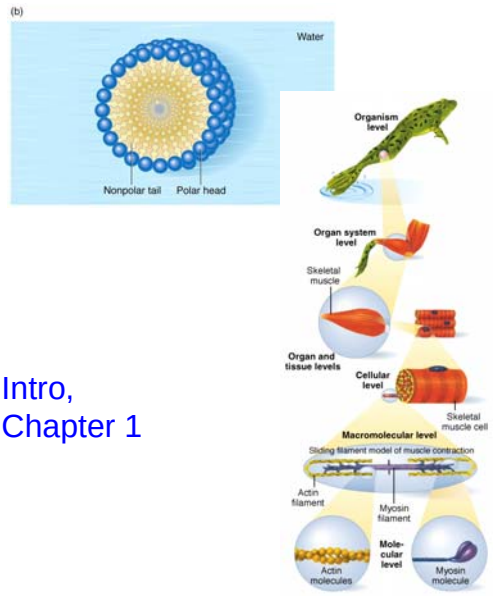
Lecture 2, 18 Jan 2008

Vertebrate Physiology
ECOL 437 (MCB/VetSci 437)
Univ. of Arizona, spring 2008

Kevin Bonine & Kevin Oh



1. Vertebrate Physiology
   - Integration
   - Structure/Function
   - Homeostasis
   - Feedback
   - Adaptation
   - Literature
2. Biochem Blitz (Chap 2)

Intro,
Chapter 1

Cells, Membranes, Molecules, Pathways

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http://eebweb.arizona.edu/eeb_course_websites.htm

Housekeeping, 18 January 2008

Did everyone get emails from Kevin Oh?
if not, email him today (koh@email.arizona.edu)

Upcoming Readings

today: Textbook, chapter 1&2
Wed 23 Jan: Textbook, chapter 2&3
LAB Wed 23 Jan: Lienhard et al. 1992, Nesse & Williams 1998
see website for links to these papers
Fri 25 Jan: Textbook chapter 3

Lab discussion leaders: 23 Jan
1pm – xx
3pm – xx

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Physiology (intro and lessons from Chap 1)

PHYSIOLOGY: How animals function, how they work

Integrate many systems, levels, areas of biology, physics, chemistry, biochemistry, genetics, etc.

Lots of cool examples and questions.

Hummingbirds
High-altitude geese
Endotherms in cold water
Freeze tolerance
Nitrogen excretion
Camels
Etc.

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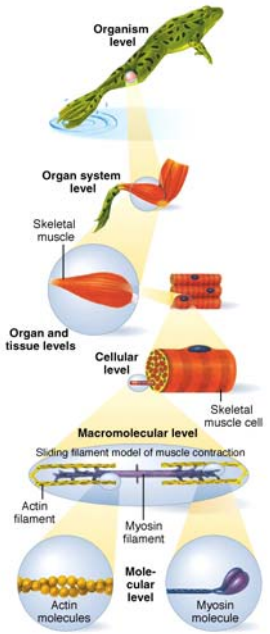

