AQA Biology – Infection & Response Part 1 Journey of Knowledge

Context and Introduction to Unit Pathogens are microorganisms such as viruses and bacteria that cause infectious diseases in animals and plants. They depend on their host to provide the conditions and nutrients that they need to grow and reproduce. They frequently produce toxins that damage tissues and make us feel ill. This section will explore how we can avoid diseases by reducing contact with them, as well as how the body uses barriers against pathogens. Once inside the body our immune system is triggered which is usually strong enough to destroy the pathogen and prevent disease. When at risk from unusual or dangerous diseases our body's natural system can be enhanced by the use of vaccination. Since the 1940s a range of antibiotics have been developed which have proved successful against a number of lethal diseases caused by bacteria. Unfortunately many groups of bacteria have now become resistant to these antibiotics. The race is now on to develop a new set of antibiotics.
Prior Knowledge – Cell Biology, Organisation.

CORE KNOWLEDGE **BIOLOGY (SEPARATES) ONLY**

A communicable disease is a disease that can be spread from one person or animal to another, these are called by pathogens. A pathogen is a microorganism that causes disease. There are four main types of pathogen; bacteria, virus, protist and fungus. When bacteria enter the body, they reproduce rapidly by binary fission; a simple type of cell division that prokaryotes use to divide and multiply. Bacteria produce toxins that make you feel ill. These toxins are carried in the blood stream, meaning the effects can be felt all over your body. Differing to bacteria, viruses are not living cells and so are much smaller in size. When a virus invades a host cell, it will force the cell to produce new copies of the virus, essentially replicating itself thousands of times. This causes the host cell to burst and allows the virus to go on to invade more cells. This is not reproduction, as the virus is not living.

Pathogens can be spread through direct contact and indirect contact as well as being vector borne, food borne, water borne or air borne. The spread of diseases can be reduced or prevented through; simple hygiene measures (e.g. handwashing, thoroughly cleaning cutlery/surfaces etc.), safe food handling and water consumption (e.g. separating raw meat, cooking thoroughly, boil or filter water, avoid bathing/swimming in contaminated water), isolation of infected individuals (e.g. children not allowed to go to school when infected with chicken pox/impetigo etc. COVID 19 isolation rules), destroying/removing contact with vectors (e.g. mosquito nets), vaccination (e.g. MMR vaccination, HIV vaccinations). Ignaz Semmelweis, known as the Father of Infection Control, discovered in the 19th century that mandatory hand washing by doctors drastically reduced deaths from childbed fever, a common post-childbirth illness.

Measles is a viral disease showing symptoms of fever and a red skin rash. Measles is a serious illness that can be fatal if complications arise. For this reason, most young children are vaccinated against measles. The measles virus is spread by inhalation of droplets from sneezes and coughs. HIV initially causes a flu-like illness. Unless successfully controlled with antiretroviral drugs the virus attacks the body's immune cells. Late-stage HIV infection, or AIDS, occurs when the body's immune system becomes so badly damaged it can no longer deal with other infections or cancers. HIV is spread by sexual contact or exchange of body fluids such as blood which occurs when drug users share needles. Tobacco mosaic virus (TMV) is a widespread plant pathogen affecting many species of plants including tomatoes. It gives a distinctive 'mosaic' pattern of discolouration on the leaves which affects the growth of the plant due to lack of photosynthesis. Salmonella food poisoning is spread by bacteria ingested in food, or on food prepared in unhygienic conditions. In the UK, poultry are vaccinated against Salmonella to control the spread. Fever, abdominal cramps, vomiting and diarrhoea are caused by the bacteria and the toxins they secrete. Gonorrhoea is a sexually transmitted disease (STD) with symptoms of a thick yellow or green discharge from the vagina or penis and pain on urinating. It is caused by a bacterium and was easily treated with the antibiotic penicillin until many resistant strains appeared. Gonorrhoea is spread by sexual contact. The spread can be controlled by treatment with antibiotics or the use of a barrier method of contraception such as a condom. Rose black spot is a fungal disease where purple or black spots develop on leaves, which often turn yellow and drop early. It affects the growth of the plant as photosynthesis is reduced. It is spread in the environment by water or wind. Rose black spot can be treated by using fungicides and/or removing and destroying the affected leaves. The pathogens that cause malaria are protists. The malarial protist has a life cycle that includes the mosquito. Malaria causes recurrent episodes of fever and can be fatal. The spread of malaria is controlled by preventing the vectors, mosquitos, from breeding and by using mosquito nets to avoid being bitten.

