**Patterning via self-organisation**

Intro to patterns/self-organisation

Patterns can be found everywhere...

Question: are there general principles or do unique rules and mechanisms exist in each case

FIGURE: examples?

**Principles of self-organisation**

Turing’s work showed that a system of just two chemical species can give rise to complex patterns, provided that they react with each other in a certain way and exhibit differential diffusion kinetics. At the time the biological mechanisms were unclear. He refers to these chemical species as ‘genes’.

In an array of what he referred to as cells, biomolecules (referred to as morphogens) are produced which diffuse and interact with each other. At high concentrations, genes are switched on which lead to cell differentiation

All that is needed to form a pattern is two chemicals that react with each other in a certain way and exhibit different diffusion kinetics

Relate to stripes on an animal

This work was later generalised by Gierer and Meinhardt.

In order for a pattern to form, a deviation from uniformity must have positive feedback to cause it to increase further. However, positive feedback alone isn't sufficient, as this would cause uncontrolled spreading. Pattern formation requires that the spread be confined. Common ways to achieve this are a long-range inhibitory signal that extends from the region of growth.

Variations are possible. Depletion of a pool of material required for self-enhancement can provide a long-range inhibitory signal. Requires that diffusion of the depleted substance be faster than diffusion of the activator. Positive feedback can result from inhibition of inhibition (double negative feedback). If two species inhibit each other mutually, an increase in one leads to inhibition of the other, which frees inhibition on the first and allows if to amplify. Both of these concepts are useful to bear in mind for models of PAR polarity, which I will discuss later.

FIGURE: positive feedback vs double negative feedback

Gierer-meinhardt

Generalised his theory

Short range activation and long range inhibition

Can try and explain this intuitively

Use this to introduce the concept of partial differential equations

MISC NOTES

Proof of these models requires the identification of morphogens and measurements of their kinetics

If initiated randomly, the pattern will have some irregularity

Linear instability

Patterns can be static or oscillatory. Static patterns are more obviously applicable to cell polarity, but oscillatory patterns are also important such as min. Maybe come back to this.

A number of interpretations for what cells and biomolecules are. May be actual cells. Diffusing chemicals or neural activity.