# FISH270

Lecture 2

# Last time

- Questions about logistics or anything?

# Last time

- What did you do since then?

# Last time

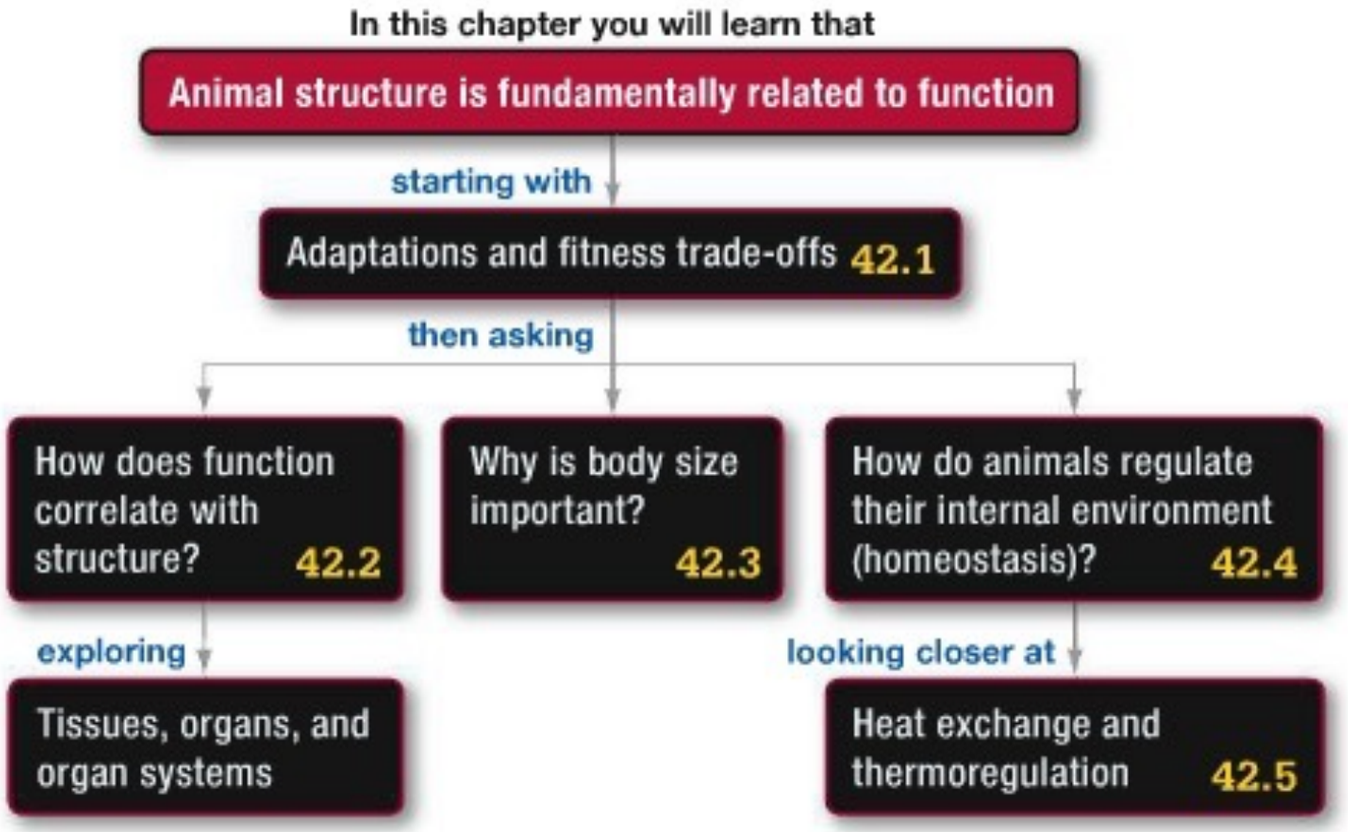
- Main points

# Today

- Form and Function

- Homeostasis

# 42 Animal Form and Function



# Anatomy and Physiology

# Adaptations

# Adaptations

*Heritable traits* that allow individuals to…

Adaptations occur through…

# Role of fitness trade-offs

## RESEARCH

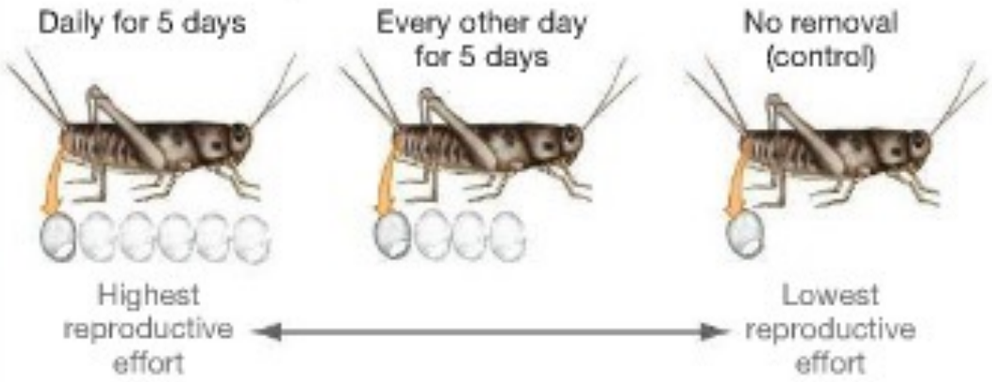
### QUESTION: Is there a trade-off between reproductive and immune function in male crickets?

**HYPOTHESIS:** Male crickets need to make an energy trade-off between reproductive function and immune function.

**NULL HYPOTHESIS:** No energy trade-off between reproductive function and immune function is required.

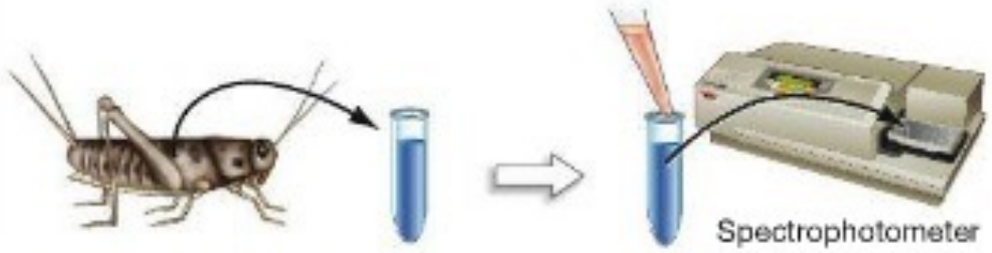
**EXPERIMENTAL SETUP:**

**1.** Remove spermatophores from male crickets:




**2.** Draw hemolymph samples from the three sets of crickets.

**3.** Add bacteria to samples; measure lysis of bacteria.

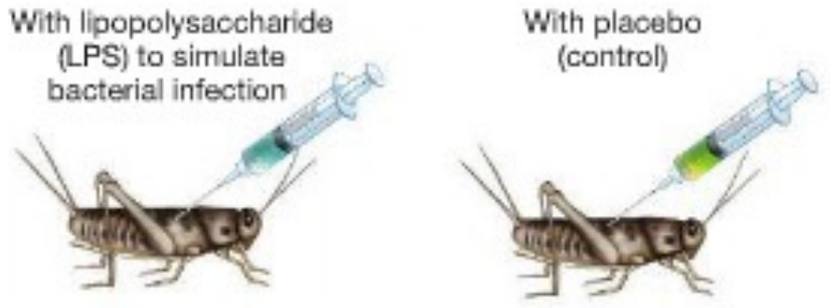



**PREDICTION:** Hemolymph from males forced to produce more spermatophores will exhibit lower lytic activity than controls.

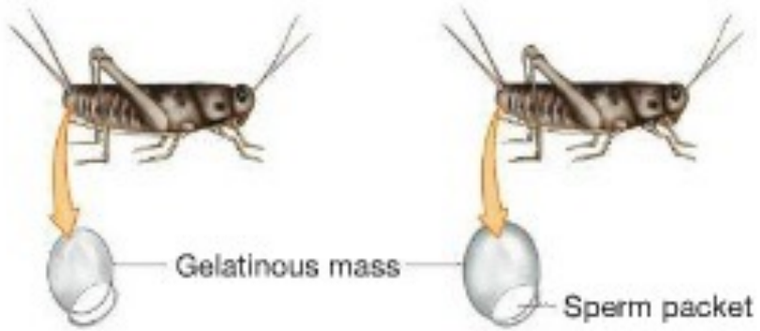
**PREDICTION OF NULL HYPOTHESIS:** There will be no difference in lytic activity between treated males and control males.

**EXPERIMENTAL SETUP:**

**1.** Inject male crickets:



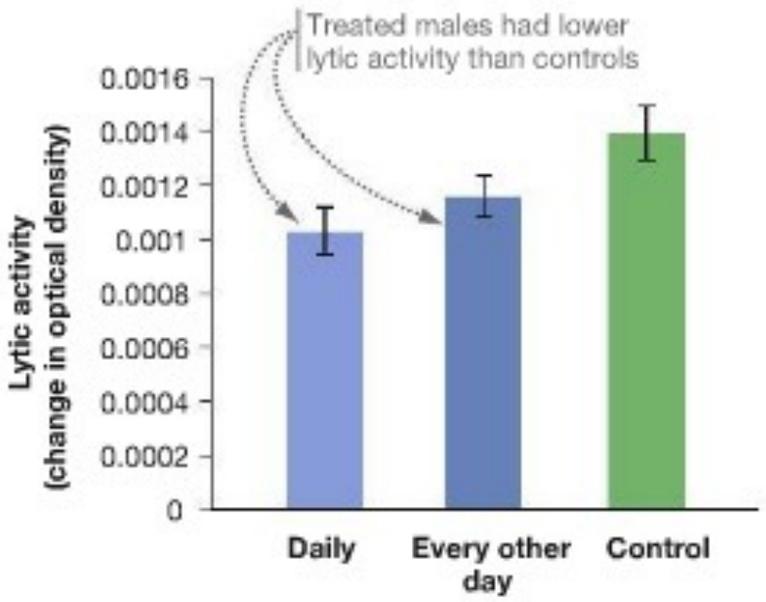

**2.** Remove spermatophores and measure size of gelatinous mass.



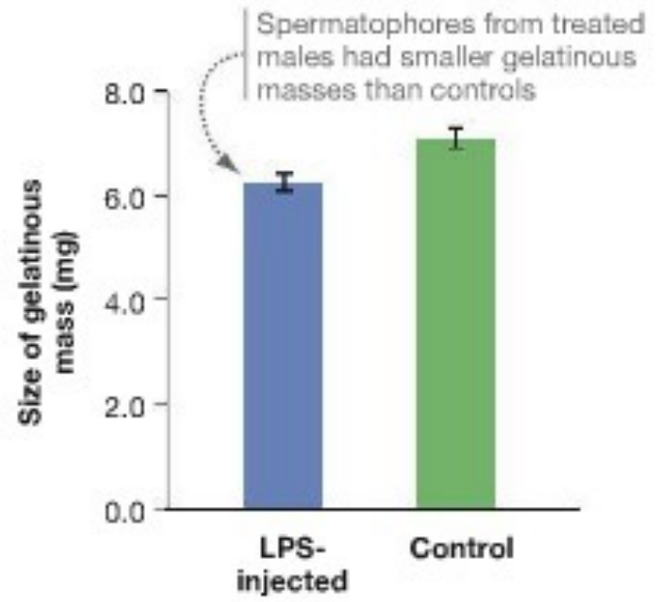

**PREDICTION:** Spermatophores from LPS-injected males will have smaller gelatinous masses than those from control males.

**PREDICTION OF NULL HYPOTHESIS:** There will be no difference in gelatinous mass size between treated and control males.

