MATHEMATICAL BIOLOGY WITH DR BARD ERMENTROUT

TALKING POINTS

KNOWLEDGE

1. What is spontaneous symmetry breaking?
2. What are non-linear dynamics?

COMPREHENSION

3. What are some advantages of patterns in the natural world?

APPLICATION

4. Imagine you are a researcher who needs funding to investigate the application of maths to neuroscience. How would you convince would-be funders that your project is valuable?
5. How could a deeper understanding of natural patterns further societal progress?

ANALYSIS

6. How has Bard's research proved useful in understanding a) flicker hallucinations and b) cone shells?
7. Use your knowledge of evolution to think about how spatial and temporal patterns might have evolved. What might have existed before what we see today?

EVALUATION

8. Computer models are becoming more and more sophisticated. Do you think there will come a point when they are more sophisticated than the human brain? Why or why not?

MORE RESOURCES

1. Wolfram Alpha is useful for all kinds of things, from solving equations to visualising models. It will almost definitely prove useful if studying any form of mathematics: https://www.wolframalpha.com/

2. We Use Math takes you through the wealth of career options that studying maths could open up for you: http://weusemath.org/

3. This TED talk is from an inspiring mathematical biologist who uses models to describe the dynamics of cancer. Her work aims to help develop new cancer-combatting drugs: https://www.youtube.com/watch?v=Tu01sNfs5SQ

ACTIVITIES YOU CAN DO AT HOME OR IN THE CLASSROOM

1. Wolfram Alpha is a free site that transforms mathematical equations into graphs. Find it here: https://www.wolframalpha.com/

Use the internet to find equations for the following biological phenomena, copy them into Wolfram Alpha, and answer the related questions:

- The surface area to volume ratio of a sphere. This tells you how an animal's surface area changes as its volume increases (i.e. the animal gets bigger). A sphere is used as a very rough approximation of an animal.

•How might surface area and volume affect body temperature in warm-blooded animals (e.g. mammals)?

- Why aren't there mice in Antarctica?
- Why do you think animals in cold climates (e.g. seals) are more sphere-shaped than animals in warm climates? Look up fennec foxes on the internet if you need a clue.

- Exponential growth. This tells you how a population (e.g. of rabbits) would increase over time with infinite food and space.

- Why do you think exponential growth is not seen often with animals in the real world?
- Bacteria populations on a petri dish will often undergo exponential growth at first, until they run out of resources. What do you think happens next?
- Find a graph of human population growth over the last 1,000 years. Do you notice any similarities?

2. The most famous patterns in nature involve the golden ratio and Fibonacci numbers. They are seen across the natural world, from flowers to seashells. Start your research using this site: https://www.mathsisfun.com/numbers/nature-golden-ratio-fibonacci.html

Use this site and others on the internet to answer the following questions:

- What is the Fibonacci sequence?
- What is the golden ratio?
- What is the relationship between Fibonacci numbers and the golden ratio?
- What are some interesting examples of the golden ratio in the natural world?
- Why do you think so many organisms use the golden ratio?
- Do you think there's a reason why we find the golden ratio aesthetically pleasing?