

GCSE (9–1)
Transition Guide

GATEWAY SCIENCE

BIOLOGY A

J247
For first teaching in 2016

KS3–KS4 focus
Global Challenges

Version 1



GCSE (9–1)

GATEWAY SCIENCE BIOLOGY A

Key Stage 3 to 4 Transition guides focus on how a particular topic is covered at the different key stages and provide information on:

- Differences in the demand and approach at the different levels;
- Useful ways to think about the content at Key Stage 3 which will help prepare students for progression to Key Stage 4;
- Common student misconceptions in this topic.

Transition guides also contain links to a range of teaching activities that can be used to deliver the content at Key Stage 3 and 4 and are designed to be of use to teachers of both key stages. Central to the transition guide is a Checkpoint task which is specifically designed to help teachers determine whether students have developed deep conceptual understanding of the topic at Key Stage 3 and assess their 'readiness for progression' to Key Stage 4 content on this topic. This checkpoint task can be used as a summative assessment at the end of Key Stage 3 teaching of the topic or by Key Stage 3 teachers to establish their students' conceptual starting point.

Key Stage 3 to 4 Transition Guides are written by experts with experience of teaching at both key stages.

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Key Stage 3 Content

- The consequences of imbalances in the diet, including obesity, starvation and deficiency diseases.
- The interdependence of organisms in an ecosystem, including food webs and insect pollinated crops.
- The impact of plant reproduction through insect pollination in human food security.
- How organisms affect and are affected by, their environment, including accumulation of toxic materials.
- Heredity as the process by which genetic information is transmitted from one generation to the next.
- Changes in environment may leave individuals within a species, and some entire species, less well adapted to compete successfully and reproduce, which in turn may lead to extinction.



Key Stage 4 Content

GCSE Content

- B6.1a - explain how to carry out a field investigation into the distribution and abundance of organisms in a habitat and how to determine their numbers in a given area
- B6.1b - describe both positive and negative human interactions within ecosystems and explain their impact on biodiversity
- B6.1c - explain some of the benefits and challenges of maintaining local and global biodiversity
- B6.1d - evaluate the evidence for the impact of environmental changes on the distribution of organisms, with reference to water and atmospheric gases
- B6.2a – describe some of the biological factors affecting levels of food security
- B6.2b - describe and explain some possible agricultural solutions to the demands of the growing human population
- B6.2c - explain the impact of the selective breeding of food plants and domesticated animals
- B6.2d - describe genetic engineering as a process which involves modifying the genome of an organism to introduce desirable characteristics
- B6.2e - describe the main steps in the process of genetic engineering
- B6.2f – explain some of the possible benefits and risks of using gene technology in modern agriculture
- B6.2g - describe and explain some possible biotechnological solutions to the demands of the growing human population

Key Stage 4 Content

- B6.3a - describe the relationship between health and disease
- B6.3b - describe different types of diseases
- B6.3c - describe the interactions between different types of disease
- B6.3d - explain how communicable diseases (caused by viruses, bacteria, protists and fungi) are spread in animals and plants
- B6.3e - explain how the spread of communicable diseases may be reduced or prevented in animals and plants
- B6.3f - describe a minimum of one common human infection, one plant disease and sexually transmitted infections in humans including HIV/AIDS
- B6.3g - describe physical plant defence responses to disease
- B6.3h - describe chemical plant defence responses
- B6.3i - describe different ways plant diseases can be detected and identified, in the lab and in the field
- B6.3j - explain how white blood cells and platelets are adapted to their defence functions in the blood
- B6.3k - describe the non-specific defence systems of the human body against pathogens
- B6.3l - explain the role of the immune system of the human body in defence against disease
- B6.3m - describe how monoclonal antibodies are produced
- B6.3n - describe some of the ways in which monoclonal antibodies can be used
- B6.3o - explain the use of vaccines and medicines in the prevention and treatment of disease
- B6.3p - explain the aseptic techniques used in culturing organisms

Key Stage 4 Content

- B6.3q - describe the processes of discovery and development of potential new medicines
- B6.3r - recall that many non-communicable human diseases are caused by the interaction of a number of factors
- B6.3s - evaluate some different treatments for cardiovascular disease
- B6.3t - analyse the effect of lifestyle factors on the incidence of non-communicable diseases at local, national and global levels
- B6.3u - describe cancer as the result of changes in cells that lead to uncontrolled growth and division
- B6.3v - discuss potential benefits and risks associated with the use of stem cells in medicine
- B6.3w - explain some of the possible benefits and risks of using gene technology in medicine
- B6.3x - discuss the potential importance for medicine of our increasing understanding of the human genome

