Staying Healthy

1. Health is the state of physical and mental well-being
2. Diseases, both communicable and non-communicable, are major causes of ill health
3. Communicable diseases can be transferred from one person to another or from one organism to another
4. Non-communicable diseases are not transferred between people and/or other organisms
5. Examples of non-communicable diseases are cancer, diabetes, heart disease, neurological disorders and genetic diseases and conditions
6. Different types of disease may interact
7. Defects in the immune system mean that an individual is more likely to suffer from infectious diseases
8. Viruses living in cells can be the trigger for cancers. For example, the majority of cervical cancers are linked with a virus present in the female reproductive system
9. Immune reactions initially caused by a pathogen can trigger allergies such as skin rashes and asthma
10. Diet, stress and lifestyle factors, such as alcohol and other drugs may have a profound effect on both physical and mental health
11. Severe physical ill health can lead to depression and other mental illness.
12. There is a human and financial cost to non-communicable diseases to an individual, a local community, a nation or globally
13. Alcoholism can lead to increased rates of violence and anti-social behaviour, increased risk of accidents, increased absence from work, mental decline and increased treatment costs to the NHS
14. Lifestyle factors including diet, alcohol and smoking have an effect on the incidence of non-communicable diseases at local, national and global levels

Epidemiology: Correlation, Causation and Sampling

15. Risk factors are linked to an increased rate of a disease. Something that increases the likelihood of developing a disease is a risk factor
16. A correlation is when there is a clear association between variables. This does not necessarily mean the factor causes the outcome
17. Scientists have determined some causal mechanisms for risk factors
18. Scientists cannot study every person on the planet so must use sampling
19. Samples must be representative (an accurate reflection of the population as a whole)
20. Representative samples must be wide and cover all groups in the population being studied
21. Scientists must take into account variation due to differences between the sexes, between different age groups and between different lifestyles
22. Subsets of the data can be analysed to make comparisons
23. Epidemiology is the study of the distribution and patterns of health and disease, in and across populations

Risk Factors: Smoking and Diet & Obesity

24. Carcinogens present in smoke cause lung cancer
25. Smoking increases the risk of cardiovascular disease by:
    - damaging arterial lining, encouraging the build up of fatty material in the arteries, leading to a heart attack or stroke
    - inhalation of carbon monoxide reduced the amount of oxygen that can be carried in the blood
    - nicotine increases the heart rate, straining the heart
    - chemicals in cigarette smoke increase the likelihood of clots leading to heart attack or stroke
26. Smoking may cause lung diseases, including COPD (chronic obstructive pulmonary disease), where smoking damages the bronchioles and can

destroy alveoli, airways become inflamed and mucus builds up, the person becomes breathless and it is more difficult to get enough oxygen for respiration

27. Smoking during pregnancy increases the risk of miscarriage, means that babies and children are more likely to suffer from asthma and respiratory infections, may affect physical and intellectual development, increases the risk of birth defects and may reduce the birthweight of the baby
28. Obesity leads to high blood pressure and the build up of fatty deposits on the walls of arteries, leading to cardiovascular disease
29. Obesity accounts for much of the risk of type 2 diabetes, where the body's cells lose their sensitivity to insulin
30. Rising obesity levels are linked with diets that are higher in fast or processed foods and a sedentary/inactive lifestyle
31. The risk of developing cardiovascular disease and type 2 diabetes can be reduced by eating a balanced diet and exercising regularly
32. High salt intake increases the risk of high blood pressure
33. Many diseases are caused by the interaction of a number of factors

Risk Factors: Alcohol

34. Alcohol affects the brain by slowing reaction time, causing difficulty walking, impairing memory, causing slurred speech and changes in mood and sleep patterns
35. Long term alcohol abuse can cause brain shrinkage, memory problems and psychiatric problems
36. Drinking excess alcohol can damage the liver, which is the organ responsible for breaking down alcohol. The liver can regenerate itself but excessive consumption over a long period of time can cause serious harm
37. Alcohol causes build up of lipids in the liver, causing fatty liver disease
38. Alcohol damage leads to alcoholic hepatitis
39. Cirrhosis of the liver is when the liver becomes scarred and loses its function irreversibly, reducing the ability to process alcohol. This can also lead to brain damage
40. Alcohol abuse during pregnancy can cause foetal alcohol syndrome, where the foetus is smaller, has a smaller brain, distinct facial features and is likely to have long-term learning and behavioural difficulties

