*Biology> Big idea BHD: Health and disease > Topic BHD1: What are health and disease?*

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| **Key concept (age 11-14)** |
| **BHD1.2: Disease** |

**What’s the big idea?**

A big idea in biology is that 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.

**How does this key concept develop understanding of the big idea?**

This key concept helps to develop the big idea by exploring the idea that the good health of organisms can be compromised by diseases, which have a variety of causes.

The conceptual progression starts by checking understanding of the idea that all organisms, not just humans, can be affected by disease. It then supports the development of understanding of the differences between infectious and non-infectious diseases, the appropriate use of medicine and treat diseases, and appreciation of ideas about risk.

**Using the progression toolkit to support student learning**

Use diagnostic questions to identify quickly where your students are in their conceptual progression. Then decide how to best focus and sequence your teaching. Use further diagnostic questions and response activities to move student understanding forwards.

**Progression toolkit: Disease**

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| **Learning focus** | The good health of organisms can be compromised by infectious and non-infectious diseases, which can be caused by germs, lifestyle, environment, or information in the genome. | | | | |
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| **As students’ conceptual understanding progresses they can:** | **C o n c e p t u a l p r o g r e s s I o n** | | | | |
| Recall that the good health of all organisms can be compromised by diseases.  **P** | Recall that diseases can be caused by germs, lifestyle, environment or information in the genome. | Distinguish between infectious and non-infectious diseases. | Explain that medicines, including antibiotics, can be used to treat the cause or symptoms of some diseases. | Apply the idea that some factors increase or decrease the risk of disease. |
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| **Diagnostic questions** | Only humans? | What causes disease? | Can they catch it? | Antibiotics | Disease – cause and effect |
| Plant diseases | Passing it on |
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| **Response**  **activities** | Plant disease detectives | What would happen if… |  | Antibiotics and resistance |  |

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| Key: | | | |
| **P** | Prior understanding from earlier stages of learning | **B** | Bridge to later stages of learning |

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| **Only humans?** | **Plant diseases** | **What causes disease?** | **Passing it on** | **Can they catch it?** |
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| Simple multiple choice | Two-tier multiple choice | Drawing | Two-tier multiple choice | Two-tier multiple choice |
| **Antibiotics** | **Disease – cause and effect** | **Plant disease detectives** | **What would happen if…** | **Antibiotics and resistance** |
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| Two-tier multiple choice | Confidence grid | Fieldwork | Discussion | Challenge to thinking, media |

**What’s the science story?**

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

Diseases are one cause 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.

Medicines can be used to treat the symptoms of some diseases, and to cure some diseases by eliminating the cause. Diseases caused by bacteria and fungi can be treated using antimicrobial medicines, but diseases and ill health caused by other factors, including viruses, cannot.

**What does the research say?**

*Learning about health and disease*

Over recent decades, a rapidly growing body of research has considered the promotion, measurement and effects of *health literacy* within populations. Put simply, health literacy at the individual level enables a person to access, understand, appraise and use information to make informed decisions about their health. The school curriculum has an important role to play in developing health literacy (IUHPE, 2010; Paakkari and Paakkari, 2012; Kilgour et al., 2015; Bruselius-Jensen, Bonde and Christensen, 2017). 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), and that efforts to improve the health literacy of school children can have impacts on their behaviour (e.g. Park et al., 2017).

*Developing a broader view of disease*

Health literacy includes both physical health literacy and mental health literacy (Kutcher et al., 2016). Health literacy can be developed in schools through the science curriculum as well as through specific curriculum strands related to social, health, sex and relationships education. In England, the current 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; and students are only required to to learn about plant diseases from age 14, a requirement that was introduced for the first time in 2014 (Department for Education, 2013b; 2013a; 2014).

Extensive curriculum development work undertaken by the Royal Society of Biology 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. A focus only on disease in humans would provide an undesirably restricted view, and could lead to (or reinforce) the misunderstanding that only humans get diseases.

Learning about plant diseases is important due to the interdependence of organisms; for example, plant disease has a significant impact on human food security. It has been estimated that plant pests and pathogens are responsible for approximately 12.5% of global crop losses (Oerke, 2006), and for losses of up to 42% of the annual production of the six most important food crops (Guest, 2012).

*Understanding the concepts of illness and disease*

Searching the education research literature for keywords such as ‘health’, ‘wellbeing’, ‘illness’ and ‘disease’ produces an enormous array of papers on managing students’ and teachers’ health issues in the classroom, and the effects of specific examples of ill health on learning. It can be challenging to locate, from amongst all of this, research into students’ understanding of disease as a concept, and into effective teaching approaches to developing such understanding. Some papers that provide useful insights are summarised here. (Note: Further research into students’ understanding of the causes of non-infectious and infectious diseases is summarised in topics BHD2 *Human lifestyles and health* and BHD3 *Infectious disease*, respectively.)

Ill health (or “illness”) can be defined as deviation from the ‘normal’ appearance, functions and behaviour of an organism, although defining ‘normal’ and what constitutes a deviation from it even for an individual organism is not necessarily straightforward (Boruchovitch and Mednick, 2002). Diseases are one cause of ill health.

