Development of *Dictyostelium discoideum* (cellular slime mold)

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Cellular Slime Molds

Fuligo septica

Physarum polycephalum
Dictyostelium discoideum
Dictyostelium discoideum Life Cycle

- **Myxamoebae**: 6 hours
- **Cell streams**: 9 hours
- **Loose aggregate**: 10 hours
- **Tight aggregate**: 12 hours
- **MIGRATION**: 14 hours
- **Slug**: 15 hours
- **15 hours**:
- **16 hours**:
- **17 hours**:
- **20 hours**:
- **23 hours**:
- **24 hours**:
- **Mature fruiting body**: 24 hours
- **Spores**: 23 hours
- **Spore case**: 23 hours
- **CULMINATION**:

**Dictyostelium discoideum Life Cycle**
Questions

What signals trigger the switch from myxamoebae to pseudoplasmodium? (What controls growth?)

How do myxamoebae find each other? (How do cells communicate?)

How do the myxamoebae move? (gastrulation, morphogenesis)

How do cells in the pseudoplasmodium decide whether they are pre stalk or prespore cells? (differentiation, morphogenesis, organogenesis)

How do the prestalk and prespore know where to go when forming a fruiting body? (communication, morphogenesis)

What take place in the cells to change them into stalk and spore cells (differentiation, reproduction)
Intercellular Signaling - Chemotaxis

**Chemotaxis** – movement induced by a chemical
- myxamoebae move in response to a chemical signal sent by other myxamoebae

Chemotactic signal: **cyclic adenosine 3’,5’-monophosphate (cAMP)**
Intercellular Signaling - Chemotaxis

Chemotaxis – movement induced by a chemical:

cyclic adenosine 3′,5′-monophosphate (cAMP)

Myxamoebae move in response to cAMP signal sent by other myxamoebae
Intercellular Signaling - Chemotaxis

1) Myxamoebae secrete cAMP.

2) Other myxamoebae receive cAMP signal with specific receptors and move toward the cAMP source.
   - cAMP stimulates organization of actin filaments in the membrane cortex

3) Later (~3 min), the receiving myxamoebae secrete cAMP of their own.

4) This process results in movement of myxamoebae towards a central location.

But...
Chemotaxis - 2

....with all myxamoebae secreting and receiving cAMP, how do they know which way to travel?

Required: a mechanism to reset the system

5) **Phosphodiesterase** breaks down cAMP - shuts down chemotaxis.
   - clears receptors for next round of binding, movement, and cAMP production
cAMP-Stimulated Motility

cAMP stimulates polymerization of globular (g)-actin to filamentous (f)-actin (microfilaments)

- polymerization establishes polarity of microfilaments (i.e. defines anterior and posterior)

Myosin (motor protein) uses actin microfilaments to move cells.
**Regulation - Developmental Strategy**

**Anterior** cells become stalk.

**Posterior** cells become spores.

However, cut the slug in half...
- both halves form stalks and spores

Therefore, identities of stalk and spore cells must be somewhat flexible!

**Regulation**: the ability of cells to change their developmental fates according to their location.

- this gives the developing organism the ability to compensate for environmentally induced changes in structure.

- also, it implies that cells must “sense” their position within the organism.
Cell Adhesion

Active mitotically-dividing cells can’t stick to each other.
Migrating pseudoplasmodium cells must stick to each other.
Stalk prespore cells have to slide over one another.

starvation +10 h

streaming amoebae

migrating pseudoplasmodium

gp24

gp80

gp150

(gp = glycoproteins - developmentally-regulated adhesion molecules)
Dictyostelium Morphogenesis 2, Aggregation
Dictyostelium Morphogenesis 3, Migrating Pseudoplasmodia
Dictyostelium Morphogenisis 4, Culmination
Dictyostelium Morphogenesis 5, Trisected Pseudoplasmodium