Randall et al. 2002

Integration

Structure/Function relationships

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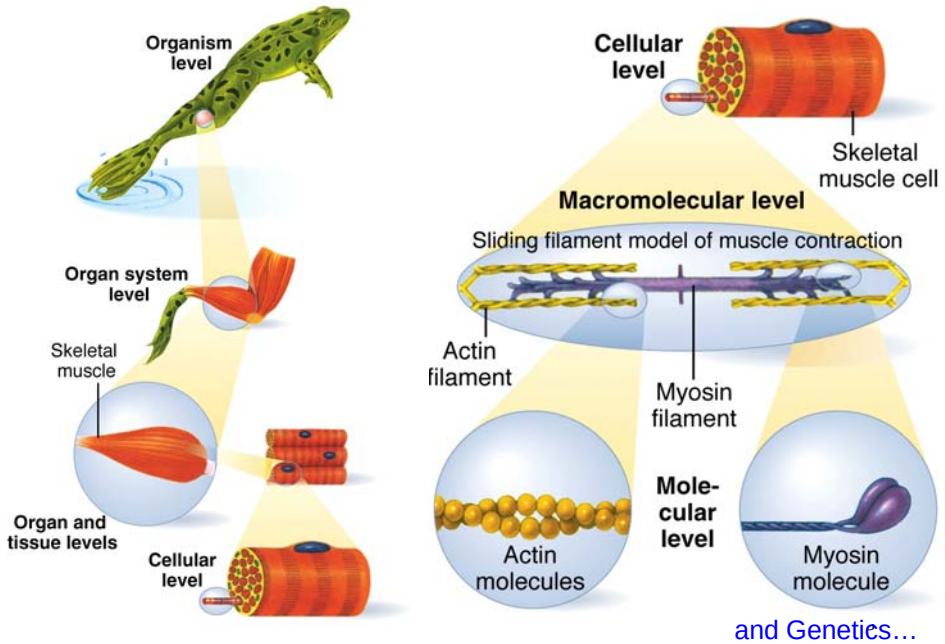
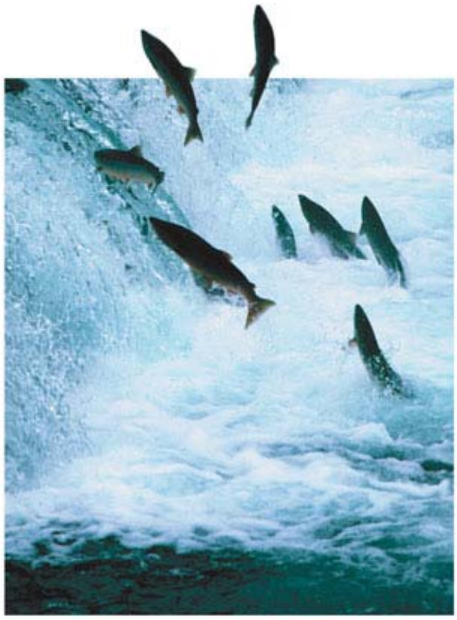


and Genetics…

Randall et al. 2002

Salmon…



Hill et al. 2004

Homeostasis

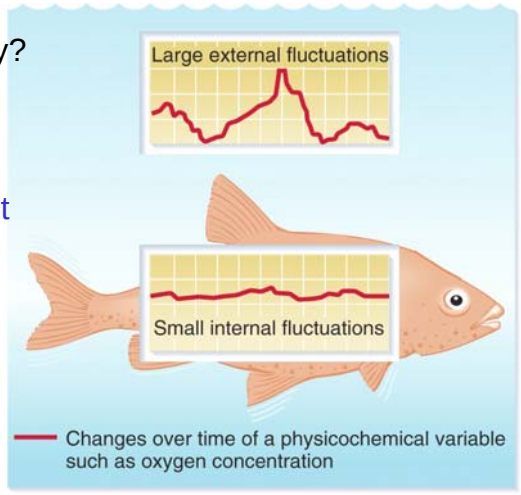
"**The coordinated physiological processes which maintain most of the [constant] states in the organism**"

(Hill et al. 2004, p. 12)

The role of physiology?

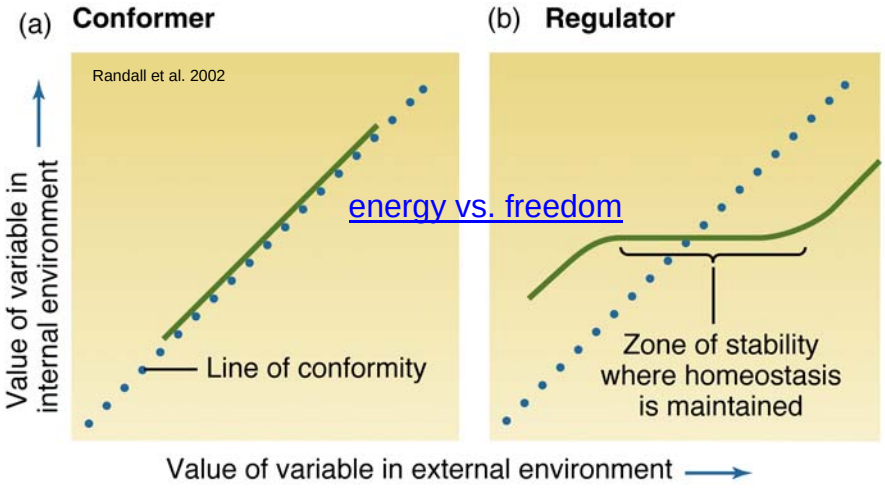
milieu interior
internal environment

scale?