Comment

Differences in the demand from Key Stage 3 to Key Stage 4

At Key Stage 3 learners will be familiar with the interdependence of organisms in an ecosystem and how organisms are affected by their environment, including the effects on population size after the removal of one group of organisms from a food chain, however they will not have learned ways of measuring populations sizes which is required at Key Stage 4. This area of understanding is also taken further at Key Stage 4 with a more detailed look at how humans in particular affect biodiversity by the reduction of land and hunting and what can be done to maintain biodiversity, including some of the challenges this entails.

Learners at Key Stage 3 will have gained knowledge of a healthy diet and the importance of insect pollinated crops in food security. At Key Stage 4 learners are expected to describe what factors affect food security and explain possible agricultural and gene technological solutions to increase food security. Learners should have some idea of DNA/genes forming our genetic make-up and this is built on at Key Stage 4 where learners will be able to explain how DNA/genes can be used to genetically modify organisms, giving examples of beneficial characteristics scientists can add to crops and farm animals to help meet the demand on global food sources.

During Key Stage 3 learners will have learned the effects of drugs and diet on health. At Key Stage 4 the focus is shifted towards communicable and non-communicable diseases; how lifestyle choices may affect our health, how the body defends itself against communicable diseases, how immunity is achieved, how technology and new medicines can be used to prevent, diagnose and treat diseases. Topics within this area that are fairly untouched at key stage therefore will be new to learners are how monoclonal antibodies are made and their uses, aseptic techniques, preclinical and clinical testing of new medicines and physical and chemical plant defence responses to disease.

Challenges learners face when tackling this topic at GCSE

There are a large number of key terms learners need to know and understand in this topic, therefore introducing these terms and regular recapping of them in a variety of ways such as DART exercises, key word bingo, odd-one-out, crosswords etc. will help learners remember the terminology and their meanings.

Although learners should not have any major difficulties with the different methods of sampling techniques to estimate distribution and abundance of population size, many will believe that selecting a sample randomly will select the sample evenly from the population i.e. the sample will be a miniature version of the population.

Learners may also understand that species have always gone extinct and losing a species does not affect humans directly and so we shouldn't worry about loss of biodiversity as it is natural. It is therefore important to highlight to learners that it is the rate of biodiversity loss as a result of human activity that is key (some sources state up to 1000 times the 'natural' rate). It may also be useful to have learners think about how other organisms are essential for human life such as plants to produce breathable air, decomposers to break down organic matter into nutrients for the crops we eat and insects, bees and birds to pollinate these crops.

The topic of selective breeding can be quite confusing for learners as some learners often think that it only occurs in animals and that it gets rid of 'bad' genes after one cross rather than selects genes coding for characteristics that are beneficial to humans over several generations. Some may also believe that two different species can be crossed to create a new species with the desired characteristics.

Within the topic of health there can be a number of misconceptions such as all micro-organisms are bad, antibiotics kill all micro-organisms, a person can get the disease from the vaccine, health is purely physical not mental, cancer is genetic. In addition, causes of cancer can be very confusing to learners who may have seen various articles in the media such as artificial sweeteners, mobile phones, antiperspirants and hair dye all being examples of carcinogens. It may be worth discussing as a class what learners already know about cancer and what causes it to dispel some of these myths.

Activities

Bioaccumulation in the food chain: Department of Environmental Conservation - New York

http://www.dec.ny.gov/docs/administration_pdf/ifnyfdwebbioacclp.pdf

A lesson plan to show how bioaccumulation occurs in an aquatic system. The lesson plan includes discussion questions to recap prior knowledge and introduce new content, instructions on how to carry out a role play modelling toxins in a food chain and a summary worksheet.

How bees pollinate flowers: agclassroom .org

http://www.agclassroom.org/ny/programs/pdf/login/buzzy_bee.pdf

A lesson plan recapping how insects pollinate plants, in this case bees pollinating apple trees. The role play in this lesson plan is particularly good to look at the effects the environment has on pollination of crops e.g. one variable teachers can choose to use is the application of insecticides on a particular orchard reducing the number of bees. Learners draw graphs of the results over a number of 'seasons' with varying environmental conditions.

