**Temperature relations**

*Hot enough for you?*

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**Outline**

- Microclimate
- Ecological “laws” for individuals
- Temperature optima of organisms
- Temperature regulation by plants and animals

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**Microclimates**

- What environmental conditions are most important for organisms?

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**Physiological ecology**

- AKA ecophysiology
- How individual organisms respond to the abiotic environment:
  - Temperature
  - Water
  - Light
  - Nutrients

  “The Big Four”

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**Underlying mechanism**

- So, how do individual organisms ultimately respond to their environment?
- “Nothing in biology makes sense except in the light of evolution.” The American Biology Teacher (1973)
  - Theodosius Dobzhansky (1900 – 1975)

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**Ecological “laws” (1)**

- Patterns describing how individuals interact with their environment
  - Law of the minimum (von Liebig):
    - Always the same?
    - Co-limitation?
  - Law of limiting factors (Blackman):
Ecological “laws” (2)

- Law of tolerance (Shelford)

Life and temperature

- Life requires a certain temperature (or range of temperatures) for optimal metabolism
  - Cold environments & metabolic rate: prediction?
  - Hot environments & metabolic rate?
  - Why?
  - Overall result?

Trout and an enzyme

- Do trout show an optimum temperature for activity?

Plants and temperature optima

- These last examples show natural selection selects for genetically-determined traits that allow the organism to be adapted physiologically to its thermal environment
- But, can an organism show shorter-term adjustments to changes in temperature (within certain evolutionary-set bounds) that allow it to be successful?
  - Acclimation
  - Temperature regulation

Take-home messages:

- Life is a compromise
  - Can you be adapted to all environmental conditions?
  - Once you have maximum fitness under one set of conditions, what does that mean if the environment changes or if you move?
  - Many species can co-exist in the same region by specializing in different conditions

Shorter-term adjustments to environmental changes

Acetylcholinesterase activity

Rainbow trout have 2 forms of this enzyme

Recent concerns?

Fig. 5.8

Fig. 5.11
Acclimation by desert shrubs

All experimental shrubs were grown from cuttings; so, we do not have to worry about differences due to?

Global heat transfers

Temperature regulation

Organisms must balance gains and losses of heat energy

Direction of heat energy?

Types of heat transfer

- Sunlight (short-wave radiation)
- Long-wave infrared radiation from objects
- Metabolism
- Evaporation
- Conduction
- Convection

Desert plants & heat

Jojoba

Brittlebush

Creosote bush

Also see Fig. 5.16

Types of physiological groupings

- Ectotherms
- Endotherms
- Heterotherms

Ectotherms (1)

Characteristics

- High thermal conductance
- Low metabolic rate

Metabolic rate increases with increasing temperatures

Figure 5.9: Eastern fence lizard

Schmidt-Nielsen 1997
Ectotherms (2)

- $Q_{10}$
  - $Q_{10} = \frac{R_T}{R_{T-10}}$
  - Where $R_T$ is the rate at any given body temperature $T$
  - $R_{T-10}$ = rate at body temperature $T - 10^\circ C$
  - Typically $Q_{10}$'s are around 2, which means?

Ectotherms (3)

- How do you regulate your temperature in more extreme conditions that last a long time?
- Diapause
  - Usually genetically determined and timed by various environmental cues (e.g., light and temperature)

Endotherms

Heterotherms (1)

- Roach
- Hawkmoth

Heterotherms (2)

- Desert tortoise

Heterotherms (3)

- Dormouse