Biophysics

with Dr Wilfred D. Stein

Talking *points*

Knowledge

1. What are trichocytes?
2. What is a placode?

Comprehension

3. What is the relationship between placodes and keratin-associated proteins (KRTAPs) in hair evolution?
4. What led researchers to conclude that the disease ectodermal dysplasia is due to a mutation on the X chromosome?

Application

5. From your own deduction, what factors do you think drove the following scenarios? What questions could you research to learn more?
   - The evolution and spread of small, nocturnal mammals, during the age of the dinosaurs.
   - The diversification of mammals into many different species, big and small, following the extinction of the dinosaurs.
   - The loss of most body hair in early humans (but not in other apes, e.g. chimpanzees).
6. How do you think the findings of Wilfred's team could inform hair healthcare?

Evaluation

7. How do you think the rise of 'big data', such as that used in bioinformatics, is driving advances in biophysics? What do you think this means for the future of biophysics?
8. Premature balding involves the loss of hair at an earlier age than average. To what extent do you think that premature balding should be considered a health issue and/or a research priority, and why?

Activities

Using the internet, look up diagrams of the 'Tree of Life', which shows the evolutionary relationships between different organisms. OneZoom is an accessible, interactive tree of life: **www.onezoom.org**

Focus on the part that shows animals. If two branches divide close to their ends, it means the animals on those branches are quite closely related and went down different evolutionary pathways relatively recently in the history of the world. If the point where two branches divide is far from their ends, these animals are more distantly related.

To give an example unrelated to Wilfred's article, imagine you are trying to find the point where the placenta first evolved. All mammals have a placenta besides the monotremes, which is a group that includes the platypus and echidnas. On the Tree of Life, we can find the 'mammals' branch, and a smaller 'monotremes' branch that leaves it. Everything 'downstream' of the point where the monotremes branch off contains all the mammals that have a placenta, so we can reason that the placenta evolved before any more mammals separated on their evolutionary journey. This point is labelled 'therian mammals' on the diagram and happened 160 million years ago.

Use the diagram to deepen your understanding of the evolution of hair. Use the information in the article to identify the points on the Tree of Life where the following potentially first evolved:

- Placodes
- KRTAPs
- Trichocytes

For each, write a small paragraph that explains the significance of the evolution of this feature, and how it is used by the animals that have it.

Next, research the innovative ways that evolution has modified hairs in certain mammals. This could include:

- Spines and quills (e.g., hedgehogs, porcupines)
- For visual signalling (e.g., skunks)
- To protect against sunburn (e.g., camels)
- For camouflage (e.g., zebras, tigers)

Find these animals on the Tree of Life. Using your understanding of evolution, answer the following questions:

- Do you think these modifications evolved once, or several times?
- What might have driven this evolution?
- To what extent do you think it's 'easier', in evolutionary terms, to evolve these modifications than to evolve hair in the first place? Why?