Microbiologist use a process known as aseptic technique when culturing microorganisms. This ensures safe practice and also prevents the development of unwanted microorganisms. Pre-Inoculation: Sterilise the petri dish and agar before use in an autoclave. Sterilise the work-space thoroughly and discard of paper towels/wipes. Pass the inoculation loop through the hottest part of the Bunsen burner, starting nearest to the handle and working your way to the loop. Allow the inoculation loop to cool. Inoculation: Dip the cooled inoculation loop into the liquid bacteria solution. Open the lid of the petri dish as little as possible to prevent microbes from the air from entering. When opening, ensure this is done pointing away from you. Spread bacteria solution onto the agar in a zig-zag motion. Post-Inoculation: Seal the petri dish closed using tape to prevent microbes from the air from entering. Incubate the agar at 25°C to allow the bacteria to culture. Sterilise the work-space thoroughly and discard of paper towels/wipes.To investigate the effect of different antiseptics on the growth of bacteria, spread bacteria evenly on an agar plate and place filter paper discs soaked with different antiseptics on the surface. After incubation, measure the zones of inhibition (the clear areas around the discs where bacteria haven't grown) to assess each antiseptic's effectiveness. Larger zones indicate stronger antibacterial action, allowing comparison between the antiseptics tested. To calculate the area of a zone of inhibition, measure the diameter of the zone of inhibition. Repeat at perpendicular to the first measurement and calculate a mean diameter. Divide the mean diameter by 2 to work out the radius of the circle. Calculate the area of the zone of inhibition using πr^2.

Disciplinary Knowledge
Microbiology Required Practical: investigate the effect of antiseptics or antibiotics on bacterial growth using agar plates and measuring zones of inhibition. WS 1.3, 1.4, 1.5, 1.6

Vocabulary
Communicable, Pathogen, Virus, Bacteria, Protist, Fungi, Transmission, Symptom, Prevention, Vector, Borne, Toxin, Aseptic Technique, Inoculation, Zone of Inhibition, Phagocytes, Phagocytosis, Lymphocytes, Antibodies, Antitoxins, Antigens, Agglutination, Drug, Clinical Trial, Toxicity, Efficacy, Dosage, Double-blind, Placebo, Antibiotic, Painkiller, Vaccination, Herd Immunity, Monoclonal Antibody

Reading is Power
Malaria and HIV

Where Next?
Paper 2: Inheritance & Variation (evolution & antibiotic resistance), Ecology (impact of pathogens on ecosystems).

AQA Biology – Infection & Response Part 2 Journey of Knowledge

Context and Introduction to Unit Pathogens are microorganisms such as viruses and bacteria that cause infectious diseases in animals and plants. They depend on their host to provide the conditions and nutrients that they need to grow and reproduce. They frequently produce toxins that damage tissues and make us feel ill. This section will explore how we can avoid diseases by reducing contact with them, as well as how the body uses barriers against pathogens. Once inside the body our immune system is triggered which is usually strong enough to destroy the pathogen and prevent disease. When at risk from unusual or dangerous diseases our body's natural system can be enhanced by the use of vaccination. Since the 1940s a range of antibiotics have been developed which have proved successful against a number of lethal diseases caused by bacteria. Unfortunately many groups of bacteria have now become resistant to these antibiotics. The race is now on to develop a new set of antibiotics.
Prior Knowledge – Cell Biology, Organisation.