Communicable Diseases

41. A pathogen is a microorganism that causes a disease
42. Diseases caused by pathogens are called communicable diseases
43. Diseases can be caused by viruses, bacteria, fungi and protists, and spread in animals and plants by contact, water or air
44. The life cycle of a pathogen involves infecting a host, reproducing (or replicating), and spreading to infect other organisms.
45. Pathogens have structural adaptations that allow them to be successful at infecting other organisms
46. Transmission (spreading) can occur by contact, water, air, unhygienic food preparation or by vectors
47. A vector is an organism that allows the transmission of a pathogen e.g. mosquitoes
48. Bacteria and viruses can reproduce rapidly inside the body

Types of Communicable Disease

49. Viruses are not living organisms because they do not carry out all the seven life processes
50. Viruses are described as strains rather than species
51. Viruses live and reproduce inside cells and cause damage
52. Viruses are made up of a length of DNA surrounded by a protein coat

53. Viral diseases cannot be treated by antibiotics
54. Viruses infect host cells, where they replicate their DNA and protein coats thousands of times to make new virus particles. The host cell bursts and can infect other nearby cells
55. Measles is a viral disease causing a high-temperature and a red skin rash, and is often caught by young children
56. Measles is a serious infection that can cause death if there are complications. It can also cause infertility in adults who did not catch the disease as children
57. The measles virus is spread by inhaling it from sneezes or coughs
58. Young children are vaccinated against measles so that if they come into contact with the virus, the disease will not develop
59. Vaccination is more prevalent in developed countries
60. HIV (human immunodeficiency virus) infection can cause the disease AIDS (acquired immunodeficiency syndrome) because the virus attacks the immune system cells
61. Antiviral drugs can be used to manage an HIV infection so that AIDS does not develop
62. HIV is spread by sexual contact or sharing other bodily fluids, such as blood in shared needles of drug abusers
63. Tobacco mosaic virus (TMV) infects many plants including tobacco plants and tomato plants, transmitted by contact between plants
64. TMV causes a distinct 'mosaic' pattern of discolouration on leaves because it infects the chloroplasts of plant leaves. This means that leaves cannot absorb light for photosynthesis so the plant does not grow normally. This can reduce the crop yield
65. Pathogens are microorganisms that cause disease and not all bacteria are pathogens. There are many useful bacteria, such as those in the human gut
66. Bacteria can make poisons called toxins that damage cells and tissues inside the body

67. Salmonella food poisoning is spread by bacteria eaten in food. It is often caused by unhygienic food preparation or undercooked foods, such as meat, eggs or poultry
68. Salmonella causes stomach cramps, vomiting and diarrhoea because of the effect the toxin has on the digestive system
69. Chickens in the UK are vaccinated against salmonella to prevent it spreading
70. Gonorrhoea (an STD) is a bacterial infection spread by sexual contact so its spread can be prevented by using a condom during sex
71. Gonorrhoea infection causes a yellow-green discharge from the penis or vagina and pain during urination. If untreated it can lead to infertility
72. The antibiotic penicillin was used to treat gonorrhoea, however there are now many new strains resistant to antibiotics
73. Not all fungi are pathogens (e.g. yeast) and not all are unicellular (e.g. mushrooms). Fungi are eukaryotes.
74. Fungal infections are treated using fungicide chemicals
75. Athlete's foot is caused by a fungus and usually found between toes. It is spread by touching infected skin or surfaces but can be treated with antifungal medication
76. Rose black spot is a fungal disease where purple/black spots form on leaves. This means that leaves cannot absorb light for photosynthesis so the plant does not grow normally
77. Rose black spot is spread by water and by wind
78. Protists are unicellular eukaryotes which have features that belong to animals, plants and fungi

79. A protist pathogen called plasmodium causes malaria and is spread by living inside mosquitos, which pass the protist to the next person they suck blood from. Mosquitos are malarial vectors
80. The symptoms of malaria are fever, headaches, vomiting and diarrhoea. Approximately half of people infected with malaria die from it
81. The spread of malaria is controlled by preventing mosquitos from breeding and biting. People can sleep under mosquito nets and use insect repellent. Antimalarial drugs can also be taken to prevent infection and symptoms

