

Biology

Big idea (age 11-14)

BHD: Health and disease

What's the big idea?

Organisms must stay in good health to survive and thrive; the health of an individual organism results from interactions between the organism's body, behaviour, environment and other organisms.

Key concepts

The big idea is developed through a series of **key concepts** at age 11-14, which have been organised into teaching topics as follows:

Topic BHD1

What are health and disease?

Key concepts:

- BHD1.1 Good and ill health
- BHD1.2 Disease

Topic BHD2

Human lifestyles and health

Key concepts:

- BHD2.1 Diet and exercise

Topic BHD3

Health and infectious disease

Key concepts:

- BHD3.1 Pathogens
- BHD3.2 Preventing infection

The numbering gives some guidance about teaching order based on research evidence on learning pathways and effective sequencing of ideas. However, the teaching order can be tailored for different classes as appropriate.

This document last updated: December 2019

Guidance notes

In England, the National Curriculum programme of study for science requires students to learn about the effects of diet, exercise and drugs on the human body from age 6; aside from requiring basic understanding at age 6 of the importance of personal hygiene, students are not required to learn about pathogens and infectious diseases until age 14; there is no explicit requirement to learn about mental health at any stage (Department for Education, 2013b; 2013a; 2014).

Extensive curriculum development work undertaken by the Royal Society of Biology (RSB) in the UK (McLeod, 2018) and the American Association for the Advancement of Science (AAAS Project 2061, 2009) advocates learning about good and ill physical and mental health, and about the causes of both infectious and non-infectious diseases, in science lessons from age 5.

The school curriculum has an important role to play in developing the health literacy of young people (IUHPE, 2010; Paakkari and Paakkari, 2012; Kilgour et al., 2015; Bruselius-Jensen, Bonde and Christensen, 2017), and research has shown that the development of health literacy in children is important in reducing the incidence of disease (e.g. Hanson and Gluckman, 2011).

The learning progression presented on the following pages and the associated resources developed for *Best Evidence Science Teaching* adopt the approach advocated by the RSB and the AAAS, and also draw on guidance from the Mental Health Foundation (2019), with the aim of developing physical and mental health literacy throughout compulsory science education.

Learning progression

The science story associated with the big idea develops from age 5 to age 16, and could be summarised as follows:

Science story at age 5-11

Health

The physical health and the mental health of an organism can range from good to ill.

Diet, exercise and behaviour have impacts on the functions of the human body. Humans and other animals need to eat appropriate amounts of different types of food and get appropriate amounts of exercise to stay in good health.

Diseases are one cause of ill health. Medicines can be used to treat the symptoms of some diseases, and to cure some diseases by eliminating the cause.

Human lifestyles and health

Eating too much or too little of particular foods, lack of exercise, smoking, and drinking alcohol can lead to physical and mental ill health, including some diseases. These diseases cannot be passed from one person to another; they are caused by a person's lifestyle and behaviour. Changes in lifestyle and behaviour can help to prevent these diseases or reduce their effects.

Health and infectious disease

Some diseases in humans, other animals and plants are caused by infection by germs, including some bacteria and viruses, which are usually too small to see. Germs can be passed from one organism to another via surfaces, body fluids, food, water and animals (e.g. insects).

Good personal hygiene, including washing hands and brushing teeth, can help to prevent ill health by removing germs. Proper refrigeration and cooking of food can help to prevent germs in food from making us ill. Vaccinations help the body to fight the germs that cause some diseases.

Science story at age 11-14

Health

The physical and mental health of an individual organism result from interactions between the organism's body, behaviour, environment and other organisms. Changes in the normal appearance, functions and behaviour of an organism can be signs or symptoms of ill health.

The good health of all organisms can be compromised by disease. Diseases can be caused by germs, lifestyle, environment, and information in the genome. Some factors increase or decrease the risk of disease.

Diseases caused by bacteria and fungi can be treated using antimicrobial medicines, but diseases and ill health caused by other factors, including viruses, cannot.

Human lifestyles and health

Humans need to eat a diet made up of appropriate amounts of carbohydrates, lipids (fats and oils), proteins, vitamins, minerals, dietary fibre and water. Eating too much or too little of particular foods can increase the risk of physical and mental ill health. Humans also need appropriate amounts of exercise, which has short-term and long-term effects on the body, including the gas exchange system and the circulatory system.

To stay in good health, an individual must maintain a balance between the amount of food they eat (their energy intake) and the level of activity (which requires energy) in their daily life. Variation between individuals and their lifestyles, including how active they are, affects their dietary requirements. Making changes in lifestyle and behaviour, such as diet and exercising, can help to reduce the risk of ill health.

Infectious disease

The health of humans, other animals and plants can be affected by diseases caused by infection by pathogens, including viruses, and some bacteria and fungi. Pathogens are usually too small to be seen without a microscope. Microorganisms are present on and in the human body all the time; most are not pathogens, and some form part of our defences against pathogens. Symptoms of disease appear when the body's cells or systems have been damaged or are not working normally. An organism may not always show symptoms after infection with a pathogen; pathogens only cause symptoms when they are present in sufficient numbers.

