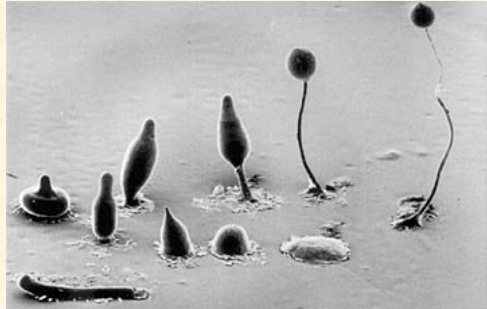


## Slime Mold

*(Dictyostelium discoideum)*  
“Dicty”

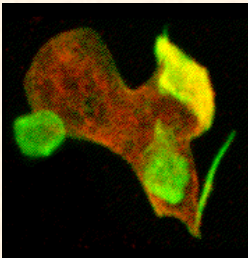
8/31/04 1

## Complete Life Cycle



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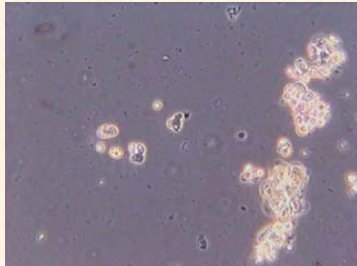
## Amoeba Stage



- Single cell
- Lives in soil
- Free moving
- Engulfs food (bacteria)
- Divides asexually

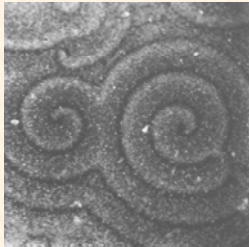
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## Amoebas



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### Aggregation Stage

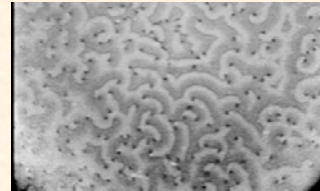


- Triggered by exhaustion of food
- Aggregate by *chemotaxis*
- Form expanding concentric rings and spirals
- Up to 125 000 individuals

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### Spiral Waves



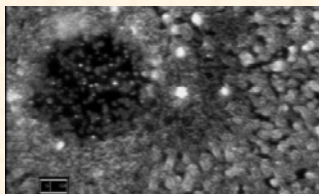
- Spiral accelerate cell aggregation (18 vs. 3  $\mu\text{m}/\text{min}.$ )
- Waves propagate 120 – 60  $\mu\text{m}/\text{min}.$
- 1 frame = 36 sec.

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(video < Zool. Inst., Univ. München)

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### Center of Spiral



- Mechanisms of spiral formation are still unclear
- Involves symmetry breaking
- 1 frame = 10 sec.

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(video < Zool. Inst., Univ. München)

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### Stream Formation Stage




- Streams result from dependence of wave propagation velocity on cell density
- Breaks symmetry
- As density increases, begin to adhere
- Begin to form *mound*

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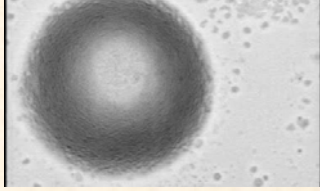
### Mound Stage



- Cells differentiate
- Some form an elongated finger

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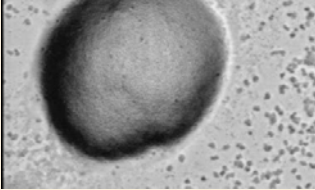
### Concentric Waves in Mounds



- Concentric or spiral waves
- Mound comprises  $10^3$  to  $10^5$  cells
- Cells begin to differentiate
- 1 frame = 20 sec.

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(video < Zool. Inst., Univ. München)

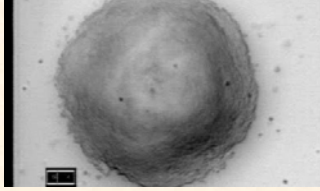
### Multiple Centers



- Multiple pacemakers
- Wave fronts mutually extinguish (typical of excitable media)
- One center eventually dominates

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(video < Zool. Inst., Univ. München)

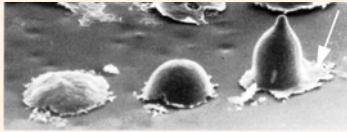
### Multi-armed Spirals



- This mound has 5 spirals
- Up to 10 have been observed

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(video < Zool. Inst., Univ. München)

### Formation of Acellular Sheath



- Composed of cellulose & a large glycoprotein
- Covers mound and is left behind slug as trail
- Function not entirely understood:
  - protection from nematodes
  - control of diffusion of signaling molecules

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### Slug Stage

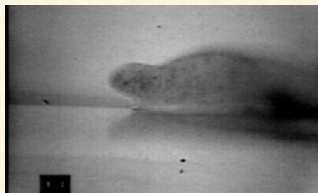


- Prestalk elongates, topples, to form slug
- Behaves as single organism with  $10^5$  cells
- Migrates; seeks light; seeks or avoids heat
- No brain or nervous system

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### Movement of Young Slug



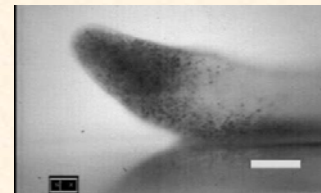
- Time-lapse (1 frame = 10 sec.)
- Note periodic up-and-down movement of tip

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(video < Zool. Inst., Univ. München)

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### Movement of Older Slug



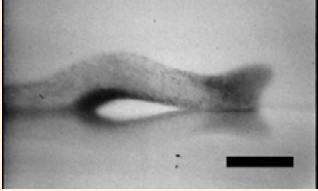
- Note rotating prestalk cells in tip
- Pile of anterior-like cells on prestalk/prespore boundary
- Scale bar = 50  $\mu$ m, 1 frame = 5 sec.