Preventing the Spread

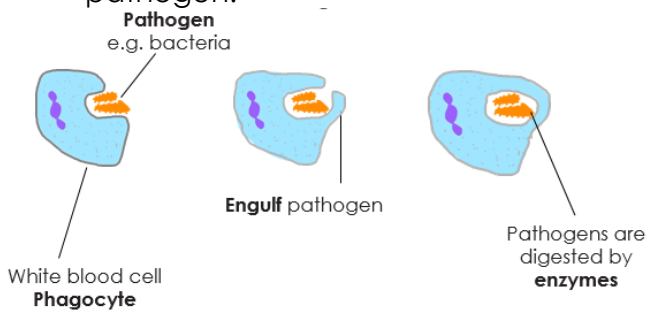
82. Transmission of pathogens can be reduced in different ways
83. Sterilising water with chemicals or UV light can reduce transmission of cholera
84. Cooking food thoroughly and maintaining hygienic preparation can reduce transmission of salmonella
85. Disinfecting surfaces can reduce transmission of athlete's foot
86. Vaccinations can reduce transmission of measles
87. Using barrier contraception methods such as condoms can reduce transmission of STDs and HIV

Human Defence Systems

88. The immune system defends against disease
89. The first line of defence is the non-specific defence systems of the human body against pathogens include the skin, nose, trachea and bronchi, and stomach. These ty to stop pathogens entering the body
90. If the skin is cut, it begins to heal itself by forming a scab as a physical barrier
91. Parts of the body that do not have skin have other barriers, such as the eyes producing tears which contain enzymes to act as chemical barriers
92. The nose contains hair and cells that produce mucus. This traps pathogens before they can enter the lungs. The pathogens in the mucus can be removed when the nose is blown.
93. The trachea and bronchi contain ciliated cells, which have tiny hairs called cilia. They also have goblet cells, which produce mucus, as a physical barrier. The ciliated cells waft their hairs, moving the mucus and pathogens towards the throat. Mucus is then swallowed into the stomach
94. Stomach acid is hydrochloric acid and is a chemical barrier against pathogens, as it is strong enough to kill pathogens that have been swallowed with mucus, or consumed with food or drink

The Immune Response

95. If a pathogen enters the body the immune system tries to destroy the pathogen
96. White blood cells help to defend against pathogens by: phagocytosis, antibody production and antitoxin production
97. The two types of white blood cell are phagocytes and lymphocytes
98. Phagocytes surround pathogens and engulf them in phagocytosis. Enzymes in the phagocyte break down the pathogen.

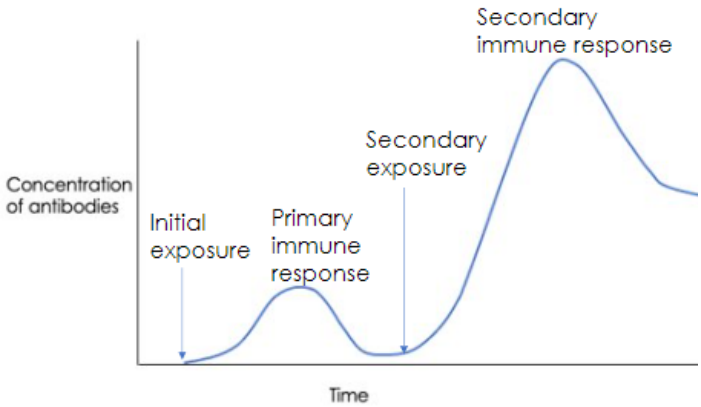


99. Phagocytes surround any pathogen, so are non-specific
100. Lymphocytes recognise proteins on the surface of pathogens called antigens. They detect these are not part of the body and produce antibodies in response. Antibodies cause the pathogens to stick together, making it easier for phagocytes to engulf them

101. Antibody production can take several days, during which time the person may feel ill
102. Some pathogens produce toxins which can make the person feel ill. Lymphocytes also produce antitoxins to neutralise the toxins
103. Antibodies and antitoxins are produced for specific antigens on pathogens, so they are specific

