# Scheme of work

## Biology – Infection and response

This resource provides guidance for teaching the Infection and response topic from our new GCSE Biology (8461). It has been updated from the draft version to reflect the changes made in the accredited specification. There have been minor changes to the specification content to sections 4.3.1.1 Communicable diseases, 4.3.1.6 Human defence system, 4.3.1.9 Discovery and development of drugs and 4.3.3.2 Plant defence responses. These alterations have not required changes to be made to the scheme of work.

The scheme of work is designed to be a flexible medium term plan for teaching content and development of the skills that will be assessed.

It is provided in Word format to help you create your own teaching plan, you can edit and customise it according to your needs. This scheme of work is not exhaustive; it only suggests activities and resources you could find useful in your teaching.

### 4.3 Infection and response

### 4.3.1 Communicable diseases

Students should understand the differences between non-communicable diseases, covered in sections 4.2.2.5 to 4.2.2.7 and communicable diseases.

The structure of bacterial cells is covered in 4.1.1.1 Eukaryotes and prokaryotes.

The Required practical in section 4.1.1.6, to investigate the effect of disinfectants or antibiotics on bacterial growth, would logically fit into this section after students have learnt about antibiotics.

Antibiotics 4.3.1.8, links with antibiotic resistance covered in 4.6.3.7, but which could be taught here, after antibiotics and before drug development.

Students are only required to know specific details of the microorganisms listed in the specification. These could be taught together, or the plant diseases could be taught when teaching 4.3.3 Plant disease.

