes. This activates clonal expansion**

**B cell, has an antigen receptor on its surface which is specific to only one antigen**

**T helper cells select the relevant specific B cell, this is clonal selection**

**The selected B cell divides by mitosis to produce clones, this is clonal expansion**

**These clones differentiate to form plasma cells which produce antibodies**

**The antibodies are complementary to the antigen**

*Memory cells*

**Both T helper and B cells will produce memory cells**

**Recognise virus / antigen / pathogen**

**They produce a clone that can change to plasma cells**

**The plasma cell then makes antibodies**

**They are responsible for secondary response which destroys viruses etc before symptoms appear**

**Circulate the body for a number of years allowing for a faster secondary response to subsequent infection**

*(j) compare and contrast the primary and secondary immune responses;*

*Primary response*

**When the infecting agent is first detected, the immune system starts to produce antibodies, but it takes a few days before the number of antibodies in the blood rises to a level that can fight the infection**

*Secondary immune response*

**The immune system recognises the pathogen if the body is infected again, so the immune**

**system can swing into action more quickly.**

**The production of antibodies has a shorter delay, is more rapid and produces more antibodies**

*(k) compare and contrast active, passive, natural and artificial immunity;*



*(l) explain how vaccination can control disease;*

**Vaccination provides immunity to specific diseases. A person who has been vaccinated has artificial**

**immunity. This is created by the deliberate exposure to antigenic material that has been rendered**

**harmless. The immune system treats the antigenic material as if it was a real disease. As a result,**

**the immune system manufactures antibodies and memory cells. The memory cells provide the long term immunity.**

*(m) discuss the responses of governments and other organisations to the threat of new strains of influenza*

*each year;*

**There are different strains of the virus as it mutates each year**

**The new strains have different antigens**

**The antibody produced by the vaccine needs to match the new antigen**

**In the UK there is an immunisation program to vaccinate all ‘at risk’ groups.**

**These are**

**the elderly**

**‘at risk’ children**

**pregnant women**

**those with compromised immune systems**

**those with chronic diseases**

**health workers**

**poultry workers**

*(n) outline possible new sources of medicines, with reference to microorganisms and plants and the need to*

*maintain biodiversity*

**Because there are many species of drugs in the tropical rainforest that are yet to be discovered, it is**

**hoped that there are many new medicinal drugs yet to discover. But biodiversity needs to be**

**maintained- plants with medicinal properties should be farmed sustainably so that the species is**

**not wiped out.**

**Research has been undertaken into the way that microorganisms cause disease. Many use**

**receptors on heir plasma membranes. The receptor sites can be blocked by a drug, and then the**

**disease-causing pathogen cannot gain access to the cell.**

*(o) describe the effects of smoking on the mammalian gas exchange system, with reference to the symptoms*

*of chronic bronchitis, emphysema (chronic obstructive pulmonary disease) and lung cancer;*