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(video < Zool. Inst., Univ. München)

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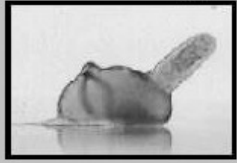
### Migration of Older Slug



- Scale bar = 100  $\mu$ m, 1 frame = 20 sec.

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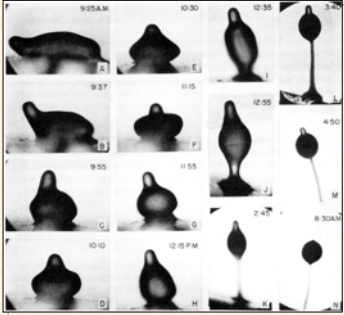
### Culmination Stage



- Cells differentiate into base, stalk, and spores
- Prestalk cells form rigid bundles of cellulose & die
- Prespore cells (at end) cover selves with cellulose & become dormant

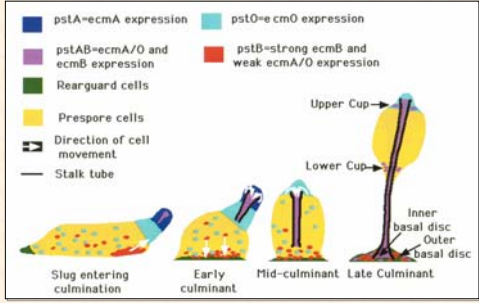
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### Stages of Culmination



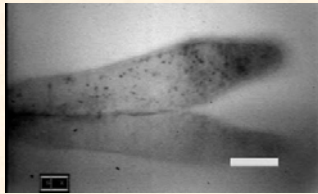
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### Cell Differentiation at Culmination



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### Early Culmination



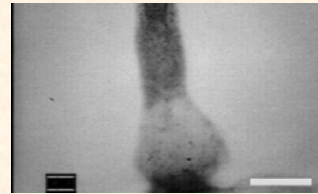
- During early culmination all cell in prestalk rotate
- Scale bar = 50  $\mu\text{m}$ , 1 frame = 25 sec.

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(video < Zool. Inst., Univ. München)

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### Late Culmination



- Vigorous rotation at prestalk/prespore boundary
- Scale bar = 100  $\mu\text{m}$ , 1 frame = 10 sec.

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(video < Zool. Inst., Univ. München)

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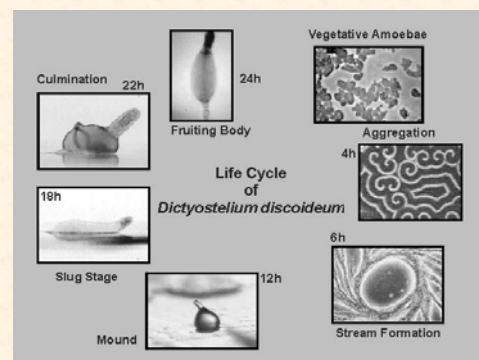
### Fruiting Body Stage



- Spores are dispersed
- Wind or animals carry spores to new territory
- If sufficient moisture, spores germinate, release amoebas
- Cycle begins again

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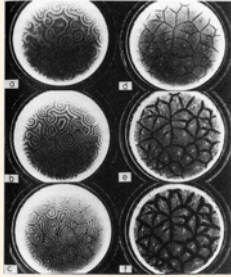
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### Emergent Patterns During Aggregation



- a-c. As aggregate, wave lengths shorten
- d. Population divides into disjoint domains
- e-f. Domains contract into “fingers” (streaming stage)

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fig. from Solé & Goodwin

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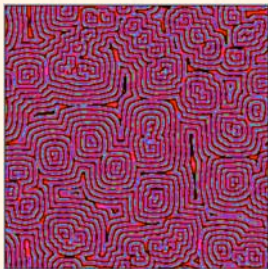
### Belousov-Zhabotinski Reaction



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### Hodgepodge Machine



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### Demonstration of Hodgepodge Machine

[Go to hodgepodge machine](#)

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## Reading

- Everyone: Flake, ch. 16
- CS594: Bar-Yam, Sections 7.1, 7.2.1-7.2.2 (pp. 621-48)

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## Universal Properties

- What leads to these expanding rings and spirals in very different systems?
- Under what conditions do these structures form?
- What causes the rotation?
- These are all examples of *excitable media*

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