**RESULTS:**



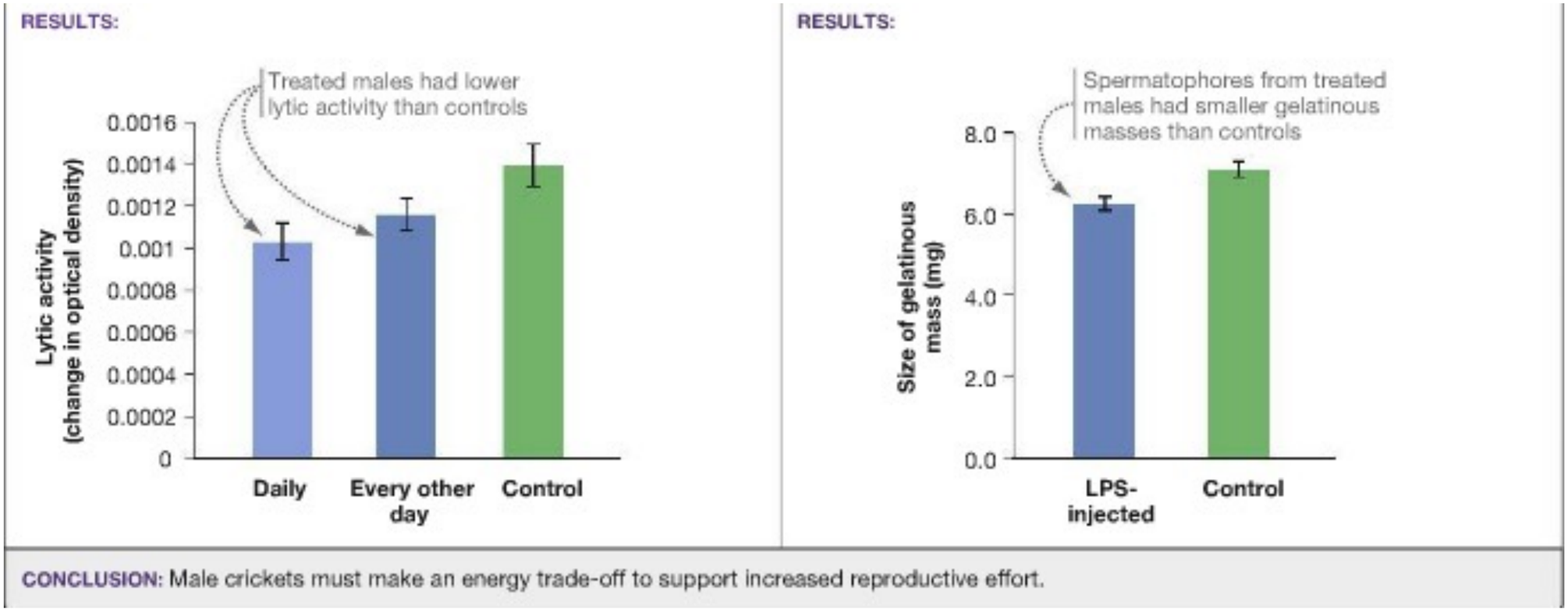

**RESULTS:**




**CONCLUSION:** Male crickets must make an energy trade-off to support increased reproductive effort.

Taken together, these two sets of experiments provide very strong evidence that there is a trade-off between reproductive and immune function in crickets.

Trade-offs, such as the compromise between energetic investment and the competing demands of reproductive and immune function, are common in nature. Desert animals that sweat to cool off are threatened with dehydration. An eagle's beak is superbly adapted for tearing meat but not for weaving nesting materials together. In studying animal anatomy and physiology, biologists study compromise and constraint as well as adaptation.



# Adaptation and Acclimatization

# Structure and Function

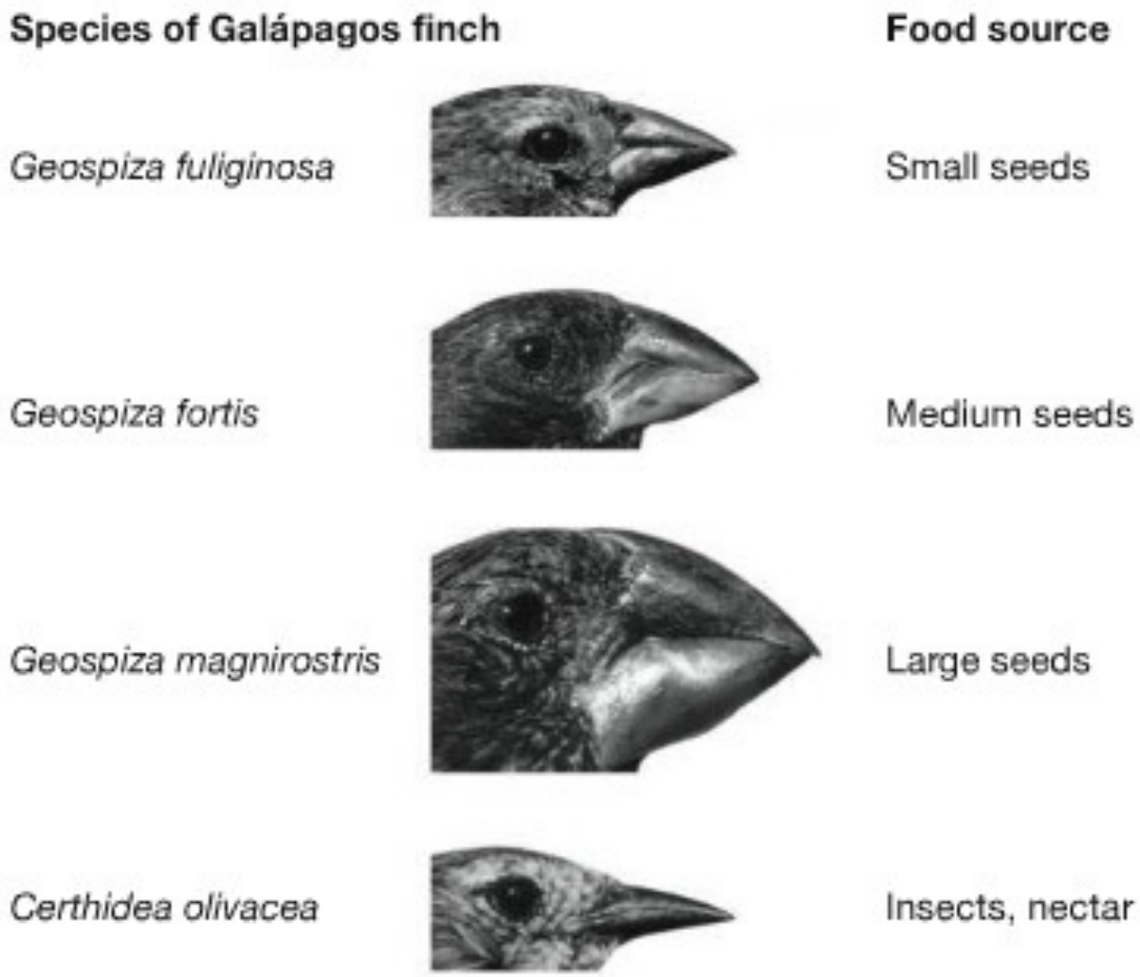
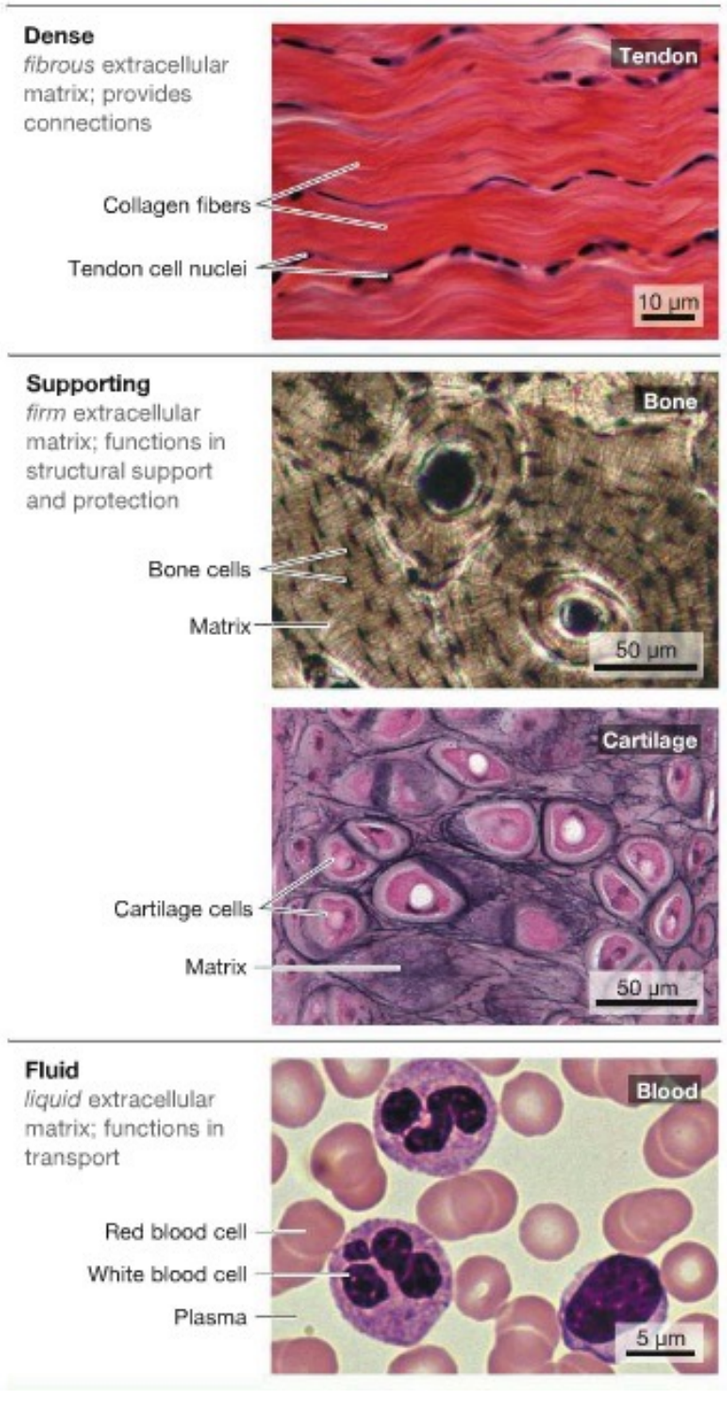
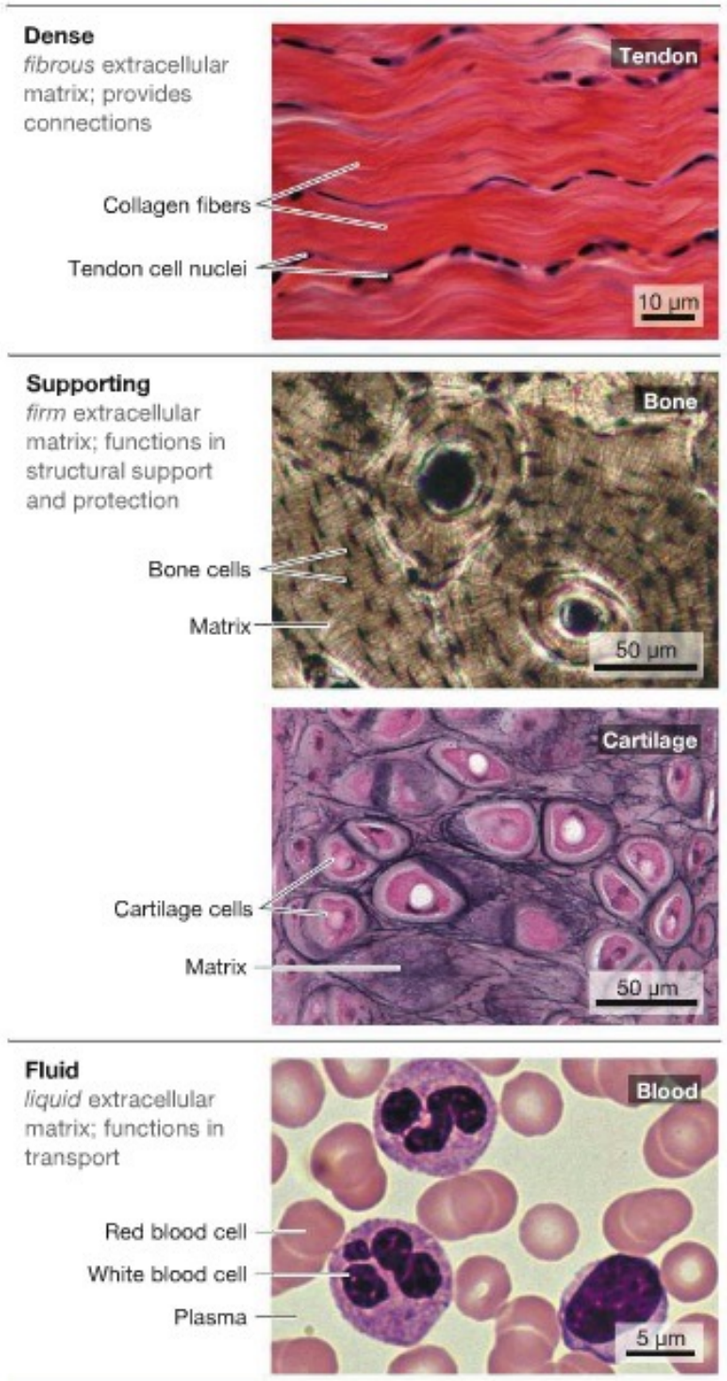



