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For issue on or after: 13 March 2024

A Level Biology B (Advancing Biology)

H422/02 Scientific literacy in biology

Advance Notice Article

To prepare candidates for the examination taken on Friday 14 June 2024 – Morning

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INSTRUCTIONS

- Before the exam, read this article carefully and study the content of the learning outcomes for A Level Biology B (Advancing Biology).
- You can ask your teacher for advice and discuss this article with others in your class.
- You can investigate the topic of this article yourself using any resources available to you.
- Do **not** take this copy of the article or any notes into the exam.

INFORMATION

- A clean copy of this article will be given to you with the question paper.
- In the exam you will answer questions on this article. The questions are worth 20–25 marks.
- This document has **4** pages.

ADVICE

- In the exam you won't have time to read this article in full but you should refer to it in your answers.

The Eye

Melanin [1]

Melanin is a brown or black pigment that is synthesised from the amino acid tyrosine. Melanin is present in melanocytes in the skin and the choroid layer of the eye (uveal melanocytes). Uveal melanocytes have different biological characteristics to melanocytes in the skin. Uveal melanocytes have roles in light absorption, regulation of oxidative stress, immune regulation and the formation of new blood vessels.

Melanin absorbs infrared light, visible light and ultraviolet radiation. In the front of the eye, melanocytes block 99.9% of these wavelengths. In the back of the eye, pigment granules reduce light-induced oxidative stress and act as a shield against scattered light.

Melanin and eye colour [2]

Eye colour is the result of pigmentation of the iris, which helps control how much light enters the eye. The phenotype of iris pigmentation varies on a continuum: iris colour ranges from very light blue to dark brown. A person's genotype determines iris colour, and this involves several genes. Most of the genes associated with iris colour are involved in the production, transport or storage of melanin. People with brown eyes have high levels of melanin in the iris, whereas people with blue eyes have much less melanin.

In humans, a region of chromosome 15 plays a major role in eye colour. There are two genes located very close together: *OCA2* and *HERC2*. The *OCA2* gene produces a protein known as the P protein, which is involved in the maturation of pigment granules. Several alleles of the *OCA2* gene produce lower levels of functional P protein. This reduces the amount of melanin present in the iris and leads to blue eyes rather than brown eyes.

A region of the *HERC2* gene known as intron 86 contains a DNA sequence that controls the activity of the *OCA2* gene. At least one allele in this region has been shown to reduce the expression of *OCA2*, which can also lead to the production of less melanin in the iris and therefore lighter-coloured eyes.

Corneal tissue-resident T memory cells [3]

Barrier tissues of the body, such as the skin and mucous membranes, are frequently exposed to pathogens. These tissues contain networks of immune cells that help protect against infection. Some tissues, such as the cornea of the eye, have more restricted networks of immune cells and reduced inflammatory responses. Populations of antigen-presenting cells reside in the cornea. Other immune cells, including T lymphocytes, are recruited during infection. During infection of the eye by herpes simplex virus (HSV), T helper cells are involved in the response to infection.

T memory cells can circulate in the blood, spleen, lymph and tissue fluid. In many tissues, these T memory cells differentiate into tissue-resident T memory cells. The tissue-resident T memory cells consist of T helper memory cells and T killer memory cells. These cells remain in specific tissues for long periods and can provide greater protection compared with the circulating pool of T memory cells.

A recent study examined T lymphocyte responses in the cornea of mice after HSV infection. The results showed that virus-specific T lymphocytes enter the cornea in significant numbers following HSV infection. Moreover, tissue-resident T memory cells form in the cornea after the virus has been removed and continue to provide protection against future infection.

References

1. *Photoprotection role of melanin in the human retinal pigment epithelium. Imaging techniques for retinal melanin.* Istrate, et al. (2020) Romanian Journal of Ophthalmology, **64**, 100–104. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7339703/

2. Is eye colour determined by genetics? In 'Genetics and human traits' MedlinePlus Genetics. https://medlineplus.gov/genetics/understanding/traits/eyecolor/

3. *Corneal tissue-resident memory T cells form a unique immune compartment at the ocular surface*. Loi et al. (2022) Cell Reports, **39**, 110852. https://doi.org/10.1016/j.celrep.2022.110852