Reaction-Diffusion Equations

Turing Mechanisms and Morphogenesis

Luke Mattfeld

Eastern Washington University

March 13, 2020

Outline

Patterns

Pattern Formation

Patterns

Pattern Formation

- Patterns in Nature:

Patterns

Pattern Formation

- Patterns in Nature:

Patterns

Pattern Formation

- Patterns in Nature:

Simpler Model

Morphogenesis

Simpler Model

Morphogenesis

- Morphogens related to cell growth

Simpler Model

Morphogenesis

- Morphogens related to cell growth
- Chemical that react

Simpler Model

Morphogenesis

- Morphogens related to cell growth
- Chemical that react
- Chemicals that diffuse?

Simpler Model

Morphogenesis

- Morphogens related to cell growth
- Chemical that react
- Chemicals that diffuse?

Simpler Model

Morphogenesis

- Morphogens related to cell growth
- Chemical that react
- Chemicals that diffuse?

Outline

Reaction Diffusion Equation

General Model

$$\frac{\partial A}{\partial t} = F(A, B) + D_A \nabla A$$

$$\frac{\partial B}{\partial t} = G(A, B) + D_B \nabla B$$

Reaction Diffusion Equation

General Model

$$\frac{\partial A}{\partial t} = F(A, B) + D_A \nabla A$$

$$\frac{\partial B}{\partial t} = G(A, B) + D_B \nabla B$$

- A, B Concentration of Chemical Morphogens

Reaction Diffusion Equation

General Model

$$\frac{\partial A}{\partial t} = F(A, B) + D_A \nabla A$$

$$\frac{\partial B}{\partial t} = G(A, B) + D_B \nabla B$$

- A, B Concentration of Chemical Morphogens
- F, G Chemical Reaction Equations

Reaction Diffusion Equation

General Model

$$\frac{\partial A}{\partial t} = F(A, B) + D_A \nabla A$$

$$\frac{\partial B}{\partial t} = G(A, B) + D_B \nabla B$$

- A, B Concentration of Chemical Morphogens
- F, G Chemical Reaction Equations
- D_A, D_B Diffusion coefficients

Reaction Diffusion Equation

General Model

$$\frac{\partial A}{\partial t} = F(A, B) + D_A \nabla A$$

$$\frac{\partial B}{\partial t} = G(A, B) + D_B \nabla B$$

- A, B Concentration of Chemical Morphogens
- F, G Chemical Reaction Equations
- D_A, D_B Diffusion coefficients
- ∇A, ∇B Diffusion

Reaction Diffusion Equation

General Model

$$\frac{\partial A}{\partial t} = F(A, B) + D_A \nabla A$$

$$\frac{\partial B}{\partial t} = G(A, B) + D_B \nabla B$$

- A, B Concentration of Chemical Morphogens
- F, G Chemical Reaction Equations
- D_A, D_B Diffusion coefficients
- ∇A, ∇B Diffusion

Reaction Diffusion Equation

General Model

$$\frac{\partial A}{\partial t} = F(A, B) + D_A \nabla A$$

$$\frac{\partial B}{\partial t} = G(A, B) + D_B \nabla B$$

- A, B Concentration of Chemical Morphogens
- F, G Chemical Reaction Equations
- D_A, D_B Diffusion coefficients
- ∇A, ∇B Diffusion