**FIGURE 42.3 In Animal Anatomy and Physiology, Form Often Correlates with Function.**

# Structure and Function

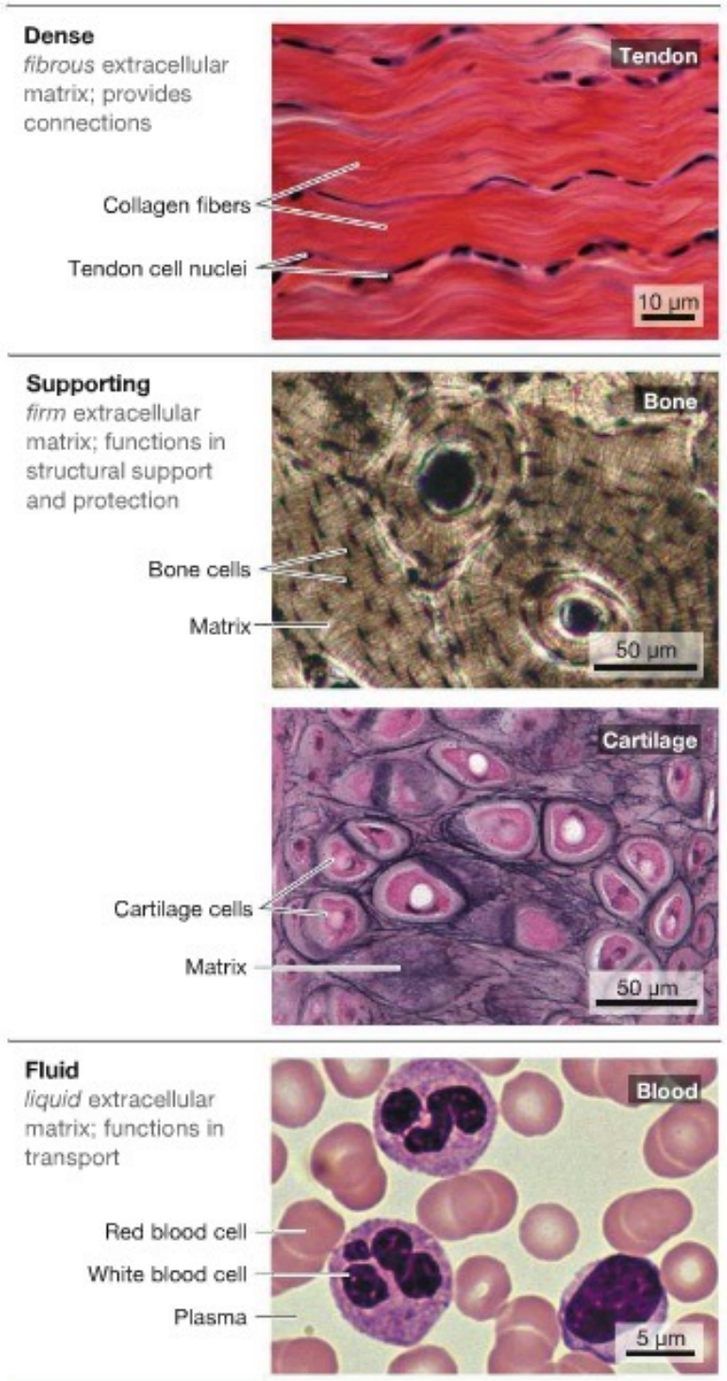


# Structure and Function




Connective tissue
Nervous tissue
Muscle tissue
Epithelial tissue

# Structure and Function



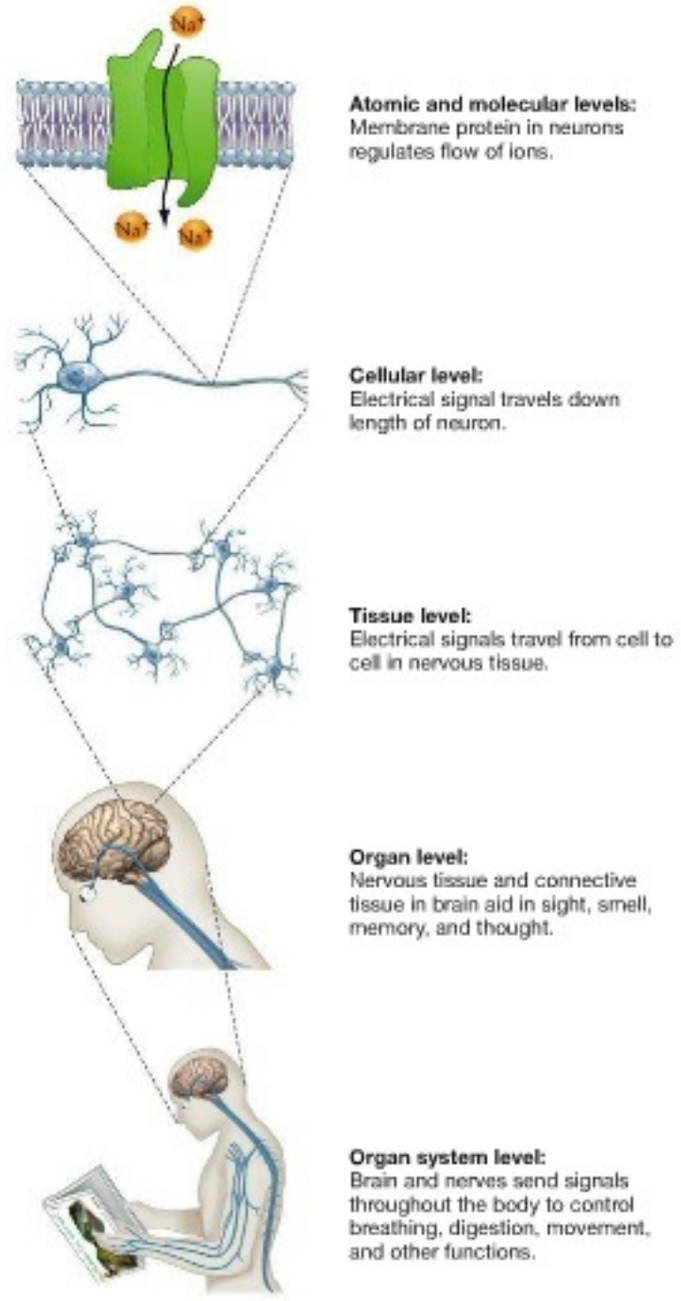

**Connective tissue**

Nervous tissue

Muscle tissue

Epithelial tissue

# Structure and Function



# Structure and Function

## check your understanding

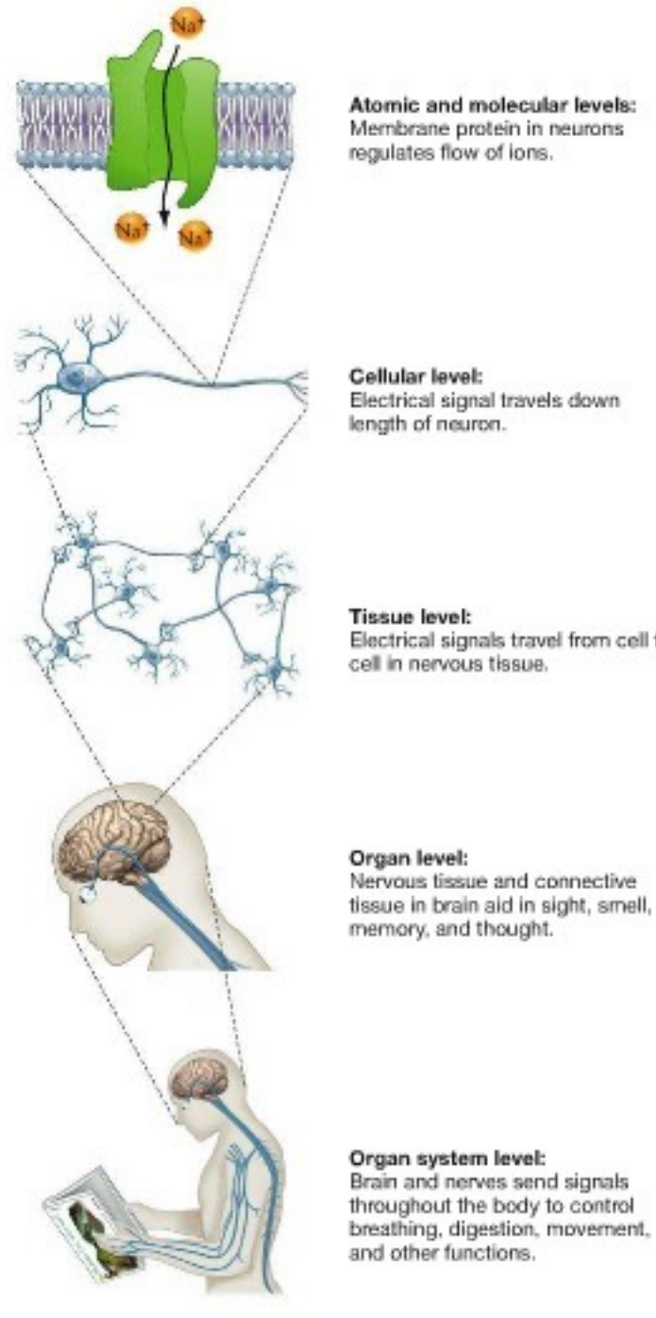
C Y U

**If you understand that . . .**

- Biologists study structure and function at the molecular, cellular, tissue, organ, and organ system levels.
- Events at each level of organization in an individual interact to form an integrated whole that responds to the environment in appropriate ways.