CORE KNOWLEDGE BIOLOGY (SEPARATES) ONLY

The innate immune system (first line of defence) is a non-specific defence system composed of physical, chemical and cellular barriers. This acts immediately upon exposure to pathogens. Its primary function is to prevent pathogens from entering the body and destroy them if they do. Physical barriers include the skin, nose hair & eyelashes, cilia (waft mucus containing pathogens up & out of trachea) & goblet cells (produce mucus). Chemical barriers include mucus & stomach acid. Cellular barriers come into action if a pathogen enters the blood stream. White blood cells known as phagocytes use a process known as phagocytosis to destroy pathogens, which involves engulfing the pathogen and using enzymes to digest it, ensuring the infection is contained. Phagocytes buy time for the adaptive immune system to coordinate a targeted response.

The adaptive immune system is a specialised part of the immune system that develops after exposure to the pathogen, it can recognise, remember and respond to specific pathogens. White blood cells called lymphocytes organise a specific and targeted response to destroy pathogens. Lymphocytes release proteins with specific shapes called antibodies that bind to proteins on the surface of the pathogen known as antigens, forming an antigen-antibody complex and neutralising the pathogen. Memory cells store the shape of the antigen allowing lymphocytes to produce and release specific antibodies faster in future exposures. Antibodies also cause pathogens to clump together (agglutination), making phagocytosis more effective as multiple pathogens are engulfed and digested at one time. Lymphocytes can also produce specialised antibodies known as antitoxins. Antitoxins bind to and neutralise toxin molecules released by bacteria, preventing them from causing harm to the body.

A drug is a chemical substance with the ability to alter chemical reactions in the body. Traditionally plants were extracted from plants and microorganisms. Most new drugs are synthesised by chemicals in the pharmaceutical industry, however the starting point may still be a chemical extracted from a plant. The painkiller aspirin originates from willow tree bark. The heart drug digitalis originates from foxgloves. The antibiotic penicillin originates from Penicillium mould and was discovered by Sir Alexander Fleming. New drugs are extensively tested for toxicity (whether the drug is harmful), efficacy (whether the drug works/is effective) and dosage (how much of the drug is effective whilst not being wasteful or risking overdose). Preclinical testing is completed in a laboratory using cells, tissues and live animals to test for toxicity. Clinical trials use healthy volunteers to test small doses of the drug for toxicity in humans before moving onto patients to test for efficacy and dosage. The findings are peer reviewed to remove bias. In double blind trials, some patients are given a placebo (fake drug) to act as a control.

An antibiotic is a drug used to treat bacterial diseases, examples include penicillin and amoxicillin. An antibiotic works by inhibiting cellular processes of bacterial cells, but do not damage normal body cells. This explains why antibiotics cannot be used to treat viral diseases. Misuse of antibiotics can lead to antibiotic resistant strains of bacteria. Painkillers and other medicines are used to treat the symptoms of disease but do not kill pathogens, examples include paracetamol and ibuprofen. Vaccinations allow a dead or weakened form of the pathogen to be introduced into the body. This causes lymphocytes to produce complementary antibodies which target and attach to the antigen on the surface of the pathogen. A second exposure to the same pathogen causes the lymphocytes to respond much quicker and produce much more of the relevant antibodies, preventing a full infection. When majority of a population is vaccinated, this is referred to as herd immunity.

Monoclonal antibodies (mAbs) are produced from a single clone of cells. The antibodies are specific to one binding site on one protein antigen. These are different to the antibodies produced in your body. Lymphocytes can make different antibodies that can bind to a range of antigens. Monoclonal antibodies are made to bind to one specific antigen only. Monoclonal antibodies are produced by stimulating mouse lymphocytes to make a particular antibody. The lymphocytes are combined with a tumour cell to make a hybridoma cell. The hybridoma cell can divide and make the antibody. Single hybridoma cells are cloned to produce many identical cells that all produce the same antibody. A large amount of the antibody can then be collected and purified. Monoclonal antibodies can be used in pregnancy tests, to identify infections and in cancer treatments.