Randall et al. 2002

Homeostasis?



energy vs. freedom

e.g.: Temp. salinity [glucose] pH [ion] pO_2

"Constancy of the internal environment is the condition of free life,"

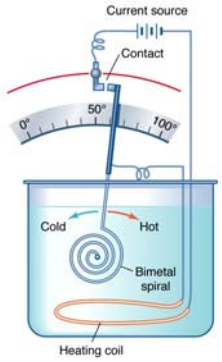
Feedback Loops

negative

set point (can be reset)

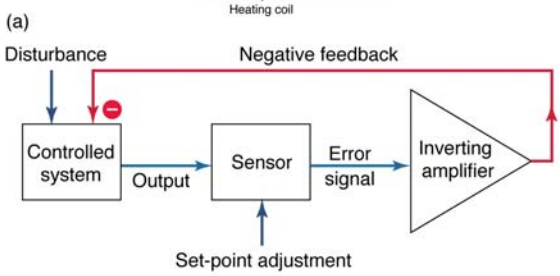
homeostasis

(blood glucose)



positive

less common
-voiding
-pregnancy
-congestive heart failure
-nerve transduction
(action potentials)



Randall et al. 2002

Negative Feedback

-opposes deviation from setpoint.

Positive Feedback

-reinforces deviation from setpoint.

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Vertebrate Physiology

Animal

-"An animal is not a discrete material object" (Hill et al 2004 p. 10)

-Energy required for organization (to fight entropy)

-Body size:

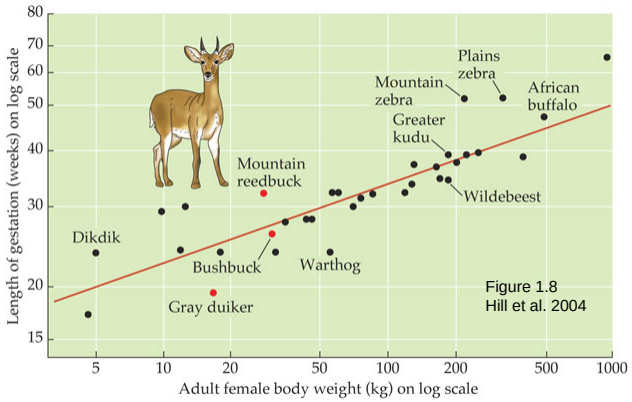


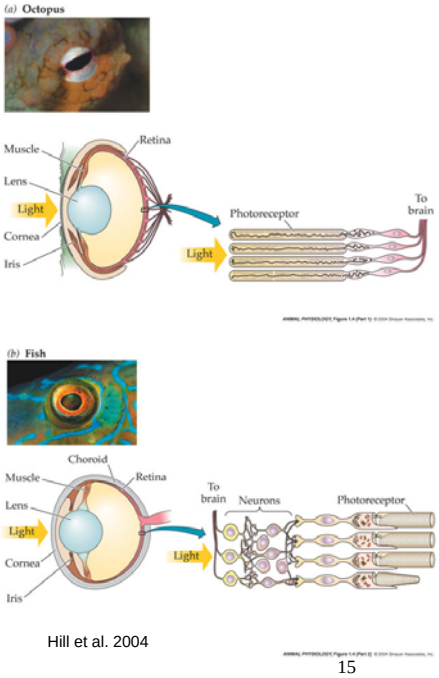
Figure 1.8
Hill et al. 2004

Physiology

1. Mechanism

2. Origin
   Adaptive Significance

TINKERING



Hill et al. 2004

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Vertebrate Physiology

Evolutionary Processes

Evolution: Change of gene frequencies over time

1. Adaptation: a subset of evolution, driven by natural selection

Which evolves, individual or population? Why?