✔ **You should be able to . . .**

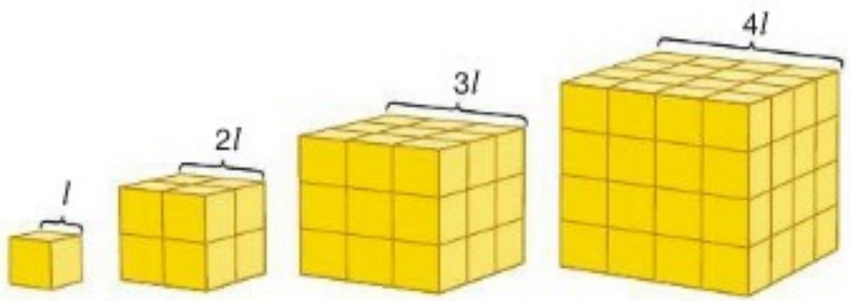
Describe and compare the structure and function of the four major types of animal tissues.



# Body size and Physiology

# Body size and Physiology

**(a)** What are the surface area and volume of each cube?




| | | | | |
|---|---|---|---|---|
| **Surface area** | $6l^2$ | $6(2l)^2 = \mathbf{24}l^2$ | $6(3l)^2 = \mathbf{54}l^2$ | $6(4l)^2 = \mathbf{96}l^2$ |
| **Volume** | $l^3$ | $(2l)^3 = \mathbf{8}l^3$ | $(3l)^3 = \mathbf{27}l^3$ | $(4l)^3 = \mathbf{64}l^3$ |
| **Ratio** (surface area/volume) | **6:1**$l$ | **3:1**$l$ | **2:1**$l$ | **1.5:1**$l$ |

**(b)** Surface area and volume of a cube versus length of a side

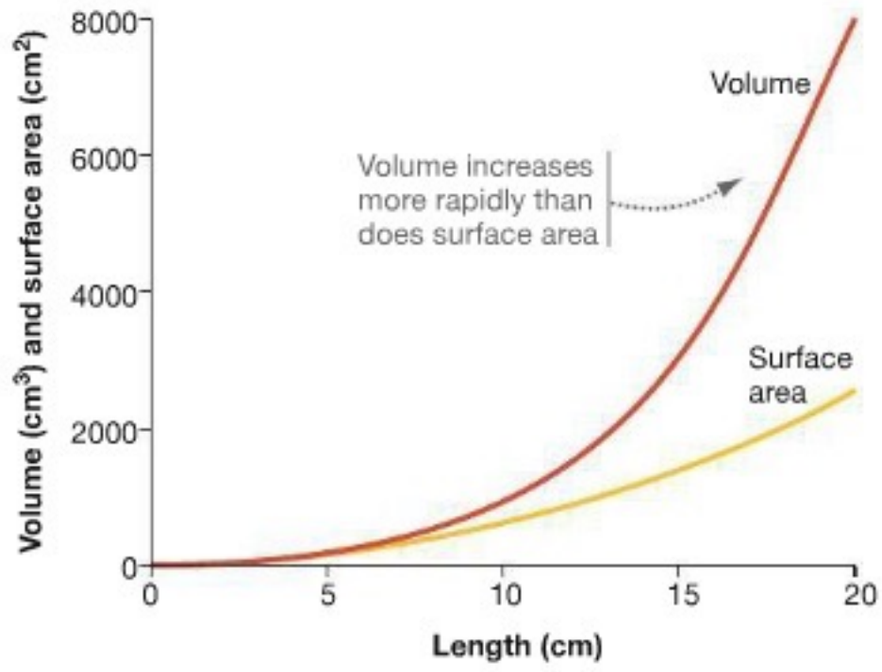



**FIGURE 42.9 Surface Area and Volume Change as a Function of Overall Size. (a)** The surface area of an object increases as the square of the length ($l$). The volume increases as the cube of the length. **(b)** Volume increases much more rapidly than does surface area as linear dimensions increase.

# Body size and Physiology

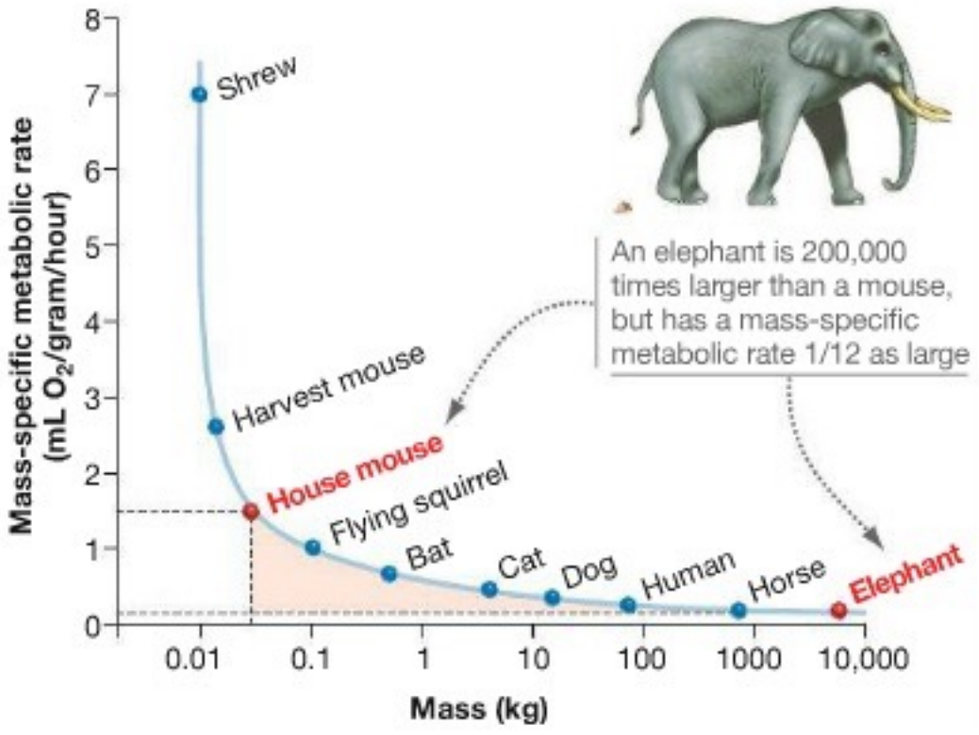



**FIGURE 42.10 Small Animals Have Higher Relative Metabolic Rates than Large Animals Do.** Overall body mass, plotted on a logarithmic scale, versus metabolic rate per gram of tissue.

# Body size and Physiology

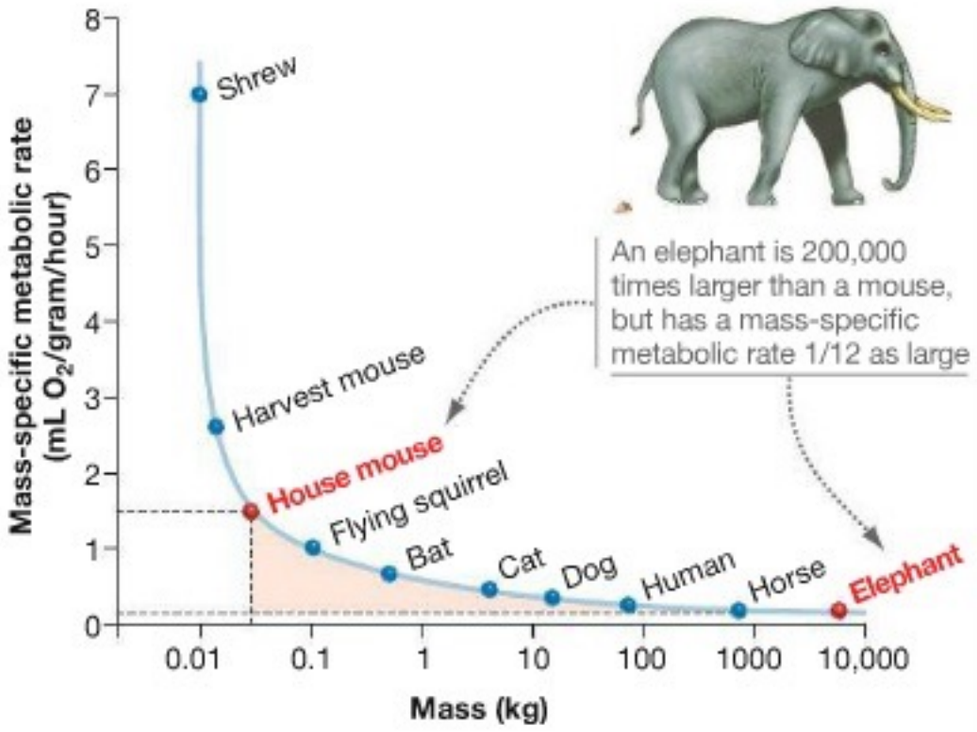



**FIGURE 42.10 Small Animals Have Higher Relative Metabolic Rates than Large Animals Do.** Overall body mass, plotted on a logarithmic scale, versus metabolic rate per gram of tissue.

change across surfaces. As an organism's size increases, its mass-specific metabolic rate must decrease. Otherwise the surface area available for exchange of materials would fail to keep up with the metabolic demands generated by the organism's enzymes.

# Salmon!!!

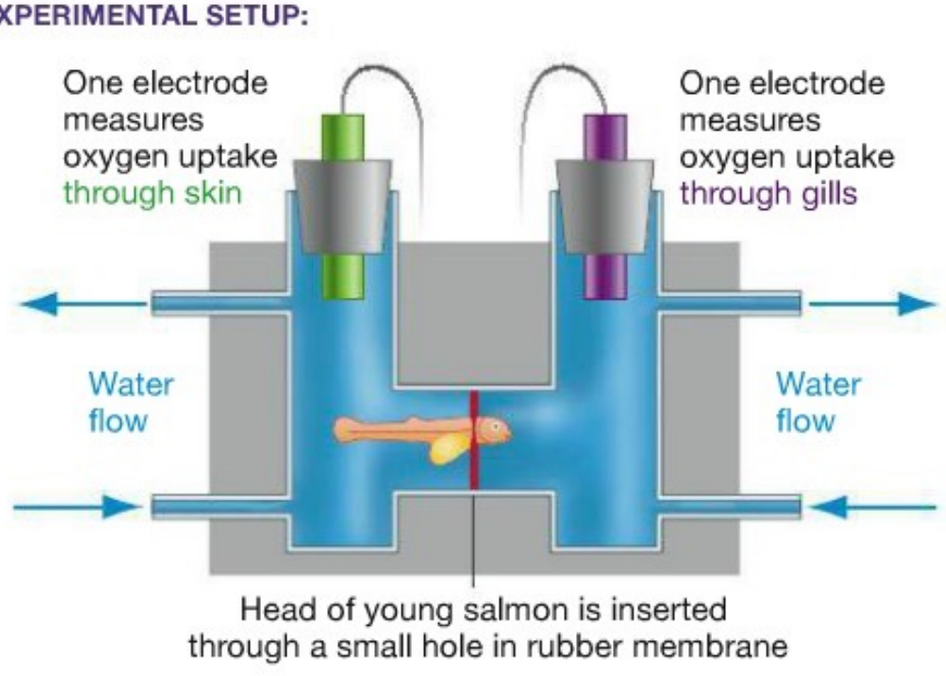
**RESEARCH**

**QUESTION:** Newly hatched salmon can breathe through their skin and through their gills. Which predominates?

**HYPOTHESIS:** The relative amount of gas exchange across gills and skin changes as a salmon grows.

**NULL HYPOTHESIS:** The relative amount of gas exchange across gills and skin does not change as a salmon grows.

**EXPERIMENTAL SETUP:**




**PREDICTION:** Juveniles will exchange a higher percentage of gas across gills and a lower percentage of gas across skin than larvae.