Disciplinary Knowledge

Microbiology Required Practical: investigate the effect of antiseptics or antibiotics on bacterial growth using agar plates and measuring zones of inhibition. WS 1.3, 1.4, 1.5, 1.6

Vocabulary

Communicable, Pathogen, Virus, Bacteria, Protist, Fungi, Transmission, Symptom, Prevention, Vector, Borne, Toxin, Aseptic Technique, Inoculation, Zone of Inhibition, Phagocytes, Phagocytosis, Lymphocytes, Antibodies, Antitoxins, Antigens, Agglutination, Drug, Clinical Trial, Toxicity, Efficacy, Dosage, Double-blind, Placebo, Antibiotic, Painkiller, Vaccination, Herd Immunity, Monoclonal Antibody

Reading is Power

Malaria and HIV

Where Next?

Paper 2: Inheritance & Variation (evolution & antibiotic resistance), Ecology (impact of pathogens on ecosystems).

AQA Biology – Infection & Response Part 3 Journey of Knowledge

Context and Introduction to Unit Pathogens are microorganisms such as viruses and bacteria that cause infectious diseases in animals and plants. They depend on their host to provide the conditions and nutrients that they need to grow and reproduce. They frequently produce toxins that damage tissues and make us feel ill. This section will explore how we can avoid diseases by reducing contact with them, as well as how the body uses barriers against pathogens. Once inside the body our immune system is triggered which is usually strong enough to destroy the pathogen and prevent disease. When at risk from unusual or dangerous diseases our body's natural system can be enhanced by the use of vaccination. Since the 1940s a range of antibiotics have been developed which have proved successful against a number of lethal diseases caused by bacteria. Unfortunately many groups of bacteria have now become resistant to these antibiotics. The race is now on to develop a new set of antibiotics.
Prior Knowledge – Cell Biology, Organisation.

CORE KNOWLEDGE BIOLOGY (SEPARATES) ONLY

Disease in plants can appear as stunted growth, spots on leaves, areas of decay, growths, malformation, discolouration or pests. Aphids are insects that suck sap from the stems (phloem) of plants. Ladybirds can be used to control aphid populations. Rose Black Spot is a fungal disease that appears as black spots on leaves, yellowing discolouration on leaves (chlorosis) and stunted growth. Rose black spot is spread by tiny spores carried in wind or water. Tobacco Mosaic Virus (TMV) is a viral disease that appears as a mosaic pattern on the leaves and stunted growth. TMV is spread via direct contact with infected plants and vectors. Mineral deficiencies can also lead to stunted growth and chlorosis. Nitrate ions are needed for protein-synthesis, magnesium and iron ions are needed for chlorophyll production. Potassium ions control water uptake and phosphorous ions are responsible for healthy root and shoot growth. Plant disease can be identified by using a gardening manual, Googling the symptoms, using an app with a camera, taking a sample to a lab to identify the pathogen under a microscope, using DNA analysis or a monoclonal antibody testing kit.

Just like animals, plants have defence responses that can be physical or chemical. Physical defences include thick bark making it hard for herbivores to chew or pathogens to permeate, a waxy cuticle to prevent the entry of pathogens and a cellulose cell wall to stop pathogens from taking over individual host cells. Chemical defences antimicrobial & antibacterial chemical secretions to kill any pathogens that enter the plant and poisons & toxins to kill/deter herbivores trying to eat the plant. Plants also have many mechanical adaptations that also help to defend against disease or herbivores. Mechanical adaptations include thorns, hairs & spines to interfere with feeding and prevent eggs from being laid, curling or drooping leaves to dislodge insects or scare larger herbivores and mimicry to appear diseased/appear to have an insect on the plant.

Disciplinary Knowledge
WS 1.4
Vocabulary
Virus, Fungus, Spores, Vector, Chlorophyll, Chlorosis, Photosynthesis, Glucose, Energy, Protein-synthesis, Mineral Ions, Physical, Chemical, Mechanical
Reading is Power
Plant Detectives
Where Next?
Paper 2: Inheritance & Variation (evolution & antibiotic resistance), Ecology (impact of pathogens on ecosystems).