Equilibrium states

Turing-specific models

- Reaction Diffusion is very general

Equilibrium states

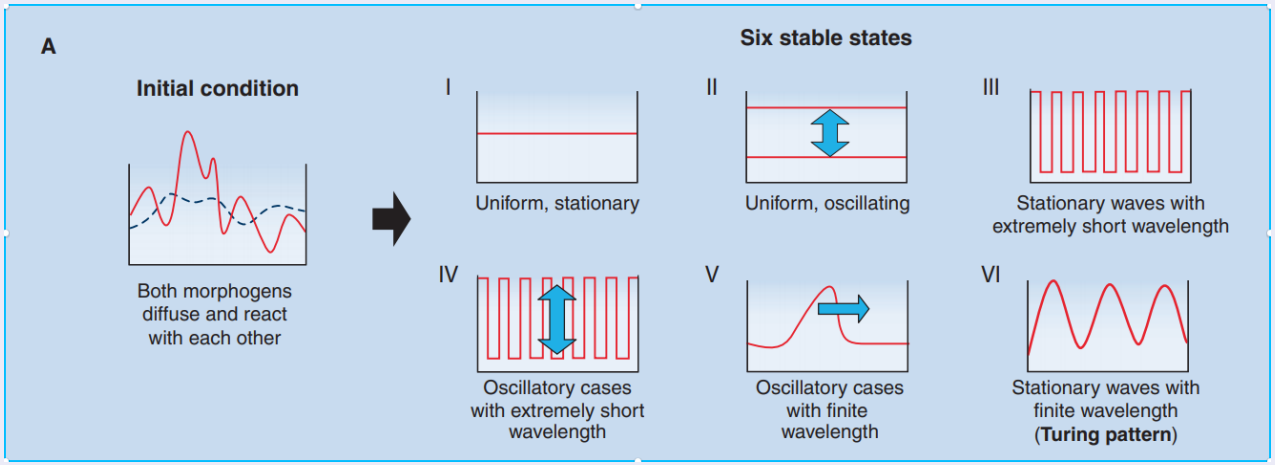
Turing-specific models

- Reaction Diffusion is very general
- Most RD equations don't form patterns

Equilibrium states

Turing-specific models

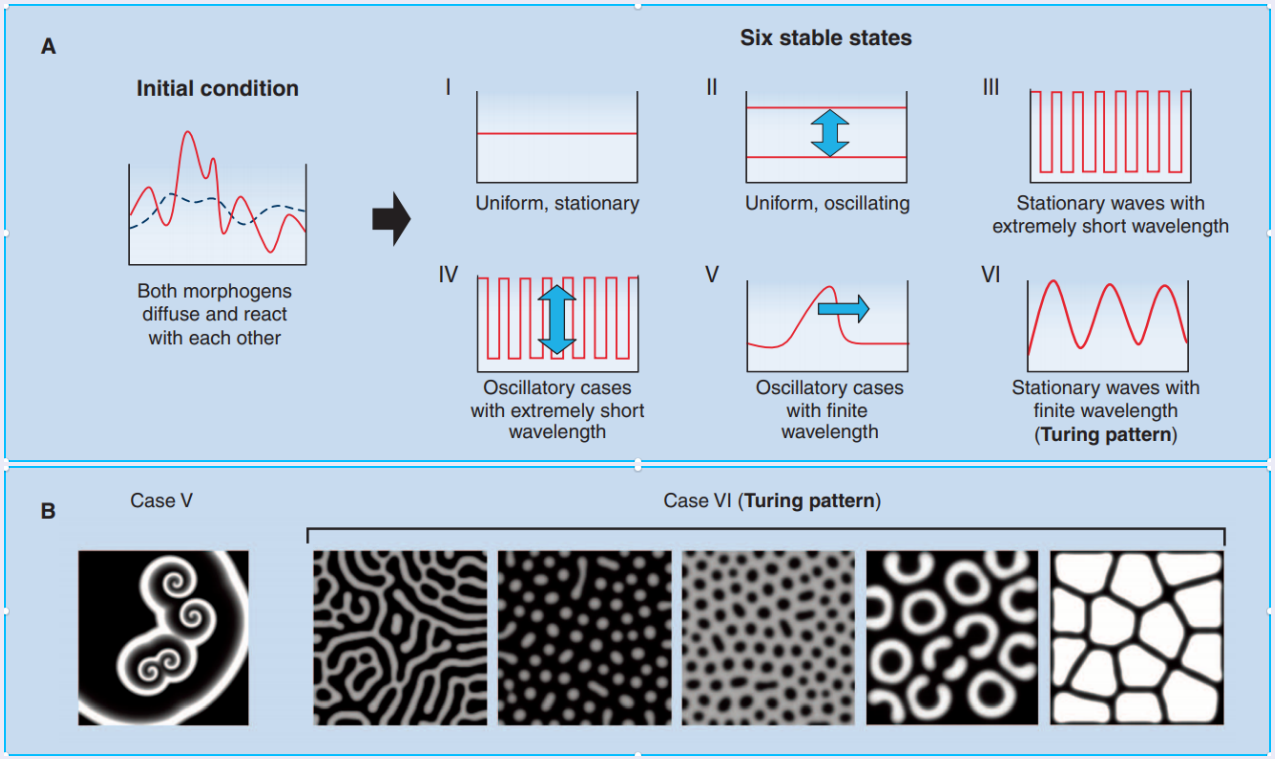
- Reaction Diffusion is very general
- Most RD equations don't form patterns



Equilibrium states

Turing-specific models

- Reaction Diffusion is very general
- Most RD equations don't form patterns



Equilibrium states

Turing-specific models

- Reaction Diffusion is very general
- Most RD equations don't form patterns