**PREDICTION OF NULL HYPOTHESIS:** Juveniles and larvae will exchange the same percentage of gas across gills and skin.

# Salmon!!!

**RESEARCH**

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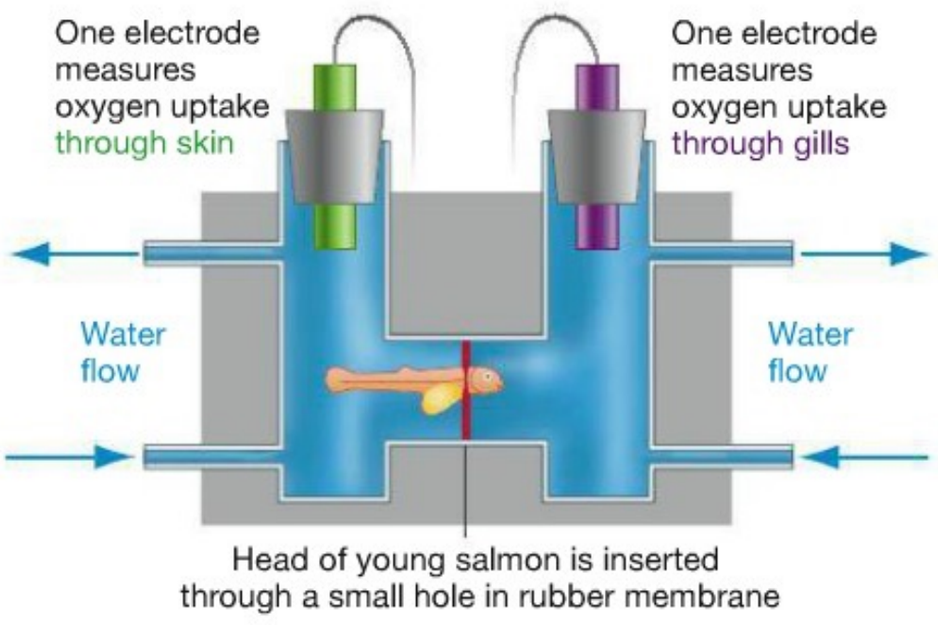


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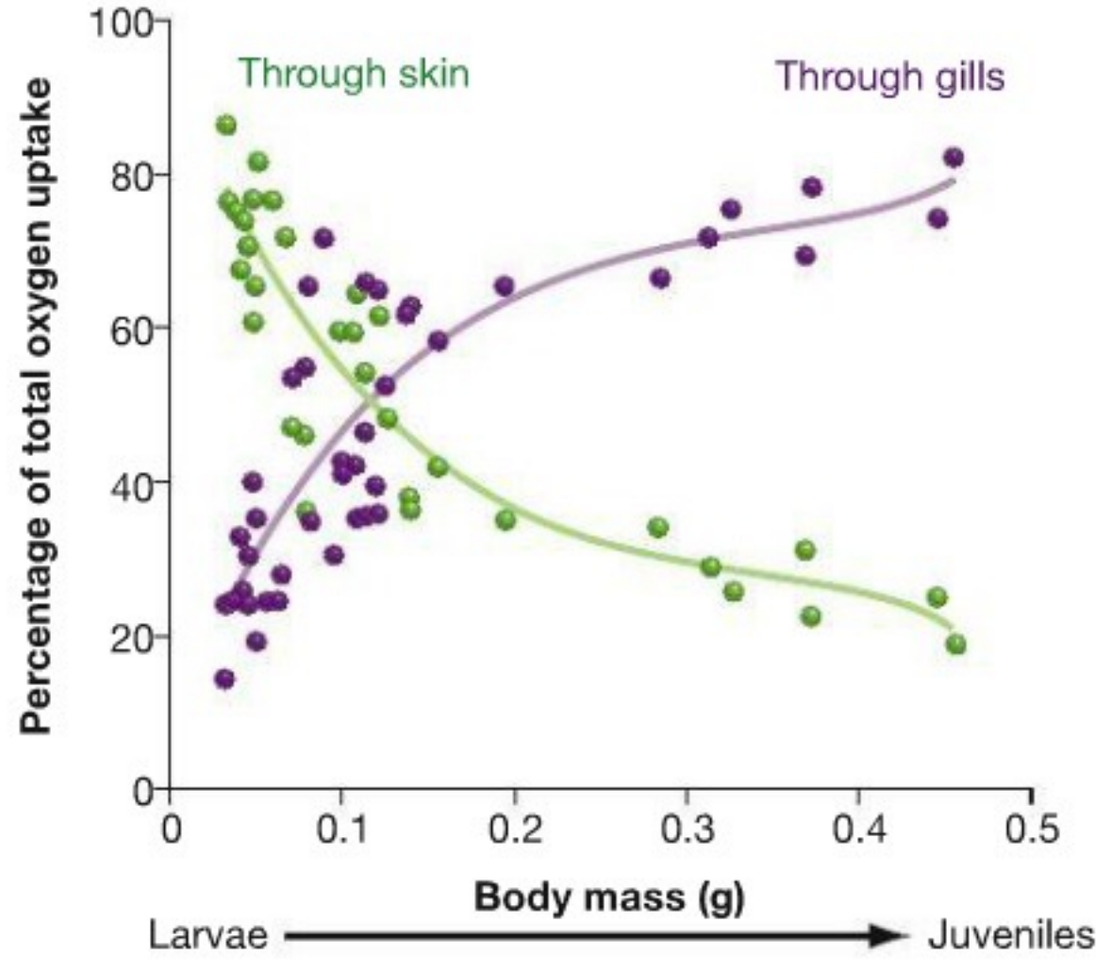


**CONCLUSION:** Breathing changes from skin to gills as larvae grow. Interpretation: Gills provide larger surface area relative to increasing volume of body.

Can surface area be increased?

## check your understanding

C Y U

**If you understand that . . .**

- An animal's overall size is important in part because body mass is affected by an array of physical forces.
- The amount of heat and waste that an animal produces and the amount of food and oxygen that it requires are proportional to its mass or volume.
- The amount of surface area available relative to that mass or volume is critical, because heat exchange and other important processes take place across surfaces.