| **Spec ref.** | **Summary of the specification content** | **Learning outcomes**  *What most candidates should be able to do* | **Suggested timing (hours)** | **Opportunities to develop Scientific Communication skills** | **Opportunities to develop and apply practical and enquiry skills** | **Self/peer assessment opportunities and resources**  *Reference to past questions that indicate success* |
| --- | --- | --- | --- | --- | --- | --- |
| 4.3.1.1 | Communicable diseases  Communicable diseases are infectious diseases caused by pathogens.  Pathogens may be viruses, bacteria, protists or fungi. They may infect plants or animals.  Pathogens can be spread by direct contact, by water or by air.  The spread of diseases can be reduced or prevented by:   * simple hygiene measures * destroying vectors * isolation of infected individuals * vaccination (see 4.3.1.7). | Define the term pathogen and state the four main groups of pathogen.  Explain how pathogens can be spread to plants or animals and cause infection.  Describe the main differences between bacteria and viruses.  Explain how the spread of disease can be reduced or prevented. | 1 | Show BBC video clip on microorganisms (see resources).  Mini-whiteboard recap – draw and label a bacteria cell.  Provide images of bacteria, viruses, protists and fungi on the internet.  Construct a table comparing fungi, virus, bacteria and protists to include size, site of reproduction and effects in the body.  Show BBC video clip on effect of proper hand washing (see resources).  Use card sort matching diseases to transmission and prevention.  Prepare advice leaflet for a doctors’ surgery explaining how people can reduce their chances of catching diseases. | Use UV powder on door handles at start of lesson and black light to show transfer of pathogen. | BBC Bitesize video clips – [Microorganisms](http://www.bbc.co.uk/education/clips/zbbygk7)  Images of pathogens  BBC Bitesize video clips – [The importance of handwashing in food hygiene](http://www.bbc.co.uk/education/clips/z9swhyc)  Exampro user guide Powerpoint |
| 4.1.1.6 | Culturing microorganisms  Bacteria can be grown as colonies on agar plates or in a nutrient broth solution.  Precautions taken when preparing an uncontaminated agar plate for use in investigations.  In schools a maximum incubation temperature of 25ºC is used to reduce the risk of growing pathogens that might be harmful to humans. | Describe how microorganisms can be safely grown on agar plates.  Explain the safety precautions you must take when growing microorganisms.  Explain why cultures are incubated at a maximum temperature of 25ºC in schools. | 1 | Use agar plates to establish a safe method using aseptic techniques which will be used for the required practical in a later lesson.  Students could investigate:   * different areas of school * unwashed and washed hands * how good toilet paper is * the effect of temperature on bacterial growth.   Explain the purpose of each step involved in the preparation of an uncontaminated culture of microorganisms. Students could sequence the steps and match to the correct reason using cards.  Discuss what could happen if plates were incubated above 25ºC. | Evaluate risks when growing microbial cultures.  Observe the number and type of microbes that grow on agar plates from a choice of investigations. Observe results in a later lesson. | Agar plates materials:   * sterile Petri-dishes * sterile molten agar in bottles * biohazard tape * hand-wash/ soap.   Other materials:   * cotton buds to swab areas of school * toilet paper * incubator(s) and areas of different temperatures * thermometers.   Nuffield Foundation [Incubating and viewing plates](http://www.nuffieldfoundation.org/practical-biology/incubating-and-viewing-plates)  Nuffield Foundation [How good is your toilet paper For toilet paper?](http://www.nuffieldfoundation.org/practical-biology/how-good-your-toilet-paper) |
| 4.1.1.6 | Culturing microorganisms  Bacteria can be grown as colonies on agar plates or in a nutrient broth solution.  Bacteria multiply by simple cell division (binary fission) as often as once every 20 minutes if they have enough nutrients and a suitable temperature. | Recognise bacterial and fungal colonies growing on agar plates.  Describe safety precautions for microbial investigations.  Describe the optimum conditions for bacterial growth.  Calculate the number of bacteria in a population after a given time, when given the mean division time. | 1 | Watch BBC video clip showing bacterial cells dividing (see resources).  Provide photograph plates to label and stick in books (see resources).  Write a report on the investigation. Discuss the best way to present the results.  Calculate bacterial population growth.  Discuss what bacteria need for optimal growth.  Interpret graphs showing bacterial population growth. | Observe the results from the previous lesson, identifying bacterial and fungal growth. Make conclusions and suggest reasons.  Analyse results from the agar plates, suggesting reasons for the results.  Calculate cross-sectional areas of colonies using.  Model bacterial population growth.  Interpret graphs. | BBC Bitesize – [Microorganisms and bacteria](http://www.bbc.co.uk/education/clips/z2pwmp3)  Science Buddies – [Images of common bacteria/ fungal colonies](http://www.sciencebuddies.org/science-fair-projects/project_ideas/MicroBio_Interpreting_Plates.shtml)  Agar plates materials:   * plates from previous lesson * hand-wash * disposal bag. |