Vaccination

104. Vaccination will prevent illness in an individual. The spread of pathogens can be reduced by immunising a large proportion of the population
105. Vaccination involves introducing small quantities of dead or inactive forms of a pathogen into the body to stimulate the white blood cells to produce antibodies. If the same pathogen re-enters the body the white blood cells respond quickly to produce the correct antibodies, preventing infection
106. Primary and secondary exposure can be shown on a graph (see below). Primary infection results in slow antibody production. Secondary infection results in a quicker response from the white blood cells to produce many more antibodies and prevent infection



107. Herd immunity is the term given to a population that has a high percentage of vaccination, so offers protection against the specific disease
108. If the proportion of the population that is vaccinated against a disease drops, it can leave the rest of the population at risk of mass infection as there are more likely to come into contact with infected contagious individuals

Antibiotics

109. Antibiotics, such as penicillin, are medicines that help to cure bacterial disease by slowing or stopping the growth of infective bacteria inside the body. It is important that specific bacteria should be treated by specific antibiotics
110. The use of antibiotics has greatly reduced deaths from infectious bacterial diseases. However, the emergence of strains resistant to antibiotics is of great concern
111. A range of different antibiotics is needed for the treatment of different bacterial diseases, as one antibiotic may only work against one or a few types of bacteria
112. Painkillers and other medicines are used to treat the symptoms of disease but do not kill pathogens. Examples are paracetamol and aspirin. They treat the symptoms but the immune system still fights the pathogen
113. Antibiotics cannot kill viral pathogens
114. It is difficult to develop drugs that kill viruses without also damaging the body's tissues because antiviral drugs may damage the host cell while killing the virus
115. Antiviral drugs slow down viral development, but viruses are able to change their antigens quickly, so new drugs have to be created regularly

Taking if Further: Culturing Microorganisms

116. Petri dishes are used to produce cultures of bacteria and other micro-organisms and prepared using aseptic

technique to prevent contamination and the growth of harmful bacteria

117. Agar is a type of nutrient media that contains nutrients needed for microorganisms to grow

118. Petri dishes, inoculating loops and culture media must be sterilised before use. A flame can be used to sterilise equipment

119. An inoculating loop is a piece of equipment used to transfer bacteria to the petri dish

120. The lid of a Petri dish should be partially secured with tape to ensure bacteria cannot escape but conditions remain aerobic

121. The Petri dish must be stored upside down to prevent condensation affecting bacterial growth

122. In school laboratories, cultures should generally be incubated at 25 °C to prevent the growth of harmful bacteria

123. Bacteria on a Petri dish divide rapidly by binary fission whilst the nutrient supply is rich. Every time the bacteria reproduce, the number doubles.

124. The total number of bacteria can be calculated using the following formula: Final number of bacteria = Initial number of bacteria x $2^{\text{number of divisions}}$

Taking if Further: Effectiveness of Antibiotics

125. The effectiveness of antibiotics can be measured by measuring the clear zone around a colony or sample

126. A clear zone (also called zone of inhibition) means that bacteria have not been able to grow or divide

127. The area of the clear zone can be calculated using πr^2

Antibiotic Resistance

128. Bacteria can evolve rapidly because they reproduce very quickly

129. Some new strains might be resistance to antibiotics such as penicillin, which means they cannot be destroyed by them

130. Mutations of bacterial pathogens can produce new strains. Random mutations occur in the genes of individual bacterial cells, which may protect the cell from the effects of the antibiotic. Bacteria without the mutation are destroyed by the antibiotic so the resistant bacteria can reproduce with less competition

131. The resistance strain can spread because the antibiotic cannot work against it

132. MRSA is a bacteria that is resistant to most antibiotics. This has made it an infection that is very difficult to control

133. Antibiotic effectiveness is decreasing because of overuse of antibiotics, failure to complete full prescribed courses of antibiotics and the overuse of antibiotics in agriculture

134. To reduce the rate of antibiotic resistant strains developing, doctors should not prescribe antibiotics for viral infections or for non-serious infections. They should only be taken when necessary and specific bacteria should be treated with specific antibiotics

135. Patients should complete the full course of prescribed antibiotics to ensure that all bacteria are killed and none survive to be able to mutate into resistant strains

136. Antibiotics are often used in farming to prevent disease and keep food animals healthy and able to grow quickly. Legal controls are now in place to reduce agricultural overuse of antibiotics