**✔ You should be able to . . .**

1. Explain why large animals have a relatively low surface area/volume ratio.

# Homeostasis

# Homeostasis

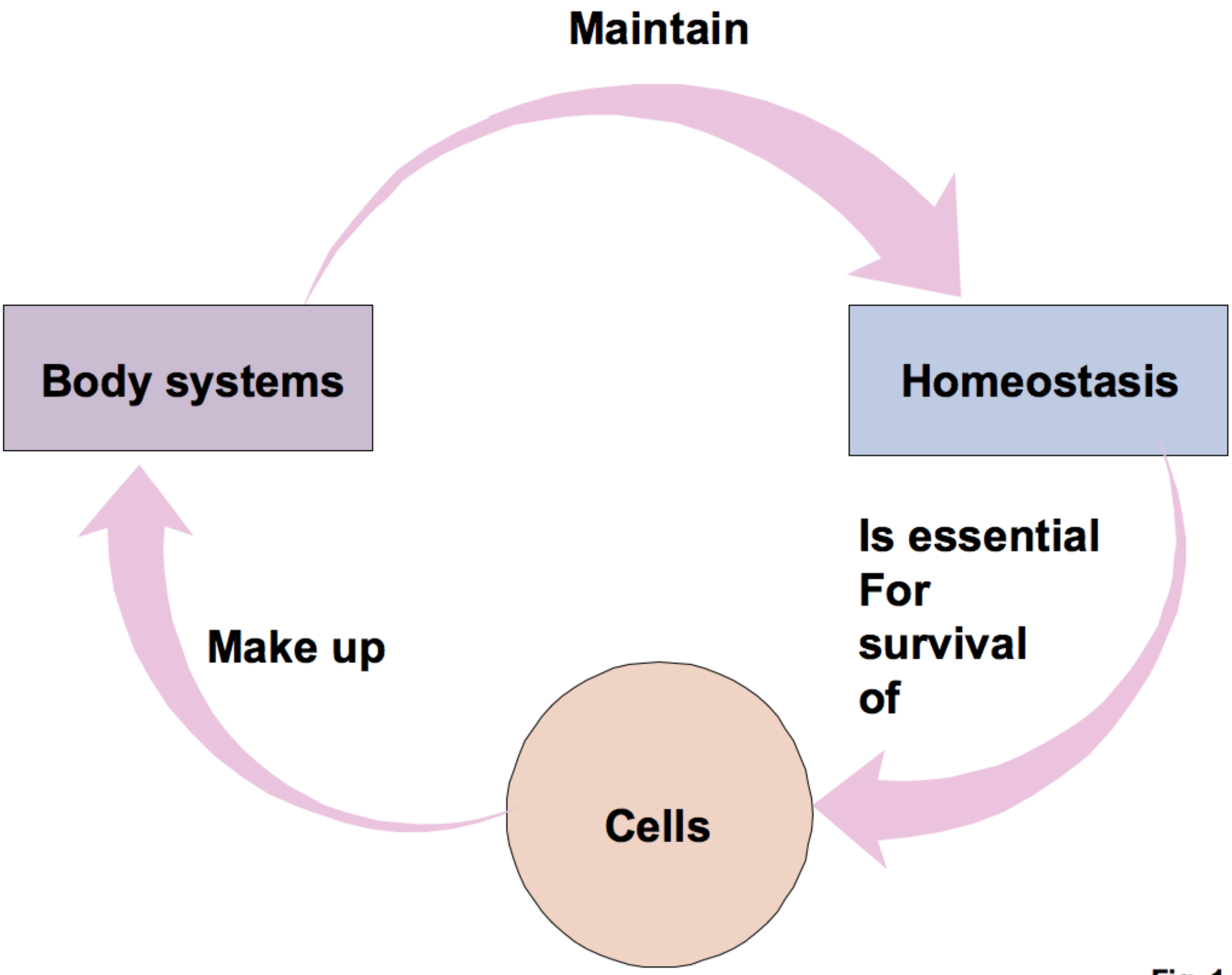


Fig. 1-6, p.11

# Homeostasis

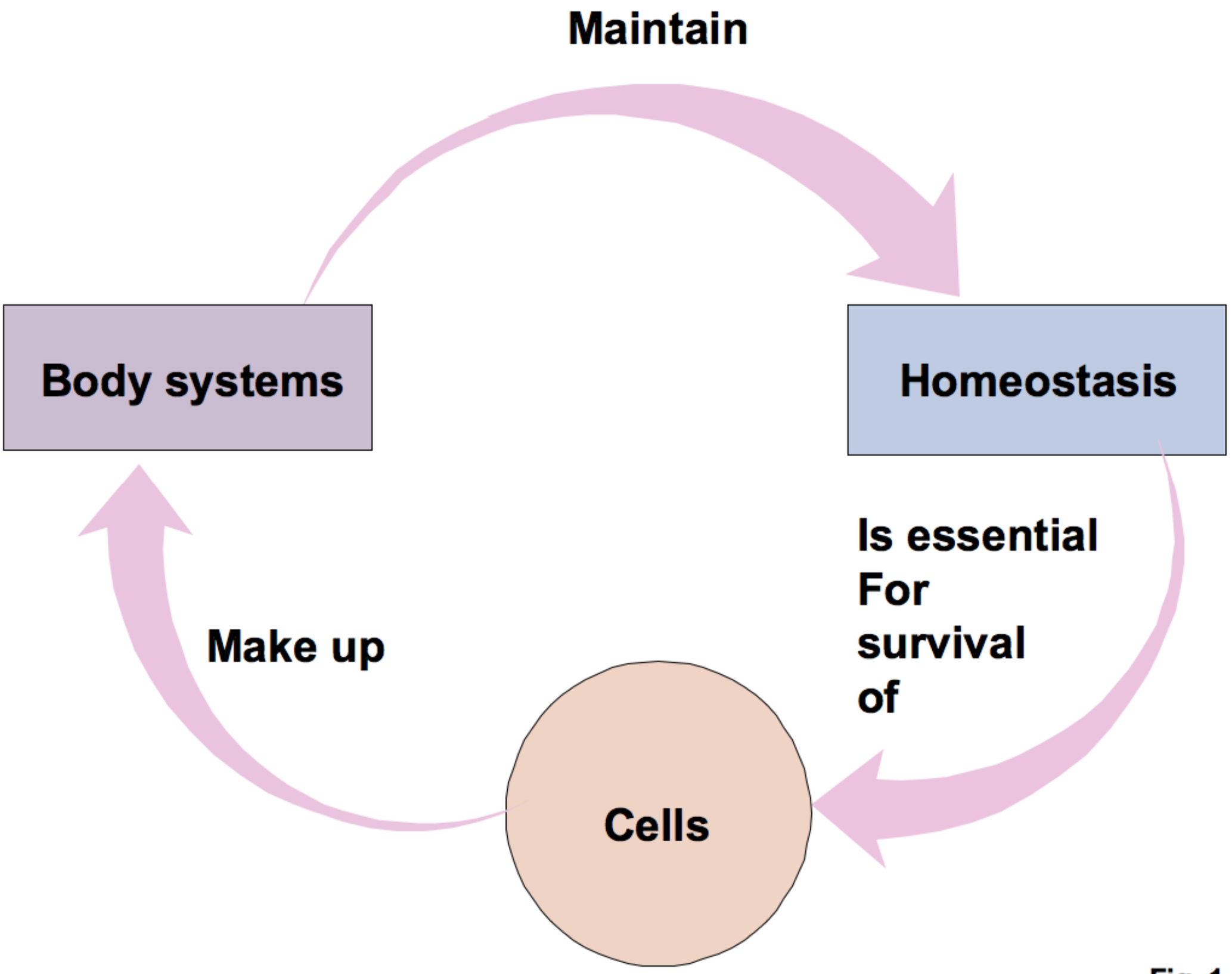


Fig. 1-6, p.11

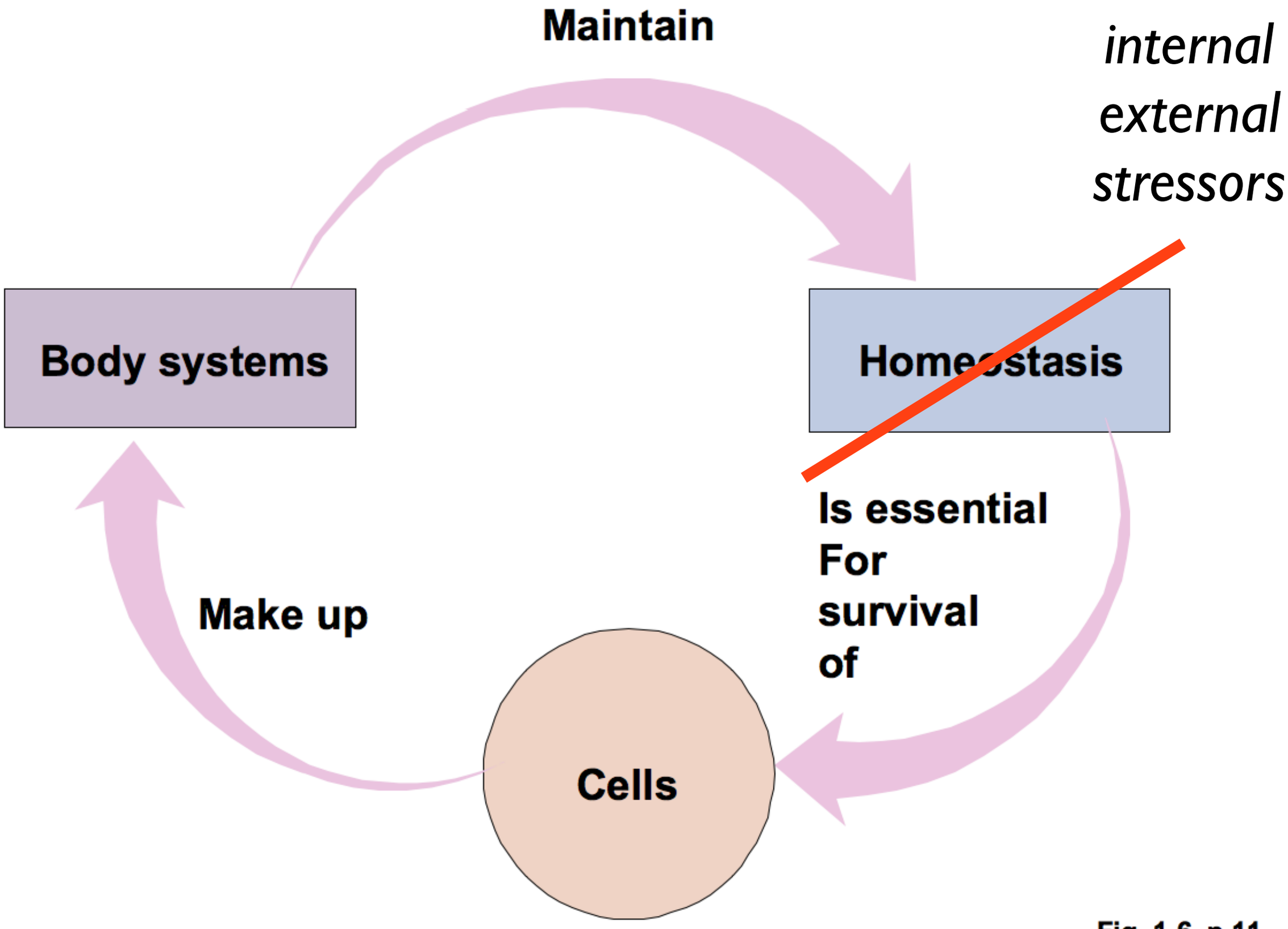
Maintain
internal
external
stressors
Body systems
Homeostasis
Is essential
For
survival
of
Make up
Cells

Fig. 1-6, p.11

# Homeostasis

## Factors of internal environment often regulated

# Homeostasis

## Factors of internal environment often regulated

- Concentration of energy rich molecules
- Concentration of O2 and CO2
- Concentration of waste products
- pH
- Concentration of water, salt, and other electrolytes

---

- Volume and pressure
- Temperature
- Social Parameters

# Homeostasis

- Most intrinsic and extrinsic control systems generally operate on the principle of negative feedback
- Inadequacies in basic negative feedback systems can be improved with feedforward systems and acclimatization systems.
- Pathophysiological states ensue when one or more of organisms systems fail to function properly.