| 4.3.1.2 to 4.3.1.4 | Viral, bacterial and fungal diseases in humans  Viral diseases include measles and AIDS, which is caused by HIV.  Viral disease cannot be treated with antibiotics.  Bacterial diseases include salmonella food poisoning and the sexually transmitted disease gonorrhoea.  Humans can also be infected with fungal diseases. | Describe the symptoms, mode of transmission, prevention and treatment for measles, HIV and AIDS, salmonella and gonorrhoea.  Describe colds and flu as viral diseases.  Describe athlete’s foot as a fungal disease. | 1 | Small group project using ICT, researching to find out about the symptoms, mode of transmission, prevention and treatment for measles, HIV and AIDS, salmonella and gonorrhoea.  Present findings in a table and illustrate with images of these microorganisms.  Students prepare class presentations and fill out summary table for all. | Carry out research and explain application of science and personal and social implications related to diseases. | ABPI – Resources for Schools [Infectious diseases](http://abpischools.org.uk/page/modules/diseases/diseases1.cfm?coSiteNavigation_allTopic=1)  Microbiology Online | Society for General Microbiology – [Downloadable resources](http://www.microbiologyonline.org.uk/students/resources-1) |
| 4.3.1.5 | Protist diseases – malaria  Malaria is caused by a protist transmitted by mosquitos.  Spread of malaria is controlled by preventing the vectors (mosquitos) from breeding and by using mosquito nets to avoid being bitten. | Describe the life cycle of the malarial protist.  Describe the symptoms, mode of transmission, prevention and treatment for malaria. | 0.5 | Watch BBC video clip showing the effect of the malarial protest on red blood cells (see resources).  Card sort key ideas into correct order, or use for ‘back-to-back’ or collective memory activity.  Research the symptoms, mode of transmission, prevention and treatment for malaria. See links and BBC reports.  Produce an illustrated report on the findings.  Role play – Aid workers visit a remote village to help educate residents on preventing malaria infection. | Carry out research and explain application of science and personal, social, economic and environmental implications related to malaria. | BBC Bitesize – [Infested with malaria](http://www.bbc.co.uk/education/clips/z2tq2hv)  ABPI – Resources for Schools - [Malaria](http://abpischools.org.uk/page/modules/diseases/diseases8.cfm?coSiteNavigation_allTopic=1)  TED Talk – [Bill Gates: Mosquitos, malaria and education](http://www.ted.com/talks/bill_gates_unplugged?language=en)  [Parasitic Protists](http://www.biologycorner.com/bio1/parasitic-protists.html) |
| 4.3.1.6  4.3.1.1 | Human defence systems  The body defends itself against the entry of pathogens.  Bacteria may produce toxins that make us feel ill and damage tissues.  Viruses live and reproduce inside cells, causing damage.  The immune system tries to destroy pathogens that enter the body.  White blood cells help to defend against pathogens by:   * phagocytosis * antibody production * antitoxin production. | Describe the body’s first line defences.  Explain how microbes make us feel ill and how viruses damage cells.  Explain how the immune system defends against disease.  Describe what white blood cells do.  Explain why antibodies are specific for one pathogen/ antigen. | 1–2 | Post it notes on a body outline to recap KS3.  Label a diagram to show how the body defends itself against the entry of pathogens.  Watch BBC video clip showing phagocytosis (see resources).  Research how white blood cells defend the body.  ABPI animations of white blood cell activity.  Observe white blood cells under the microscope or bio-viewer.  Draw diagrams or a cartoon strip to show the actions of white blood cells using key words: ingest, phagocytosis, antibodies and antitoxins.  Draw diagrams or use cut-outs to model antibody specificity. | Observe prepared blood smears using a microscope or bio-viewer. Draw the cells.  Use models to represent phagocytosis and antibody specificity. | Blood smears materials:   * prepared slides * microscopes * bio-viewers.   BBC Bitesize video clips – [White blood cells](http://www.bbc.co.uk/education/clips/z77b9j6)  BBC Bitesize – [Defending against infection activity](http://www.bbc.co.uk/schools/gcsebitesize/science/aqa_pre_2011/human/defendingagainstinfectionact.shtml)  ABPI – Resources for Schools – [White blood cells/ response to infection](http://abpischools.org.uk/page/modules/infectiousdiseases_immunity/immunity2.cfm?coSiteNavigation_allTopic=1) |
| 4.3.1.7 | Vaccination  A vaccine contains a small amount of dead or inactive pathogens. These stimulate white blood cells to produce antibodies.  Immunity allows a person to produce specific antibodies quickly to prevent infection.  If a large proportion of the population is immune to a pathogen, the spread of the pathogen is very much reduced. | Describe what a vaccine contains.  Explain how vaccines prevent disease.  Explain the idea of ‘herd immunity’. | 1 | Watch BBC video about Edward Jenner. Evaluate the method he used in developing the first vaccine and compare with modern methods.  Discuss what a vaccine contains and how it works.  Use ABPI animation to show how a vaccine works.  Role-play the level of immunity within a population and its effect on the spread of a pathogen.  Interpret graph showing primary and secondary response to a pathogen (ABPI site).  Consider the actions of Dr Wakefield and the MMR vaccine.  Role-play whether to give your child vaccinations.  Interpret data about vaccination rates and reported cases of diseases, eg whooping cough, MMR.  Spain has had its first case of diphtheria in nearly 30 years – additional example. | Consider the ethical issues and risks associated with Jenner’s method. Discuss how methods and theories develop over time.  Use a model to explain herd immunity.  Interpret graph showing primary and secondary response to a pathogen; explain the responses.  Evaluate risk in relation to practical design and data review to avoid bias.  Evaluate risks related to vaccinations. | BBC Bitesize video clip – [The life and work of Edward Jenner](http://www.bbc.co.uk/education/clips/zt7gd2p)  ABPI – Resources for Schools – [Vaccination](http://abpischools.org.uk/page/modules/infectiousdiseases_immunity/immunity4.cfm)  [BBC search on MMR debate](http://www.bbc.co.uk/search?q=MMR%20debate)  WHO/Europe – [Diphtheria detected in Spain](http://www.euro.who.int/en/countries/spain/news/news/2015/06/diphtheria-detected-in-spain) |