Bibace and Walsh (1980) describe six stages of children’s developing understanding of illness in a widely accepted model as follows:

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| **Stage of understanding** | **Conception of what causes illness** | **Conception of how or why illness arises** |
| Phenomenism | Something external to the body and remote from it in space or time (e.g. the Moon) | ‘Magically’, or no concept |
| Contagion | Something external to the body but in close proximity to it (e.g. a sick person sitting nearby) | ‘Magically’, or ‘immanent justice’ (punishment for misbehaviour), or no concept |
| Contamination | Something external to the body that has touched it | Physical contact with the cause (e.g. germs) |
| Internalisation | Something external to the body that is taken inside the body | Inhaling or swallowing the cause (e.g. germs); no concept of effects on body systems |
| Physiological | Various causes that affect internal structures, including lifestyle or something external to the body that is taken inside it | Disruption to normal functioning of body cells/organs |
| Psychophysiological | Various causes that affect internal structures, including lifestyle, or something external to the body that is taken inside it, or psychological processes such as stress | Sophisticated explanations of how internal systems are affected (e.g. link between stress, blood pressure and effects on the blood vessels and heart in cardiovascular disease) |

When children aged 14-15 in Turkey were asked to draw and write about disease (Isik, Çetin and Özarslan, 2017), the major themes in their answers were:

* names of specific diseases (most commonly measles, followed by flu, cold and cancer)
* causes of disease (most commonly microbes [58% of answers in which a cause was mentioned], malnutrition [15%], cigarettes and alcohol [11%], and dirty environment [9%])
* consequences of disease (most commonly fatigue, being sick, death and pain).

Similar results were observed when children aged 8-11 in Hungary were asked to draw and write about causes of disease (Piko and Bak, 2006). One student out of 81 in the Turkish study drew a “faded flower” that was said to be “sick”; all other answers pertained to humans. Ideas about mental health did not appear in the children’s drawings, but did appear in 17% of written answers.

It was not reported that any children in the Turkish and Hugarian studies included inheritance, genes, DNA or the genome as causes of disease in their answers. Raman and Gelman (2005) used fictional ‘switched at birth’ scenarios to investigate whether children aged 5-11 could attribute different modes of transmission to genetic disorders and infectious diseases. They found that children’s ability to link genetic disorders to birth parents (rather than to adoptive parents) increases with age, and that even the youngest children were capable of deducing the correct mode of transmission of a disease (i.e. contagion or inheritance) with a better success rate than chance when given appropriate cues. Fictional diseases were used to rule out the effects of prior knowledge of modes of transmission of particular diseases. Results suggested that the key cue used by children to decide whether a disease was more likely to have been acquired by inheritance or contagion was whether the disease was said to be permanent or temporary.

There is evidence that children up to age 11 appreciate that environmental factors, which are not germs, can cause ill health. The most commonly cited factors were pollen, exhaust fumes from vehicles, and smoke from cigarettes (passive smoking); other factors mentioned included dust, “air pollution”, factories, rubbish dumps, and “polluted water” (Woods et al., 2005; Pluhar et al., 2009).

Various researchers have investigated children’s ability to differentiate between infectious and non-infectious diseases, including some serious diseases such as HIV/AIDS and cancer (Sigelman et al., 1993; Bares and Gelman, 2008). Bares and Gelman (2008) found that children aged 5 reasoned about cancer and colds in similar ways, including that they were both contagious; by age 7 the children began to distinguish between cancer and colds in some aspects, including the seriousness, length and prognosis of the diseases; only at age 10 did the children begin to understand that cancer was not transmitted by contagion. Sigelman et al. (1993) noted that when children lack knowledge of a specific disease, they tend to draw upon their experiences with common childhood diseases such as colds and measles, and thus assume that all diseases are infectious; this can also lead them to assume that risk factors for common infectious diseases are also risk factors for non-infectious diseases.

**Guidance notes**

As noted above, curriculum development work undertaken by the Royal Society of Biology (RSB) and the American Association for the Advancement of Science (AAAS) advocates learning about good and ill physical and mental health, and about the causes of both communicable and non-communicable diseases, from the beginning of compulsory science education. The *Best Evidence Science Teaching* resources produced to support the development of the ‘health and disease’ big idea 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.

This key concept (BHD1.2 *Disease*) and the preceding one (BHD1.1 *Good and ill health*) probe and develop students’ understanding of health and disease as concepts. Understanding of the effects of specific lifestyle factors on health (including diet, exercise, asthma and recreational drug use) is developed further in topic BHD2 *Human lifestyles and health*. Understanding of pathogens and the spread of infectious diseases is developed further in topic BHD3 *Infectious disease*.

This key concept (BHD1.2 *Disease*) probes and helps to develop the idea that genetic information inherited as part of the genome can be one cause of disease. It draws upon, and uses the genomic language of, topic BHL1 *Inheritance and the genome*, which could therefore be considered a prerequisite.

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