# Homeostasis

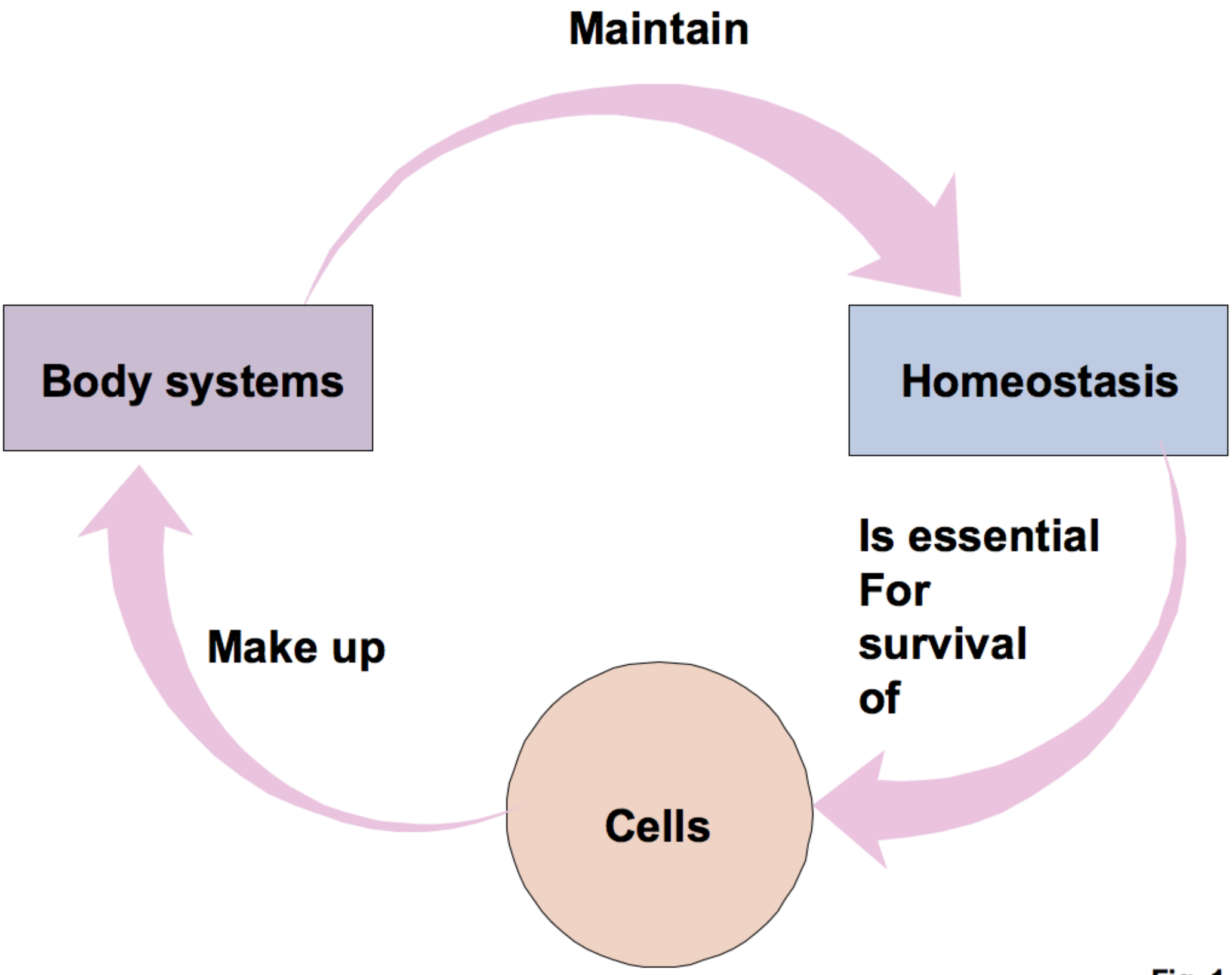


Fig. 1-6, p.11

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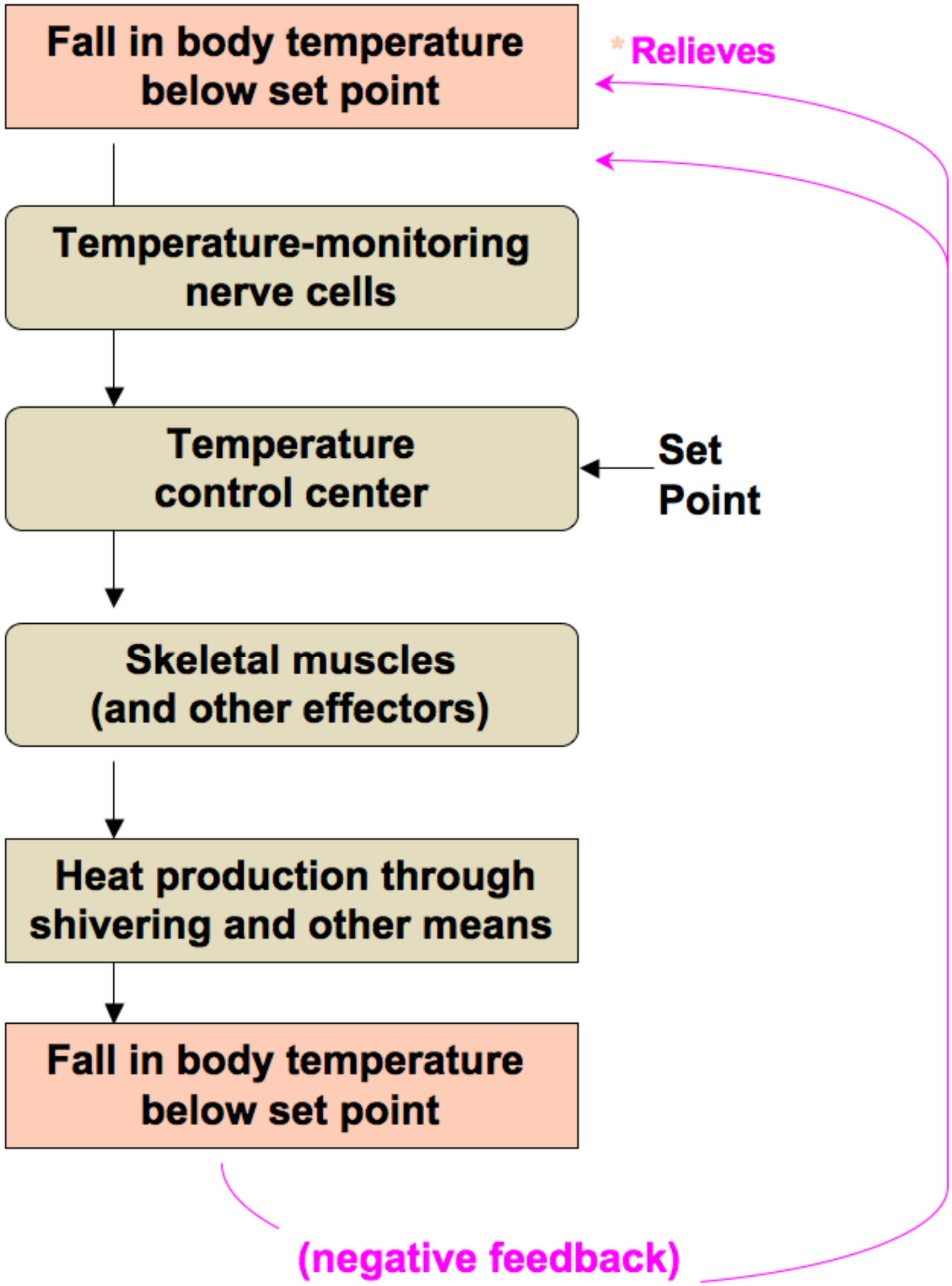
# Maintenance



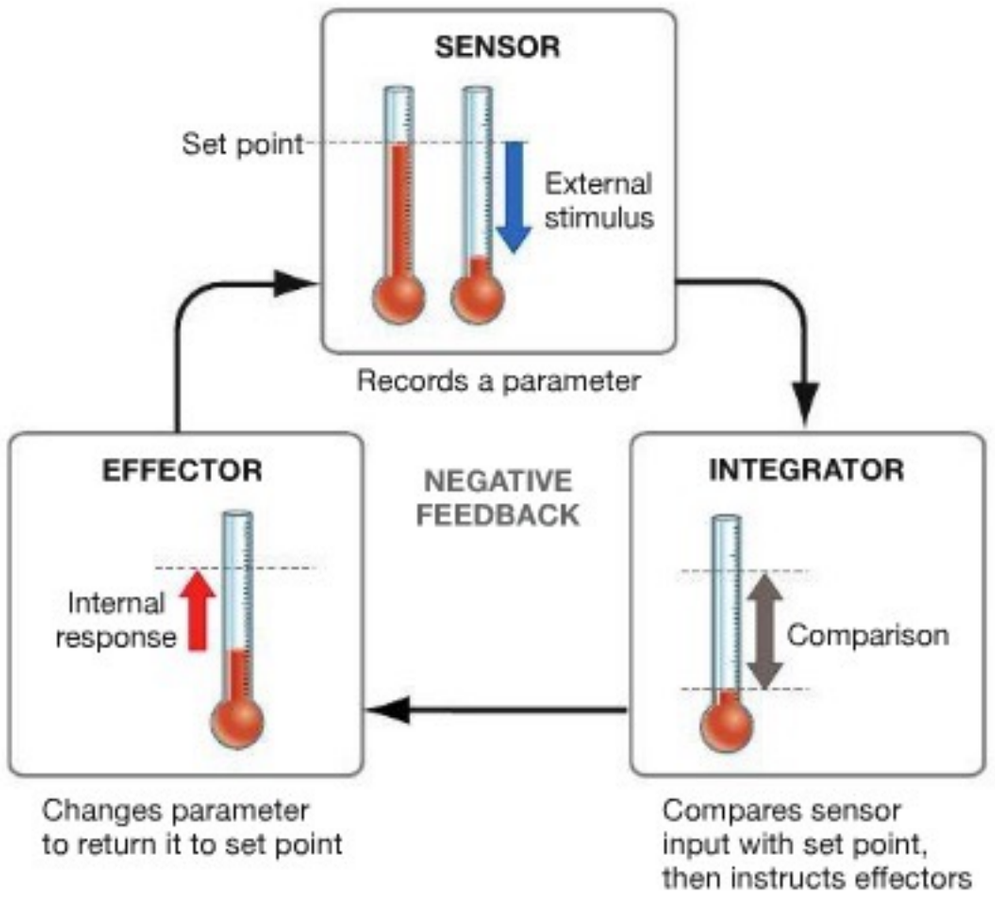
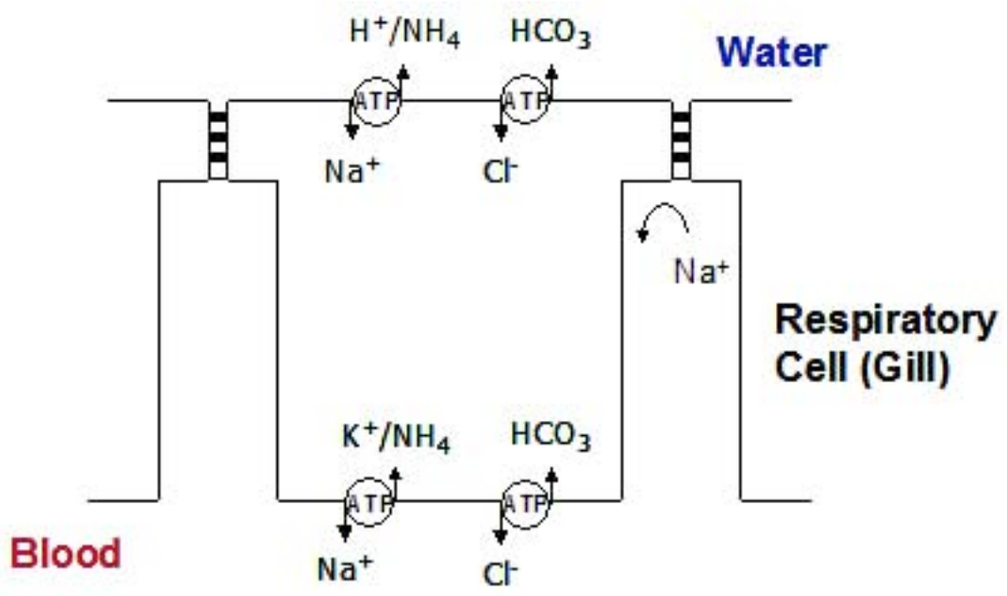
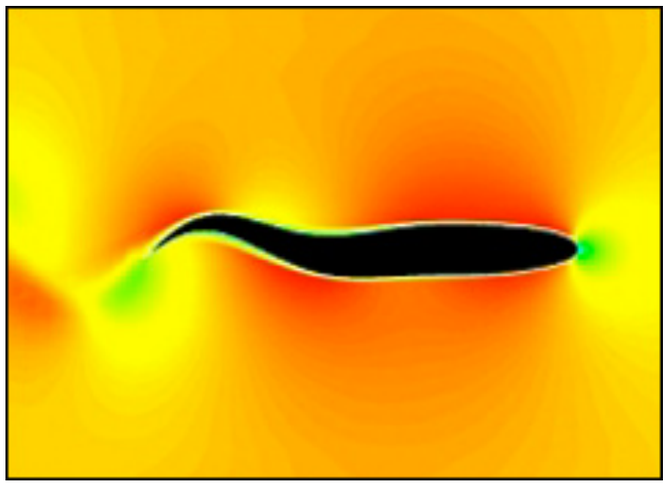



**FIGURE 42.13 Animals Achieve Homeostasis through Negative Feedback.** Many animals use homeostatic systems similar to this one to maintain a preferred range of hydration, blood pH, blood pressure, calcium ion concentration, body temperature, and so on.

# Effector
# Internal cells AND
# *Behavior*
# Killifish and salinity


http://www.oxyedge-chum.com/oxygen_or_salt.htm



# Improving negative feedback

why?