| 4.3.1.8 | Antibiotics  Antibiotics, eg penicillin, are used to kill infective bacteria inside the body.  Specific bacteria should be treated with specific antibiotics.  The emergence of strains resistant to antibiotics is of great concern.  Antibiotics cannot kill viral pathogens. | Explain how antibiotics treat only bacterial diseases and how this has saved lives.  Describe the problems associated with antibiotic resistance. See 4.6.3.7  Explain the difficulty in developing drugs that kill viruses without damaging body tissues. | 2 | Describe the importance of antibiotics and the impact of antibiotic resistance. Explain how this has impacted on cleaning practices in Britain’s hospitals. Research MRSA and C. difficile infections and treatment.  Suggest what patients, doctors and scientists should do to ensure we will have effective antibiotics in the future.  Discussion starter – imagine the world we would live in if antibiotics stopped working. | Understand how scientific methods and applications develop over time. Evaluate personal, social and economic implications of antibiotics. | [BBC search on Antibiotic resistance](http://www.bbc.co.uk/search?q=antibiotic%20resistance) |
| 4.1.1.6 | Required practical: Investigate the effect of disinfectants or antibiotics on bacterial growth. | Plan and carry out a safe investigation into the effect of disinfectants or antibiotics on bacterial growth. | 1 | Required practical.  Write up the plan. | Required practical plan and carry out a safe investigation. | Required practical (see Practical Handbook). |
| 4.1.1.6 | Required practical: Investigate the effect of disinfectants or antibiotics on bacterial growth. | Calculate the cross-sectional areas of clear zones around disinfectant/ antibiotic discs using .  Present and analyse the results. | 1 | Required practical.  Observe, report and interpret results from the previous lesson. | Required practical. Collect, present and analyse the results. Calculate the cross-sectional areas of clear zones around disinfectant/ antibiotic discs. | Required practical materials:   * agar plates from previous lesson * hand-wash * disposal bag. |
| 4.3.1.8  4.3.1.9 | Painkillers  Painkillers and other medicines are used to treat the symptoms of disease but do not kill pathogens.  Alexander Fleming discovered penicillin from the Penicillium mould. | Give examples of painkillers and other medicines used to treat symptoms.  Interpret data about painkillers and other medicines.  Describe Fleming’s discovery and explain its importance. | 1 | Samples of medicine packaging to stimulate discussion.  Role play: Pharmacist/patient giving recommendation based on symptoms (cards prepared or students’ own ideas).  Brainstorm symptoms of diseases and medicines used to relieve symptoms and treat disease; names of some antibiotics.  Watch BBC video clip about Fleming.  Research work of Fleming and/ or Florey and Chain and discuss the impact of their work on society**.**  Interpret data about antibiotics, painkillers and other medicines.  Draw a timeline to show how treatment of disease has changed over the years. | Understand how scientific methods and applications develop over time. Evaluate personal, social and economic implications of drugs.  Interpret data about antibiotics, painkillers and other medicines.  Use secondary evidence from text books, the internet and other sources to draw a timeline. | Samples of medicine packaging.  Cards of common symptoms.  BBC Bitesize – [Modern medicine Classroom Resources](http://www.bbc.co.uk/education/topics/zsfsgk7/resources/1)  BBC Bitesize – [Fleming and the discovery of penicillin](http://www.bbc.co.uk/education/clips/zxt6n39)  [BBC search on Medicine through time](http://www.bbc.co.uk/search?q=Medicine%20through%20time)  BBC Four series – [Pain, Pus and Poison: The Search for Modern Medicines](http://www.bbc.co.uk/programmes/p01f51s5) |
| 4.3.1.9 | Discovery and development of drugs  Traditionally drugs were extracted from plants and microorganisms.  Most new drugs are synthesised by chemists; the starting point may still be a chemical extracted from a plant.  New drugs are tested for toxicity, efficacy and dose.  Preclinical testing in the lab, then clinical trials involving healthy volunteers and then patients.  In a double blind trial, some patients are given a placebo; neither the doctors nor the patients know who has received a placebo and who has received the drug. | State which drugs come from plants and microorganisms.  Explain why drugs need to be tested before they can be prescribed.  Describe the main steps in the development and testing of a new drug.  Give reasons for the different stages in drug testing.  Explain the terms placebo and double-blind trial. | 1 | Discuss drug safety and how drugs are tested today.  Find information from ABPI and BBC websites.  Use cards/cut-outs to sequence the stages in drug testing and trialling and explain the purpose of each stage.  Create flow diagram of stages in process.  Answer past questions about drug testing. | Evaluate methods used in the development of a new drug.  Use a model to explain the stages in the development of a drug. | ABPI – Resources for Schools - [Developing medicines](http://www.abpischools.org.uk/page/modules/infectiousdiseases_medicines/medicines4.cfm?coSiteNavigation_allTopic=1)  BBC Bitesize – [Drugs and the human body](http://www.bbc.co.uk/education/guides/zpn9q6f/revision/2)  AQA resources: [PowerPoint B1.3 Use and abuse of drugs](http://filestore.aqa.org.uk/subjects/gcsescienceassessment/B1-3-USE-AND-ABUSE-OF-DRUGS.PPT) |

