*Biology> Big idea BHL: Heredity and life cycles > Topic BHL1: Inheritance and the genome > Key concept BHL1.2: The structure and function of the genome*

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| **Response activity** |
| **From genes to characteristics** |

**Overview**

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| Learning focus: | The structure and function of organisms depends on proteins made by cells using instructions stored in the DNA of the genome. |
| Observable learning outcome: | Apply the idea that cells use the information coded in regions of the genome called genes as instructions to make structural and functional proteins. |
| Activity type: | Discussion, concept mapping |
| Key words: | gene, genome, protein |

This activity can help develop students’ understanding of the relationship between genes, proteins and characteristics through a concept mapping task. It can be used in response to the following diagnostic questions:

* Diagnostic question: Genes

**What does the research say?**

Lewis and colleagues (Lewis, Leach and Wood-Robinson, 2000; Wood-Robinson, Lewis and Leach, 2000; Lewis and Kattmann, 2004) have reported common misunderstandings about genes in school children, including that genes and characteristics/traits are the same thing (e.g. ‘blue eyes’ is a gene) and that genes are ‘particles’ that carry a characteristics/trait.

Children can struggle to explain how genes affect characteristics because of the need to link together understanding at various interacting levels, including the visible trait/phenotype level (e.g. hair colour), the metaphorical information level (e.g. the ‘genetic information’ that can affect hair colour), and the microscopic/molecular structural level (e.g. regions of the genome in which information that can affect hair colour is encoded) (Lewis and Kattmann, 2004; Duncan and Reiser, 2007).

Dreyfus and Jungwirth (1988) found that many 16-year-olds struggled to explain how cells carry out life processes. Even students who could identify the correct cell organelles could not explain how they carry out their functions, especially how the nucleus ‘controls’ the structure and functions of a cell.

Lewis (2004) notes that “when gene and characteristic are seen as equivalent there is little intellectual need to consider how a gene might be transformed into the characteristic”. It may be helpful to establish early the idea that genes store information that is used as instructions to build structural and functional proteins that affect our characteristics; students will be less likely to conflate genes and traits, and may be more receptive to learning about the mechanisms of gene expression, transcription and translation later in their education (Pavlova and Kreher, 2013).

Researchers have used constructivist approaches that enable students to build their own explanations of the structure and function of the genome, which may help to develop students’ understanding and overcome misconceptions, including the use of group discussions and concept/knowledge mapping (Okebukola, 1990; Nesbit and Adesope, 2006).

**Ways to use this activity**

Students should complete this activity in pairs or small groups. The focus of the activity should be on group discussion to reach a consensus on how the concept map should be completed. It is through the discussions that students can check their understanding and develop their explanations. Listening in to the conversations of each group will often give you insights into how your students are thinking.

The quality of the discussions can be improved with a careful selection of groups; or by allocating specific roles to students in the each group. For example, you may choose to select a student with strong prior knowledge as a scribe, and forbid them from contributing any of their own answers. They may question the others and only write down what they have been told. This strategy encourages contributions from more members of each group.

After their discussions, each group should be prepared to report the key points of their discussion to another group, or to the class.

*Differentiation*

For some groups, the concept student worksheet could be provided with some of the empty boxes already filled in.

**Equipment**

For each pair/group:

* student worksheet (comprising concept map template)
* cards printed and cut out from the next page of this document, for groups to sort onto the concept map template

**Expected answers**

See page 4.

**Acknowledgments**

Developed by Alistair Moore (UYSEG).

**References**

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Pavlova, I. V. and Kreher, S. A. (2013). Missing links in genes to traits: toward teaching for an integrated framework of genetics. *American Biology Teacher,* 75(9)**,** 641-649.

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**Print and cut out cards for card-sort activity**

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|  |  |  |  |
| --- | --- | --- | --- |
| lifestyle and environment | regions of DNA | other regions of DNA | the information coded in genes |
| structural proteins | functional proteins | build and repair  the body | interact with  other substances |
| interact  with radiation | myosin in muscles | collagen in skin | lifestyle and environment |
| enzymes that catalyse reactions | antibodies that recognise pathogens | receptors on cells that recognise hormones in the blood | light receptors  in the eyes |

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|  |  |  |  |
| --- | --- | --- | --- |
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**Expected answers**

Genes are…

regions of DNA

the information coded in genes

Cells use…

myosin in muscles

For example…

collagen in skin

For example…

enzymes that catalyse reactions

For example…

antibodies that recognise pathogens

For example…

receptors on cells that recognise hormones in the blood

For example…

light receptors

in the eyes

For example…

lifestyle and environment

can affect how…

other regions of DNA

can affect how…

to make…

structural proteins

functional proteins

build and repair

the body

to…

interact with radiation

to…

interact with

other substances

to…

lifestyle and environment

can affect…

For example…

For example…

For example…

For example…

For example…

can affect…

For example…

to…

to…

to…

to make…

can affect how…

can affect how…

Cells use…

Genes are…

**How our genes can affect our characteristics**