**Secondary Schools/Sixth Form:  
Discovering Epigenetics – The Epigenetic Clock**

Approximate timing: 35 minutes

Required resources: PowerPoint presentation, videos, mouse cards

This lesson will introduce students to epigenetics, the difference between biological and chronological age, the role of epigenetics in ageing and how different factors can influence the “speed of ageing”.

A computer model has been developed by the Babraham Institute that can calculate the biological age and be used to better understand the mechanisms on why certain factors speed the ageing process up or down

**The lesson supports:**

*AQA GCSE Biology*

4.6.1.4 DNA and the genome

4.6.1.5 DNA structure (biology only)

4.6.2 Variation and evolution

4.6.2.4 Genetic engineering

*EDEXCEL GCSE Biology*

3.4 Describe DNA as a polymer

3.5 Describe the genome as the entire DNA of an organism and a gene as a section of a DNA molecule that codes for a specific protein

3.13 Explain the term: chromosome

*OCR GCSE Biology*

B1.1 What is the genome and what does it do?

B1.2 How is genetic information inherited?

B1.3 How can and should gene technology be used?

*AQA A Level Biology*

3.4.1 DNA, genes and chromosomes

3.4.2 DNA and protein synthesis

*EDEXCEL A Level Biology*

7.2iv Understand that gene expression can be changed by epigenetic modification, including non-coding RNA, histone modification and DNA methylation.

7.2v Know that epigenetic modification is important in ensuring cell differentiation.

*OCR A Level Biology*

5.1.1 Patterns of inheritance

5.1.3 Gene technologies

Links to Babraham Institute research themes:

<https://www.babraham.ac.uk/our-research/healthy-ageing>

<https://www.babraham.ac.uk/our-research/epigenetics>

Links to Babraham Institute scientific services

<https://www.babraham.ac.uk/science-services/sequencing-facility>

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| **Learning outcomes** | |
| All students will: | Explain the differences between biological and chronological age. |
| Most students will: | Describe how lifestyle factors can influence the ageing speed differently. |
| Some students will: | Explain how epigenetics is linked to biological age |
| Key word/s | Epigenetics, ageing, healthy ageing, life style |

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| **Teaching notes** | **Student learning activities** |
| **Starter or ice-breaker activity** (5 mins)  Ask the class what they think might be the causes & symptoms of ageing. Discuss with the class that a lot is still unknown about ageing. What we know is that it happens, but a lot is still unknown when looking at ageing at a mechanistic level.  Different lifestyle factors can influence the speed that someone ages. Discuss with the class what these possible factors would be. | Slide 2  Student actions   * Discuss with the whole class what they think happens when humans age, thinking on a mechanistic level   Discuss with the whole class what different lifestyle factors could influence ageing |
| **Development** (10 mins)  Go over slide content – refer to fact sheet | Slide(s) 3-5  Student actions  Discuss why it is interesting to know both biological and chronological age [slide 3] |
| **Principal Activity** (15 mins)   * [repeat for all 3 cards] Ask students to look at a mouse card in small groups to identify if/ how the biological ages of the mice will differ * Once a card has been discussed, discuss plenary what the expected outcomes are * Show the clock animation for the relevant card * **Explain important caveat:** any differences seen through high fat diet and caloric restriction do not mean the same effects are seen in humans. No human calorie-restriction study has been successful because of the psychological stress of eating so few calories.   Research is trying to understand what mechanisms trigger these changes to the ageing process. If we understand the mechanisms, we could trigger the positive effects without undesirable negative dietary changes. | Slide(s) 6 - 8  Student actions  Discuss in teams what the effect of the different factors could be on the speed of ageing |
| **Plenary** (5 mins)   * What is the difference between chronological and biological age? * What is the relation between epigenetics and biological age?   How do “diet fat content”, “caloric intake” and “response to growth hormone” influence the ageing speed? | Students answer question(s) on summary slide 9 to assess learning. |
| **Extension activities** | Discovering Epigenetics   * Stem cell quiz * Ageing in *C. elegans*   Making your Mark  Ethics Workshops: Animals in Research (Alternatives) |