Wind or insect pollinated?: Inquire Botany

[http://www.inquirebotany.org/uploads/files/lesson%20plan_wind%20and%20insect%20pollination\(NBGB\).pdf](http://www.inquirebotany.org/uploads/files/lesson%20plan_wind%20and%20insect%20pollination(NBGB).pdf)

A lesson plan that includes a card sort activity for learners to group pictures of wind and insect pollinated plants and discuss the features of these two types of plant.

Long term effects of unhealthy food choices: BBC Bitesize

<http://www.bbc.co.uk/education/clips/z82w2hv>

A short video clip that could be used to introduce and start a discussion about the importance of a healthy diet.

DNA - The recipe for life: BBSRC

<http://www.bbsrc.ac.uk/engagement/schools/keystage3/discovering-dna/>

Teaching instructions, notes and resources for a number of activities teaching learners about the basic structure of DNA, where it is found and how it is a 'recipe' for the organism it codes for. Activities include making shoe box cells, making cakes with and without a recipe, extracting DNA from onions and matching genetic coding to facial characteristics. Teachers could pick and choose which activities they feel are relevant to their learners needs.

Checkpoint task

The checkpoint task consists of two sections:

Plant structure, pollination and fertilisation

There are two task sheets, one for lower ability learners and one for higher ability learners. The teacher can choose the level that best suits the class or give groups of learners within the same class different level task sheets. The key idea to bring from Key Stage 3 to Key Stage 4 in this topic is the understanding that pollination is crucial to crop yield and therefore if anything was to reduce the number of insect pollinators, food security would be compromised.

How diet and genetics can affect a person's health

Learners can work through the tasks independently or in pairs at the beginning of the B6 topic at Key Stage 4 to aid planning and delivery of subsequent B6 lessons. The task may also be broken up into separate tasks and completed after the relevant topic area has been delivered at Key Stage 3 to check understanding.

Teacher Preparation

Teachers will need to photocopy one task sheet per learner.

Teacher Instructions and Answers

If learners are completing the tasks independently, they require only the task sheet most suitable to their ability.

It may be useful to have a short task on the classroom whiteboard for learners to complete if they finish the activities before the given time is up.

Answers to the task sheets can be found on the teacher sheets.

Checkpoint Task:

<http://www.ocr.org.uk/Images/370026-global-challenges-checkpoint-task.docx>

Activities

Capture-recapture

http://www.sciencetakeout.com/wp-content/themes/accelerate/images/teacher_guides/111.pdf

An activity modelling the capture-recapture techniques using bags, paper shreds and plastic spiders. Learner sheet includes instructions, questions about results and how different factors would affect percentage error and sample exam-style questions at the end.

Random sampling: Nuffield Foundation

<http://www.nuffieldfoundation.org/practical-biology/biodiversity-your-backyard>

Teacher instructions for how to carry out random sampling of an area using quadrats. The Teaching Notes section contains a number of different hypothesis learners could measure.

Deforestation: Institute for Humane Education

<http://humaneeducation.org/wp-content/uploads/2013/12/Deforestation2013.pdf>

An online activity initially looking at the loss/gain of forest ecosystems followed by research into why deforestation occurs and benefits and negative consequences. This resource introduces the idea of monoculture and teachers may want to expand this area.

Factors affecting crop growth: New York Times

http://learning.blogs.nytimes.com/2007/06/19/its-not-just-a-bug/?_r=1

A lesson plan looking at the challenges farmers face growing crops. The first part introduces some of the challenges and asks learners to think about possible solutions using an article based on a specific crop pest in California. This is followed by a role play modelling the effect of a new species of pest, use of pesticides and monoculture vs. variety within crops. Finally learners write an agricultural plan for a farm.

Selective breeding and genetic engineering: STEM Learning

<https://www.stem.org.uk/elibrary/resource/28715/selective-breeding-and-genetic-modification>

A fun video explaining how scientists select features that are beneficial to what they need and how that is different to genetic engineering.

Increasing the yield of tomato plants: California Foundation for Agriculture in the classroom

<http://archives.lessoncorner.com/e9f8ef1e4c901b193.pdf>

A series of info sheets and instructions for small group presentations on improving tomato harvesting, selective breeding and genetic modification of tomato crops. Teachers may pick the info sheets they think relevant to their learners.