Humans have non-specific defences against pathogens, including physical defences (skin, mucus, and blood clots to seal wounds), chemical defences (stomach acid, and antimicrobial substances in saliva, mucus and tears), and microbial defences (bacteria on the skin and in the gut). The spread of pathogens that cause diseases in humans, and the risk of infection, can be reduced by practices including effective hygiene and sanitation, proper storage and preparation of food, vaccination, and use of contraception during sexual activity.

Plants have non-specific defences against pathogens, including physical defences (waxy cuticle and cell walls) and chemical defences (antimicrobial substances). The spread of pathogens that cause diseases in plants, and the risk of infection, can be reduced by practices including regulating the movement of plant material, polyculture farming, crop rotation, and chemical and biological control.

Science story at age 14-16

Health

Health is not just the absence of disease, but is a measure of an individual's ability to function and cope with physical, emotional, environmental and social challenges. Individual people and government organisations have some responsibility for maintaining good health within populations. Studying data on factors associated with good and ill health at local, national and global levels can help us to devise strategies to promote good physical and mental health. Strategies that promote good health by reducing the risk of developing ill health have benefits compared to treatments administered later.

Antimicrobials (including antibiotics) used to treat some diseases are becoming less effective due to the evolution of resistant microorganisms, and their use must be carefully controlled.

Discovering and developing new medicines involves studying the genomes and proteins of pathogens and host cells to identify targets for new medicines. Large libraries of substances are screened for their ability to affect a target. All new medicines have to be tested before they are made widely available. Preclinical testing uses cultured human cells and animals to test for safety and effectiveness; clinical testing uses healthy human volunteers to test for safety, and humans with the disease to test for safety and effectiveness.

Human lifestyles and health

Whether or not a person develops a non-communicable disease depends on many interacting factors, including the information stored in their genome, their environment and aspects of their lifestyle. The interaction of these factors can increase or decrease the risk of developing non-communicable diseases including: cardiovascular diseases; cancers; lung, liver and kidney diseases; mental ill health; and diseases related to nutrition, including type 2 diabetes.

Some aspects of mental ill health can be explained by changes in the central nervous system.

Infectious disease

The immune system of the human body includes white blood cells that help to protect us against disease by destroying pathogens. White blood cells have receptors that recognise antigens on pathogens, to distinguish between self and non-self. Different types of white blood cell are adapted to either ingest and digest pathogens, or produce antibodies to disable pathogens or tag them for attack by other white blood cells. An antibody is specific for (only recognises) a particular antigen. Once the body has made antibodies against a pathogen, white blood cells called memory cells stay in the body to make antibodies quickly upon re-infection – this is immunity.

Vaccinations include disabled pathogens or parts of pathogens, and establish immunity by triggering an immune response and the creation of memory cells. The spread of infectious diseases can be controlled by vaccinating a large proportion of the population.

Plants do not have circulating immune cells and do not produce antibodies, but they have a simple immune system. For example, plants can make antimicrobial substances in response to pathogens. Protection of plants against disease caused by pathogens is important in human food security.

Effective treatment of a communicable disease depends on identification of the disease and the pathogen causing it. Identification techniques include observing symptoms and taking samples of tissue or body fluid for cell counting, culture, microscopy, staining, testing with antimicrobials, and genome analysis. Isolation and reinfection can be used to identify plant pathogens. Correct identification relies on use of aseptic techniques to avoid contamination.

References

- AAAS Project 2061. (2009). *Benchmarks for Science Literacy* [Online]. Available at: <http://www.project2061.org/publications/bsl/online/index.php>.
- Bruselius-Jensen, M., Bonde, A. H. and Christensen, J. H. (2017). Promoting health literacy in the classroom. *Health Education Journal*, 76(2), 156-168.
- Department for Education (2013a). *Science programmes of study: key stage 3 - National curriculum in England (DFE-00185-2013)*, London, UK.
- Department for Education (2013b). *Science programmes of study: key stages 1 and 2 - National curriculum in England (DFE-00182-2013)*, London, UK.
- Department for Education (2014). *Science programmes of study: key stage 4 - National curriculum in England (DFE-00677-2014)*, London, UK.
- Hanson, M. and Gluckman, P. (2011). Developmental origins of noncommunicable disease: population and public health implications. *The American Journal of Clinical Nutrition*, 94, 1754S-1758S.
- IUHPE. (2010). *Promoting Health in Schools: From evidence to Action* [Online]. International Union for Health Promotion and Education. Available at: https://www.iuhpe.org/images/PUBLICATIONS/THEMATIC/HPS/Evidence-Action_ENG.pdf.
- Kilgour, L., et al. (2015). Health literacy in schools: prioritising health and well-being issues through the curriculum. *Sport, Education and Society*, 20(4), 485-500.
- McLeod, L. (2018). Developing a framework for the biology curriculum. *School Science Review*, 100(370), 23-29.
- Mental Health Foundation. (2019). *RE: Biology curriculum content [Personal communication]*.
- Paakkari, L. and Paakkari, O. (2012). Health literacy as a learning outcome in schools. *Health Education*, 112(2), 133-152.