### 4.3.2 Monoclonal antibodies

| **Spec ref.** | **Summary of the specification content** | **Learning outcomes**  *What most candidates should be able to do* | **Suggested timing (hours)** | **Opportunities to develop Scientific Communication skills** | **Opportunities to develop and apply practical and enquiry skills** | **Self/peer assessment opportunities and resources**  *Reference to past questions that indicate success* |
| --- | --- | --- | --- | --- | --- | --- |
| 4.3.2.1  4.3.2.2  Higher Tier only | Production and uses of MABs  MABs are produced from a single clone of cells. They are specific to one antigen, so target a specific chemical or cell in the body.  A lymphocyte that makes a specific antibody is combined with a tumour cell to form a hybridoma cell. This is cloned to produce many identical cells which all produce the specific antibody.  There are many uses for MABs.  MABs can have serious side effects. | Describe what MABs are, and how they are produced.  Describe the uses of MABs and explain how these work when given appropriate information:  Explain why MABs are not yet widely used in the body.  Evaluate the advantages and disadvantages of MABs. | 1–2 | Research MAB production and uses using ABPI and cancer research websites.  Draw a flow diagram to describe how MABs are produced.  Produce a poster to describe the uses of MABs  Marketplace activity: provide stations with information sheets and diagrams. Students fill in a summary table and use info to create a poster:   * for diagnosis, eg to bind to HCG in pregnancy tests * to measure levels of hormones and chemicals in the blood * to locate specific molecules in a cell using a fluorescent dye * to treat some diseases, eg to deliver a chemical to cancer cells without harming healthy cells.   Evaluate the advantages and disadvantages of MABs.  Discussion – would you choose to be treated with MABs? | Use a model to describe how MABs are produced.  Encourage students to appreciate the power and limitations of science by explaining technological applications of science and evaluate risks in relation to MABs. | ABPI – Resources for Schools – [Monoclonal antibodies](http://abpischools.org.uk/page/modules/infectiousdiseases_immunity/immunity5.cfm)  Cancer Research UK – [About monoclonal antibodies](http://www.cancerresearchuk.org/about-cancer/cancers-in-general/treatment/biological/types/about-monoclonal-antibodies) |

### 4.3.3 Plant disease

Plant diseases mentioned in 4.3.1.2 and 4.3.1.4 are covered here.

Detection and identification of plant diseases are Higher Tier only.