Pro's and cons of genetic engineering: The Guardian

<http://www.theguardian.com/teacher-network/teacher-blog/2013/jan/06/gm-crops-farming-resources-news-lessons>

This website gives a number of links to articles and other websites that learners will find a good starting point for research into the benefits and risks of genetically modifying of crops and animals for food as well as in medicine.

How communicable diseases spread between humans: Yourgenome.org

<http://www.yourgenome.org/activities/>

This website has links to numerous activities teachers will find useful. For this topic area the following activities could easily be done in the classroom to show how microbes can be passed from one person to another: Sneeze zone, Handshake hazard and Contamination detective.

Antibiotics: Nuffield Foundation

<http://www.nuffieldfoundation.org/sites/default/files/antibiotic-role-play-33.doc>

An activity that supports learners write a short role play of a doctor and parent who wants antibiotics for their child. Information learners will need to include in the role play is: what is a virus, why will antibiotics not work, why patients need to finish the full course of antibiotics and the difference between antibiotics and vaccines.

Aseptic techniques: MicrobiologyOnline.org

<http://www.nuffieldfoundation.org/practical-biology/aseptic-techniques>

and

<http://microbiologyonline.org/file/fa3f7a18b16eef6c8eb80069a17c4bcc.pdf>

and

<http://microbiologyonline.org/file/c89f015377ba698f508f2cbcd3db6abf.pdf>

Two booklets based on aseptic techniques for growing and testing micro-organisms. The first booklet includes a number of practical activities learners can do, testing the effectiveness of different antiseptics/antibiotics is a particularly good and relevant practical. Learner and teacher sheets are included. The second booklet is great for teachers who have not taught aseptic techniques previously. It includes all the information a teacher needs about the procedures including step by step instructions for various aseptic practical activities and safety issues.

Clinical trials: Nuffield Foundation

<http://www.nuffieldfoundation.org/sites/default/files/clinical-trials-97.pdf>

and

<http://www.nuffieldfoundation.org/sites/default/files/drug-development-march-08-120.pdf>

Three activities from the Nuffield Foundation. The first activity gets learners thinking about the different variables in a clinical trial and how they may affect results. The second activity involves a card sort of the stages in a clinical trial and why each stage is carried out. The third activity is a set of exam-style questions to check learners understanding of what they have learned. Teacher will want to adapt some of this resource for lower ability learners.

CVD risk factors: Nuffield Foundations

<http://www.nuffieldfoundation.org/science-society/activities-lifestyle-and-health>

A website with links to a number of activities. The CHD risk game is an excellent board game for learners of all abilities highlighting factors that can increase and decrease the chance of a person developing cardiovascular disease.

Uses for stem cells in medicine: EuroStemCell

<http://www.eurostemcell.org/toolkititem/all-about-stem-cells-flexible-stem-cell-teaching-tool>

A resource that includes information, worksheets and poster templates for learners to complete presentations about the various uses of stem cells in medicine. There are different resources for two age ranges are 11-14 and 16+. Teachers may decide to use the 11-14 resources for lower ability learners and 16+ resources for a higher ability group.

Activities

Malaria: Yourgenome.org

<http://www.yourgenome.org/activities/malaria-challenge-managing-malaria>

An activity that can be used for more able learners either in class or as a homework/extension activity to learn more about how protists spread Malaria. Learners take the role of Programme manager for a community in Africa and use the information to work out a strategy for eliminating the disease in the community.

Biological control vs pesticides: Eden Project

<http://www.edenproject.com/learn/schools/lesson-plans/whats-eating-you>

A lesson plan including activities about interdependence within a rainforest biome. The two activities from the lesson plan that can be used here are: 'Biocontrol and pesticides' which is a card sort covering the issues surrounding both these types of pest elimination, followed by 'Signage' where learners use the information from the card sort to make a sign for to go in the biome informing the public about the need to control pests, how it can be done and the difference between biocontrol and pesticides. Teachers will want to use the other resources highlighted in this section to introduce the task to learners and learners may then complete the task either in class or as homework.

Genetic modification in salmon: PBS Learningmedia

<http://www.pbslearningmedia.org/resource/tdc02.sci.life.gen.salmon/super-salmon/>

A video explaining how genetic modification has been used to increase the growth of salmon over a much shorter period of time and the issues surrounding these salmon being grown in outdoor tanks where they may escape. Learners could use this to write a summary of the pros and cons of genetically modifying salmon and whether they think that the salmon farmer should be allowed to grow his salmon in outdoor tanks, justifying their decision.

Resources, links and support

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