*Short term*

**Tar is a combination of chemicals which settles on the inner lining of the airways and**

**alveoli. This increases the diffusion distance for oxygen entering the blood and for carbon**

**dioxide leaving the blood.**

**The tar paralyses or destroys the cilia on the surface of the airway so they are unable to**

**move the layer of mucus away and up to the back of the mouth. The tar also stimulates the**

**goblet cells and mucus secreting glands to enlarge and release more mucus. The mucus**

**collects in the airways.**

**Bacteria and viruses that become trapped in the mucus are not removed. They can**

**multiply in the mucus and eventually a combination of mucus and bacteria may block the**

**bronchioles.**

**The presence of bacteria and viruses means that the lungs are more susceptible to**

**infection. Smokers are more likely to catch diseases such as influenza and pneumonia.**

*Long term*

**The mucus and bacteria irritates the airways, and they need to be cleared to get oxygen**

**into the alveoli. This leads to smokers cough to try and shift the bacteria-laden mucus.**

**This constant cough damages the lining of the alveoli and airways. This lining will**

**eventually be replaced by scar tissue which is thicker and less flexible. The layer of smooth**

**muscle in the bronchioles also thickens. This reduces the lumen of the airway, and the flow**

**of air is restricted.**

**Frequent infections as a consequence of bacteria and viruses in the mucus inflames the**

**lining of the airways, which damages it. This attracts white blood cells which release**

**enzymes to get out of the blood and into the airways. The enzymes digest parts of the**

**lining of the lungs. The enzyme elastase is used which damages the elastic tissue of the**

**lining the lungs. Loss of elastic tissue in the alveoli can reduce the elasticity of their wall, so**

**the alveolus wall does not push air out as we exhale. The bronchioles collapse, trapping air**

**in the alveoli. This can cause the alveoli to burst as pressure in the lungs increases.**

*Chronic Bronchitis*

**Inflammation of the lining of the airways, damage to the cilia and overproduction of mucus**

**Symptoms**

**Irritation of the lungs**

**Continual coughing**

**Coughing up mucus that it often filled with bacteria and white blood cells**

**Chronic means**

**long term**

**takes time for the symptoms to show**

**degenerative (gets progressively worse)**

*Emphysema*

**The loss of elasticity in the alveoli which causes them to burst**

**Symptoms**

**Shortness of breath, especially when exerting themselves**

**The loss of elasticity makes it harder to exhale**

**The blood is less well oxygenated and fatigue occurs**

**barrel chest**

**high blood pressure to lungs**

**enlargement of right side of heart**

**heart failure**

*Lung cancer*

**Tar contains carcinogens such as benzopyrene and formaldehyde**

**It enters the epithelial cells ;**

**Tar has destroyed the cilia which prevents the removal of tar which then has a greater contact time with epithelial cells**

**Carcinogens enter the nucleus and causes mutation**

**This results in uncontrolled cell division and the formation of a tumour**

**Causes**

**Continual coughing**

**Shortness of breath**

**Pain in the chest**

**Blood coughed up in the sputum**

*(p) describe the effects of nicotine and carbon monoxide in tobacco smoke on the cardiovascular system with*

*reference to the course of events that lead to atherosclerosis, coronary heart disease and stroke;*

*Nicotine:*

**Causes addiction**

**Mimics the effects of transmitter substances at the synapses between nerves. This makes**

**the nervous system more sensitive and smoker feels more alert**

**Causes adrenaline to be released**

**Causes constriction of the arterioles leading to the extremities of the body**

**Makes platelets sticky. This increases the risk that a blood clot or thrombosis may form**

*Carbon Monoxide*

**Haemoglobin has a higher affinity for CO than for O2. Carbon monoxide combines with**

**haemoglobin to form carboxyhaemoglobin, which is very stable. This reduces the oxygen**

**carrying capacity of the blood. Smokers feel this when they exercise. The body will detect**

**lower levels of oxygen and the heart rate will rise**

**It damages the endothelium of the arteries**

*Atherosclerosis*

**Carbon monoxide can damage the endothelium of the arteries.**

**The damage is repaired by phagocytes.**

**This encourages the growth of smooth muscle and the deposition of fatty substances under the endothelium.**

**The deposits include cholesterol contained in low-density lipoproteins.**

**These deposits (atheromas) may also include fibres, dead blood cells and platelets.**

**The atheroma eventually forms a plaque which sticks out into the lumen of the artery.**

**This leaves the artery wall rougher and less flexible. It also reduces the lumen of the artery,**

**reducing blood flow.**

*Coronary Heart Disease*

**The coronary arteries carry blood to the heart muscles.**

**They carry blood at high pressure which makes them prone to damage and atherosclerosis. When the lumen of a coronary artery is narrowed by plaques, there is less blood flow to the heart muscle, so they receive less oxygen for aerobic respiration and blood carries away less carbon dioxide**

**Angina- A severe pain in the chest which may extend down the left arm or up the**

**neck**

**Heart attack or myocardial infarction- the death of part of the heat muscle, usually**

**caused by a clot in the coronary artery blocking the flow of blood to the heart**

**muscle**

**Heart failure- when the heart cannot sustain its pumping action; this can be due to**

**the blockage of a major coronary artery, but there are other types and causes.**

*Stroke*

**Death of part of the blood tissue due to the loss of blood flow to that part of the brain.**

**Two possible causes:**

**A blood clot floating around in the blood blocks a small artery leading to part of**

**the brain**

**An artery leading to the brain bursts**

*(q) evaluate the epidemiological and experimental evidence linking cigarette smoking to disease and early*

*death*

*Epidemiological*

**A regular smoker is three times more likely to die prematurely than a non smoker**

**50% of regular smokers are likely to die of a smoking related disease**

**The more cigarettes a person smokes per day, the more likely (s)he is to die prematurely, and the younger (s)he is likely to die**

**A smoker is 18x more likely than a non-smoker to develop lung cancer**

**25% of smokers die of lung cancer**

**A heavy smoker (25+ cigarettes per day) is 25 times more likely to die of lung cancer than a non-smoker**

**The chance of developing lung cancer reduces as soon as a person stops smoking**

**Chronic Obstructive Pulmonary Disease is rare in non-smokers**

**98% of people who have emphysema are smokers**

**20% of smokers have emphysema**

**It is not easy to link smoking with cardiovascular diseases because there are so many other**

**factors that can contribute to cardio-vascular disease.**

*Experimental*

**In the 1960s there were experiments on dogs.**

**Some dogs were made to breathe smoke from unfiltered cigarettes. They developed changes in their lungs that were similar to those of Chronic Obstructive Pulmonary Disease. They also developed early signs of lung cancer**

**Some dogs were made to breathe smoke from filtered cigarettes. These dogs**

**remained healthier, but their lungs still showed early signs of lung cancer**