Active transport, 4.1.3.3, should be linked to absorption of mineral ions. The investigation has been included in 4.2.3.2, Plant organs.

There are links with 4.6.2.4 Genetic engineering to produce crops that are resistant to disease or insect attack.

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| --- | --- | --- | --- | --- | --- | --- |
| 4.3.3.1  4.3.1.2  4.3.1.4  4.3.3.1 | Plant disease  Plants can be infected by a range of viral, bacterial and fungal pathogens as well as by nematode worms and insects.  Tobacco mosaic virus affects many plants, eg tomatoes. Symptoms and effects of infection.  Rose black spot is a fungal disease spread by water or wind. Symptoms and effects of infection.  Aphids feed on the sap of plants and affect plant growth.  Ion deficiencies can damage plants, eg stunted growth by nitrate deficiency and chlorosis by magnesium deficiency. | Describe the symptoms and effects of Tobacco mosaic virus and its effects.  Describe the symptoms and effects of Rose black spot fungal infection  Explain how aphids affect plant growth.  Carry out a controlled investigation into the effects of nitrate and magnesium ion deficiencies and link to active transport (4.1.3.3 and see alternative investigations in 4.2.3.2). | 1 | Research the plant disease listed in the specification and produce a poster or presentation to include illustrations, symptoms and effects.  Make a video segment for ‘Gardeners’ World’ on plant diseases – how to recognise them and why they harm your plants (include section 4.3.3.1 Higher Tier work here too). Use ICT to include images etc. or make ‘model’ infected/healthy leaves to show.  Investigate the effect of mineral ions on plant growth and write a report (see 4.2.3.2). | Investigate the effect of mineral ions on plant growth (see 4.2.3.2). | Search internet using names of diseases.  Materials:   * tomato plants * pots * compost.   Grow cultures in solutions with and without minerals, eg magnesium and nitrates. |
| 4.3.3.1  Higher Tier only | Detection and identification of plant diseases  Detected by:   * stunted growth * spots on leaves * areas of decay (rot) * growths * malformed stems or leaves * discolouration * presence of pests.   Identification:   * using a gardening manual * taking infected plants to a laboratory * testing kits that use monoclonal antibodies. | Describe visual indications of plant disease, as described in the specification.  Describe methods that gardeners and scientists can use to identify the disease causing pathogen. | 0.5 | Observe an exhibition of plants or photographs showing evidence of plant disease (as listed in the specification) and garden manuals, internet websites, testing kits (HT).  Search for illustrations on the internet to include in a report (HT). | Make observations and drawings. | Exhibition materials:   * garden manuals * testing kits * plants or photographs showing disease.   BBC Gardening – [Advice: Pests and Diseases](http://www.bbc.co.uk/gardening/advice/pests_and_diseases/)  Gardenseeker.com – [Plant Pests, Diseases and Garden Problems](http://www.gardenseeker.com/plant_pests_problems/index.htm) |
| 4.3.3.2 | Plant defence responses  Plants have physical and chemical defence responses to resist the invasion of microorganisms.  There are also mechanical adaptations to deter animals from eating or touching them. | Describe the physical and chemical ways plants can resist microorganisms.  Describe mechanical adaptations to deter animals. | 0.5 | Recap leaf structure covered in 4.2.3.1 and relate to resisting invasion.  Mind Map – ideas about other plant defence responses and poisons produced by different plants. Discuss mechanical adaptations to deter animals from eating or touching plants.  Observe an exhibition to include large labelled illustrations of leaf structure, waxy leaved plants, tree bark, plants or pictures of plants that produce toxic/ antibacterial chemicals and plants with mechanical adaptations.  Design a ‘super plant’ – combining a range of defences. | Make observations and hypotheses about plant defences. | BBC Bitesize – [Plant defences](http://www.bbc.co.uk/schools/gcsebitesize/science/edexcel/problems_in_environment/infectiousdiseaserev4.shtml)  Exhibition materials:   * leaf structure model or picture * privet * tree bark * mint * witch hazel * tobacco * foxglove * deadly nightshade * holly * rose * gorse * mimosa etc.   DVD– Private life of plants (episode with defences). |