**Genome numbers game**

**To talk about in your group**

Which number would you put in each box to match the clues?

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| --- | --- | --- |
|  |  | **Box A**  **Clue:**  The number of copies of the genome in a human body cell. |

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| --- | --- | --- |
|  |  | **Box B**  **Clue:**  The number of **individual** chromosomes in a human body cell. |

|  |  |  |
| --- | --- | --- |
|  |  | **Box C**  **Clue:**  The number of **pairs** of chromosomes in a human body cell. |

|  |  |  |
| --- | --- | --- |
|  |  | **Box D**  **Clue:**  The approximate number of genes in a human chromosome. |

|  |  |  |
| --- | --- | --- |
|  |  | **Box E**  **Clue:**  The percentage of the human genome that is genes. |

*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** |
| **Genome numbers game** |

**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: | Distinguish between the terms DNA, chromosome, gene and genome. |
| Activity type: | Discussion |
| Key words: | DNA, chromosome, gene, genome |

This activity can help develop students’ understanding of the hierarchical relationship between DNA, genes, chromosomes and genomes through a discussion-based task. It can be used in response to the following diagnostic questions:

* Diagnostic question: DNA, chromosomes, genes and genomes

**What does the research say?**

Numerous researchers have reported that students mix up the terms ‘gene’, ‘chromosome’ and ‘DNA’, perhaps thinking that they are synonyms, and struggle to understand the relationship between them (e.g. Lewis, Leach and Wood-Robinson, 2000; Lewis and Kattmann, 2004; Donovan and Venville, 2012).

Recent estimates suggest that genes (“coding” regions of DNA whose sequences encode the order in which amino acids are joined together to make proteins) make up less than 2% of the DNA in the genome (Pennisi, 2007); up to 80% of the remaining “non-coding” DNA – historically mischaracterised as “junk” – is important in controlling gene expression (how and when genes are used to make proteins).

Science education researchers have acknowledged that teaching and learning about inheritance and genetics at school must aim to prepare students to live and work in the genomic era, in which the genomes of many organisms have been sequenced and the study of whole genomes (rather than just genes) generates numerous applications and implications for our everyday lives (Stern and Kampourakis, 2017). Up to the age of 14, a useful approach may be to embed ‘pro-genomics’ and ‘pre-genomics’ practices – for example, use of language and concepts that dispose students to thinking about whole genomes rather than just genes, and ensuring that students understand the difference between DNA, chromosomes, genes and the genome (Airey, Moore and Bennett, 2018).

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 (e.g. Lewis and Kattmann, 2004).

**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 which number to put in each box. 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*

The groups could be provided with number cards, printed and cut out from the last page of this document, to sort into the correct boxes. Or for a more challenging activity, the cards could be withheld and the groups asked to write numbers in the boxes.

**Equipment**

For each pair/group:

* number cards, printed and cut out from the last page of this document (optional)

**Expected answers**

Box A: 1 Box B: 46 Box C: 23 Box D: Thousands Box E: 2

**Acknowledgments**

Developed by Alistair Moore (UYSEG).

**References**

Airey, J., Moore, A. and Bennett, J. (2018). Viewed as a whole: syntheses of research evidence and teaching support resources related to genomics education in schools. A report to the Wellcome Genome Campus Public Engagement Team: University of York, UK.

Donovan, J. and Venville, G. J. (2012). Exploring the influence of the mass media on primary students' conceptual understanding of genetics. *Education 3-13,* 40(1)**,** 75-95.

Lewis, J. and Kattmann, U. (2004). Traits, genes, particles and information: re-visiting students' understandings of genetics. *International Journal of Science Education,* 26(2)**,** 195-206.

Lewis, J., Leach, J. and Wood-Robinson, C. (2000). All in the genes? Young people's understanding of the nature of genes. *Journal of Biological Education,* 34(2)**,** 74-79.

Pennisi, E. (2007). DNA study forces rethink of what it means to be a gene. *Science,* 316(5831)**,** 1556-1557.

Stern, F. and Kampourakis, K. (2017). Teaching for genetics literacy in the post-genomic era. *Studies in Science Education,* 53(2)**,** 193-225.

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

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| --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 |
| 10 | 25 | 50 | 75 | 100 |
| < | 11 | 23 | 46 | 92 |
| > | A few | Hundreds | Thousands | Millions |