2. Genetic Drift
3. Founder Effect
4. Pleiotropy (one gene, several traits)
5. No longer adaptive

Role of Genetic Variation

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Adaptation

TIME

TABLE 1.2 The five time frames in which physiology changes Hill et al. 2004

Type of change	Description
Changes in physiology that are responses to changes in the external environment	
1. Acute changes	Short-term changes in the physiology of individual animals: changes that individuals exhibit right after their environments have changed; acute changes are reversible
2. Chronic changes (acclimation and acclimatization)	Long-term changes in the physiology of individual animals: changes that individuals display after they have been in new environments for days, weeks, or months; chronic changes are reversible
3. Evolutionary changes	Changes that occur by alteration of gene frequencies over the course of many generations in populations exposed to new environments
Changes in physiology that are internally programmed to occur whether or not the external environment changes	
4. Developmental changes	Changes in the physiology of individual animals that occur in a programmed way as the animals mature from conception to adulthood and then to senescence
5. Changes controlled by periodic biological clocks	Changes in the physiology of individual animals that occur in repeating patterns (e.g., each day) under control of the animals' internal biological clocks

Genotype vs. Phenotype

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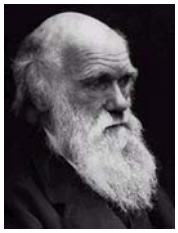
Adaptation

Ecology → Adaptation

Evolution (natural selection) → Adaptation



Adaptation

Evolution by natural selection

Acclimatization

Modification in response to environment within a lifetime (reversibility?)

Acclimation (laboratory)

Similar to acclimatization but more artificial

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Adaptation

Plasticity

Ontogenetic, environmental

Plastic Man

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Vertebrate Physiology

Environments

Chemical, physical, and biological components of an organism's surroundings

1. Temperature
2. Oxygen (air, water)
3. Water (osmoregulation)

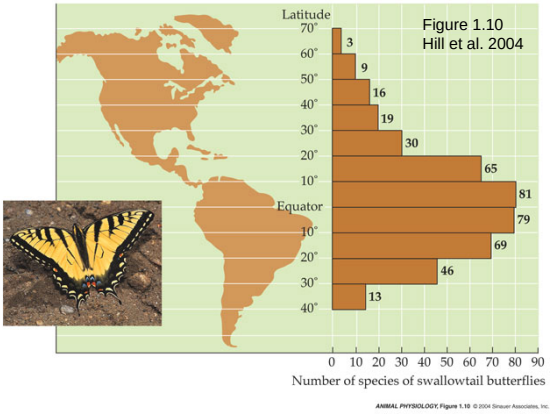


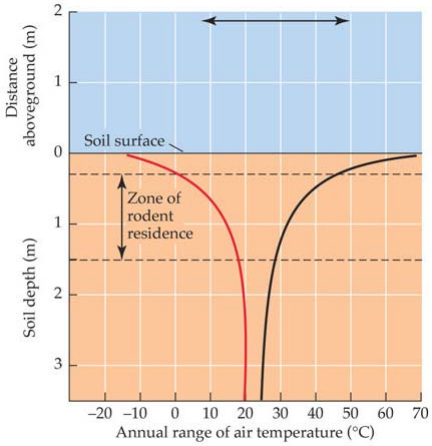
Figure 1.10
Hill et al. 2004

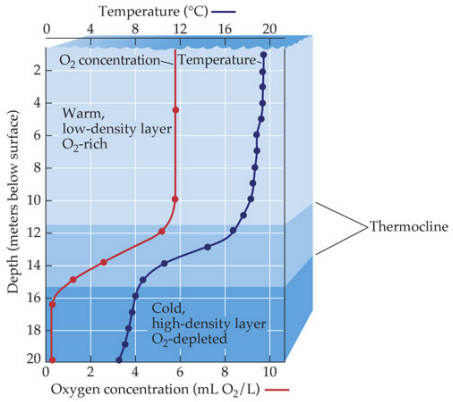
-Microhabitats
-Behavior

Environments

-Microhabitats
-Behavior

Vertebrate Physiology





Figures 1.13, 1.15
Hill et al. 2004

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Krogh principle

For many physiological questions, there is an animal model ideally suited to answer it.

Xenopus eggs

Giant squid axons

Sea raven (fish) heart

Kangaroo rat kidney

Horned lizard diet

Genetic engineering (diabetic mice, knockouts, obesity, etc.)

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Discussion Question

In small groups of about 3 students:

How would you design an experiment to test the hypothesis that saltwater crocodiles are osmoconformers?

OR

How would you ascertain whether or not the extra-long loops of Henle in Kangaroo Rat kidneys were an adaptation to their desert habitat and lifestyle?

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