Development of Drugs

137. A drug is a substance which has a physiological effect on the body. Drugs can be medicinal or recreational

138. Traditionally drugs were extracted from plants and microorganisms. The heart drug digitalis originates from foxgloves. The painkiller aspirin originates from willow. Penicillin was discovered by Alexander Fleming from the Penicillium mould
139. Most new drugs are synthesised by chemists in the pharmaceutical industry. However, the starting point may still be a chemical extracted from a plant, which inspire synthetic versions to be made
140. New medical drugs have to be tested and trialled before being used to check that they are safe and effective
141. Thalidomide is a drug that caused serious and unexpected damage to unborn babies in the 1950s and 1960s, who were born with serious limb deformities. It was developed as a sleeping pill but was found to relieve morning sickness in pregnant women, but it had not been tested for this purpose
142. The process of discovery and development of potential new medicines is now much more rigorous and includes preclinical and clinical testing
143. New drugs are extensively tested for safety (toxicity), efficacy (effectiveness) and dose. Safety is important as some drugs can be toxic or cause harmful side effects. Efficacy is tested to measure how well the drug treats the disease and symptoms. Dosage has to be strictly controlled so that the drug can be effective without being toxic
144. The first stage of a preclinical trial is done in a laboratory using computer models and human cells grown in the laboratory. Many drugs fail at this first stage
145. The second stage of a preclinical trial is testing drugs on animals. This is a legal requirement for new medicines but is illegal for testing of cosmetic and tobacco products
146. Only drugs that pass animal tests move on to clinical trials. Clinical trials use healthy volunteers and patients. Very low doses of the drug are given at the start of the clinical trial. If the drug is found to be safe, further clinical trials are carried out to find the optimum dose for the drug
147. In double blind trials, some patients are given a placebo. Double blind trials mean that neither the doctor or the patient knows whether the patient has received the drug or the placebo, to reduce the risk of bias

Taking it Further: Monoclonal Antibodies

148. Monoclonal antibodies are identical copies of one type of antibody
149. Antibodies are proteins produced by lymphocytes. Pathogens have antigen proteins on their surface, which are detected as foreign by lymphocytes, which produce antibodies to fight them
150. Antibodies are a specific immune response because each antibody binds to a matching antigen
151. Antibodies can be made to bind to antigens on other substances rather than just pathogens. Once the antibody binds to the antigen they clump together, which makes them easier to find and deal with
152. They are produced by stimulating mouse lymphocytes to make a particular antibody by injecting the antigen into the mouse
153. Spleen cells which produce the lymphocytes are removed and fused with human cancerous white blood cells (myeloma cells) to form hybridoma cells
154. Single hybridoma cells are cloned to produce many identical cells that all produce the same antibody. A large amount of the antibody can be collected and purified

Taking if Further: Using Monoclonal Antibodies

155. Monoclonal antibodies can be used in laboratories to measure the levels of hormones and other chemicals in blood
156. Monoclonal antibodies are used in pregnancy test kits. They bind with a hormone called hCG which is only found in the urine of pregnant women
157. Monoclonal antibodies can also be used to bind to specific antigens on cancerous cells. This helps to clump the cancerous cells together, which makes it easier to identify cancerous tumours to be treated or removed. They may also be used to carry drugs attached to them to the tumour, which can attack the tumour without damaging healthy parts of the body
158. Monoclonal antibodies can also be used to identify and diagnose infections, such as herpes, chlamydia and HIV
159. Some monoclonal antibodies can be attached to dyes that glow fluorescent under UV light to help identify specific molecules or disease
160. The benefits of monoclonal antibodies are that they can be used to detect pregnancy, test for diseases such as HIV, which can lead to AIDS, to treat cancers by delivering drugs directly to tumour cells. They can also be produced quickly, although they are slow to produce the first time
161. There are limitations of monoclonal antibodies, which are not the silver bullet that was expected. The human body involves many interactions so there can be a range of unwanted side effects from using monoclonal antibodies. They are also very expensive to produce
162. Because the production of monoclonal antibodies involves using injections and an operation to remove spleen cells from mice, there is an ethical consideration about the use of animals
163. A clinical trial involving monoclonal antibodies to treat arthritis and leukaemia in 2006 caused organ failure in a number of individuals. They had been safely used in animal trials but the human body is different, which is why clinical trials must be done very carefully