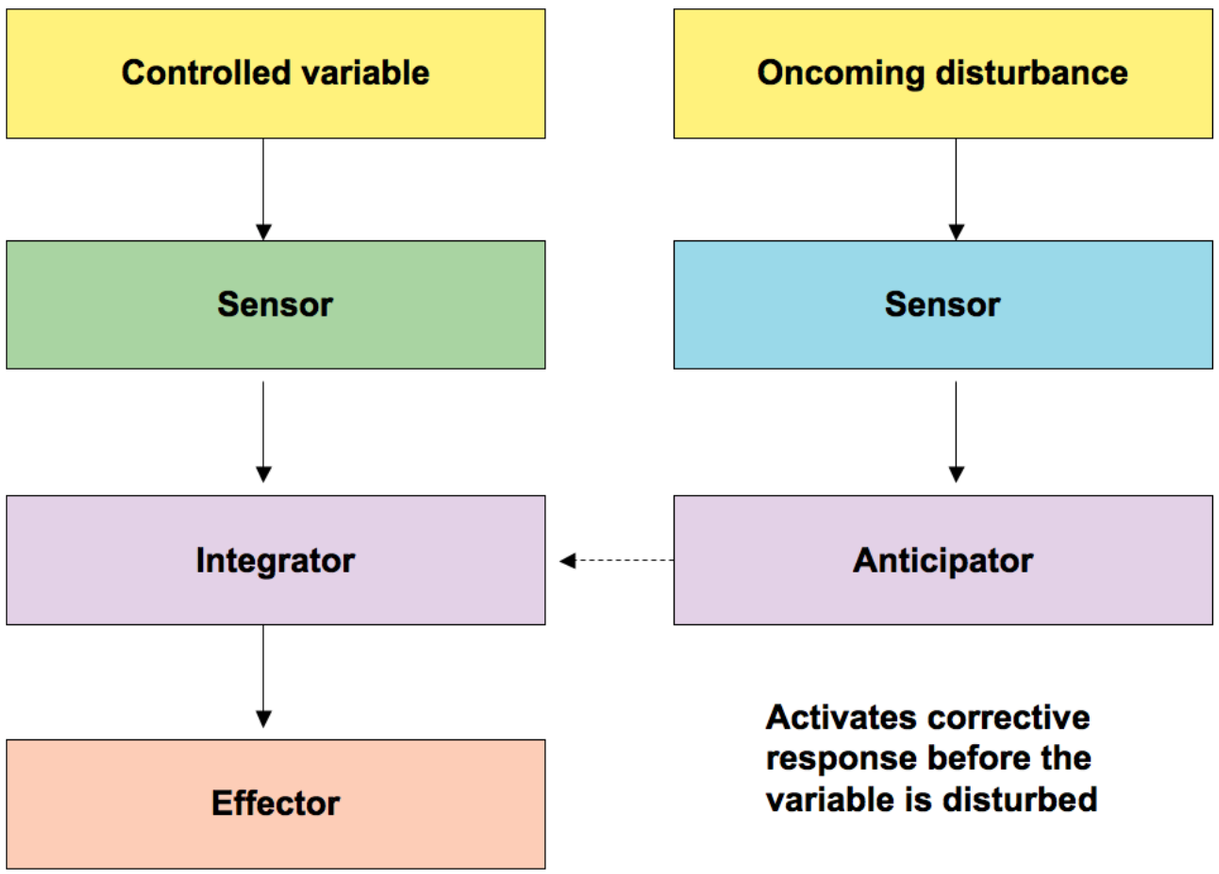
# Improving negative feedback

Anticipation

Acclimatization

# Improving negative feedback

## Anticipation



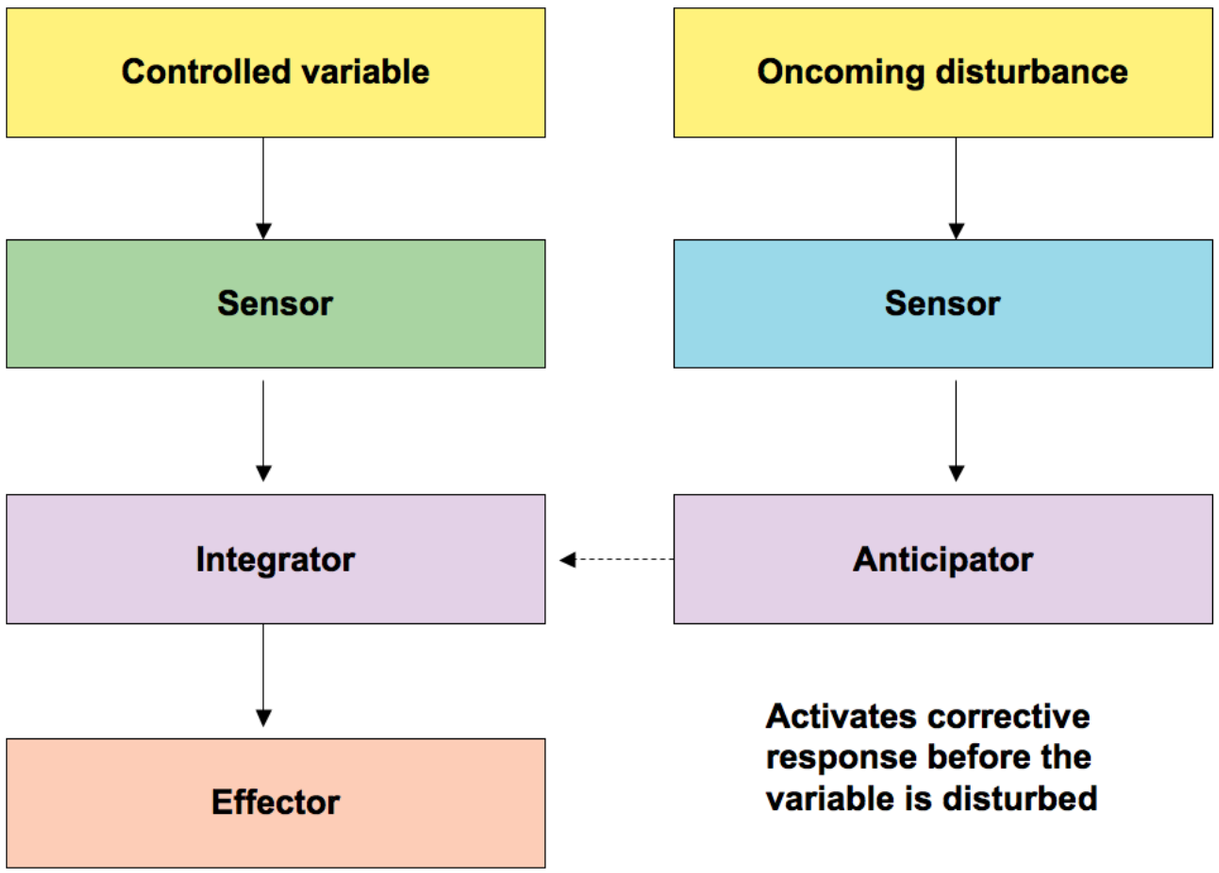

*temp*

*food*

## Acclimatization

# Improving negative feedback

## Anticipation




## Acclimatization

Uploaded on August 20, 2008
by papalars

# Acclimatization

acclimation

adaptation

# Regulated change
*when things are not homeostatic*

## Dormancy


acclimatization taken to non-homeostatic state

negative feedback will not do.

# Regulated change
*when things are not homeostatic*

## Dormancy

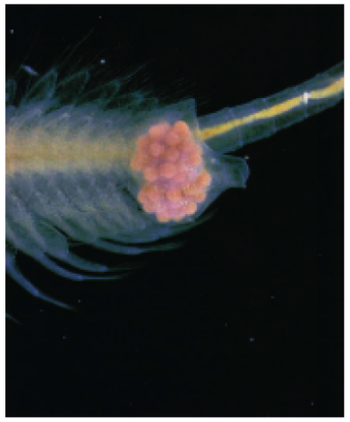
# Brine Shrimp

Class Crustacea
- Subclass Malacostraca
  - Order Isopoda—pillbugs, woodlice
  - Order Amphipoda—sand fleas
  - Order Euphausiacea—euphausiids (krill)
  - Order Stomatopoda—stomatopods
  - Order Decapoda—crabs, lobsters, shrimp, hermit crabs
- Subclass Branchiopoda—brine (fairy) shrimp, clam shrimp, water fleas
- Subclass Ostracoda—the ostracods
- Subclass Copepoda—the copepods
- Subclass Pentastomida
- Subclass Cirripedia—the barnacles

Sex and the Single Brine Shrimp

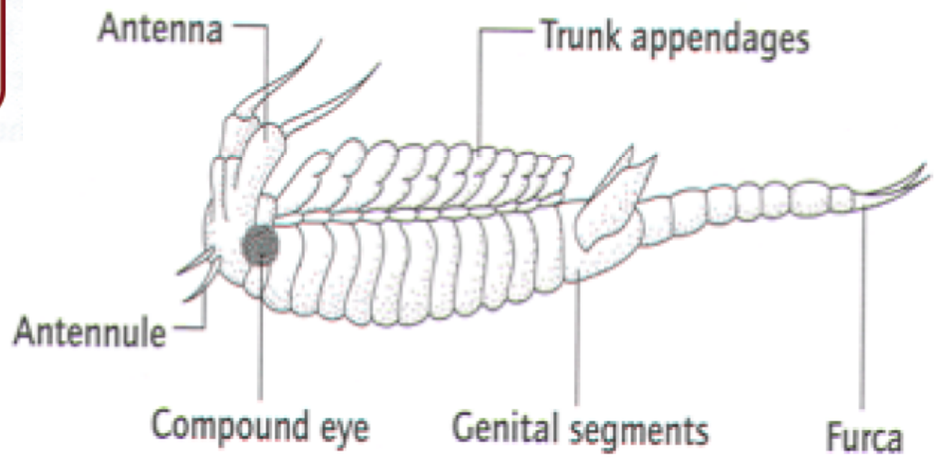
*Around the Mediterranean, female brine shrimp have been reproducing—without help from males—for millions of years*

by Robert A. Browne



## Anostraca

- Brine or Fairy Shrimps
- Lack carapace
- Brood chamber in body
- Harsh environments
- Extreme resting forms

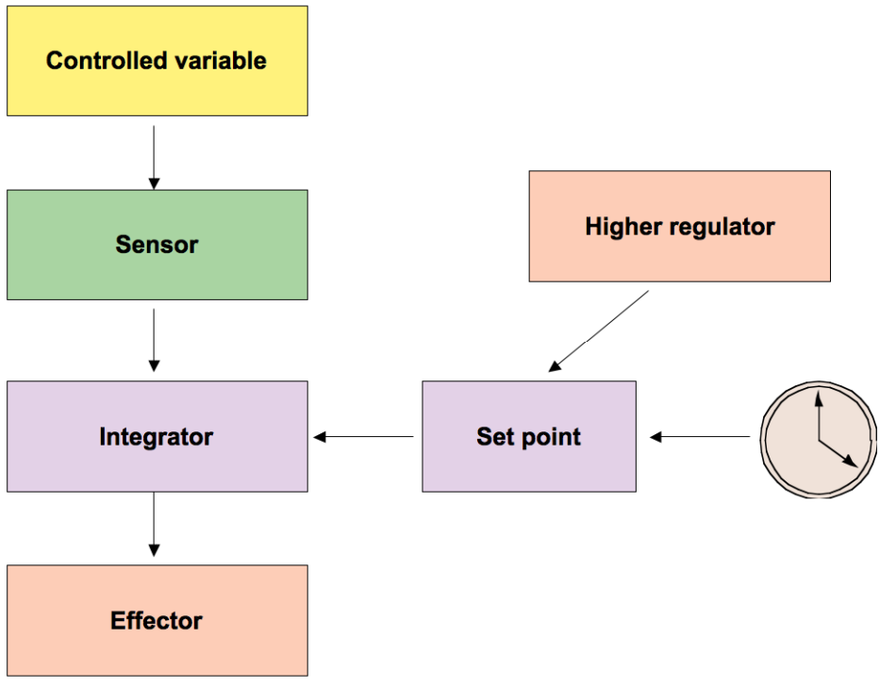



Can withstand drying, freezing, fish - birds - mammals

# Regulated change

## Dormancy


## Reset System

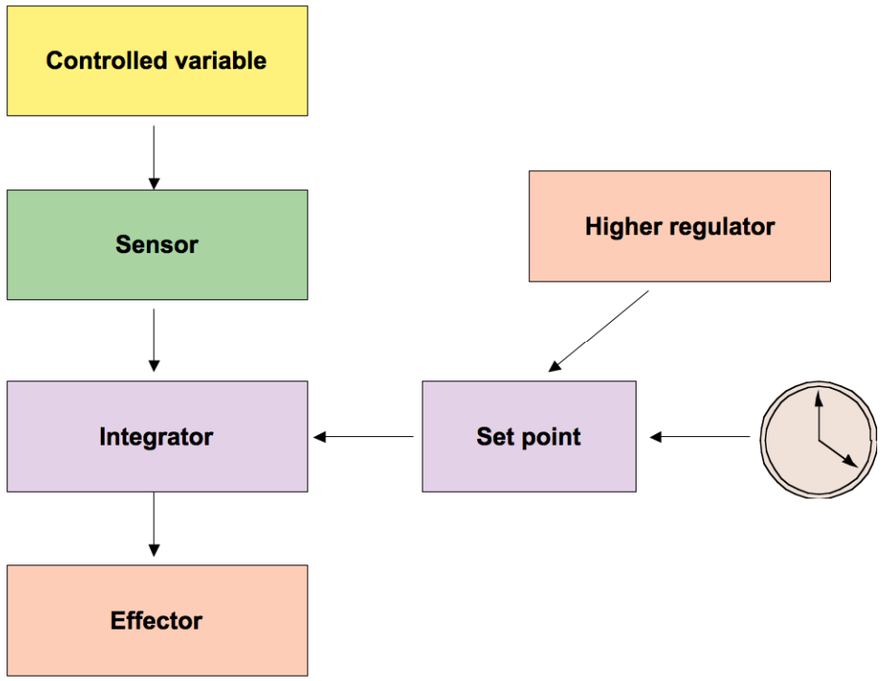



*when things are not homeostatic*

# Regulated change

## Dormancy


## Reset System





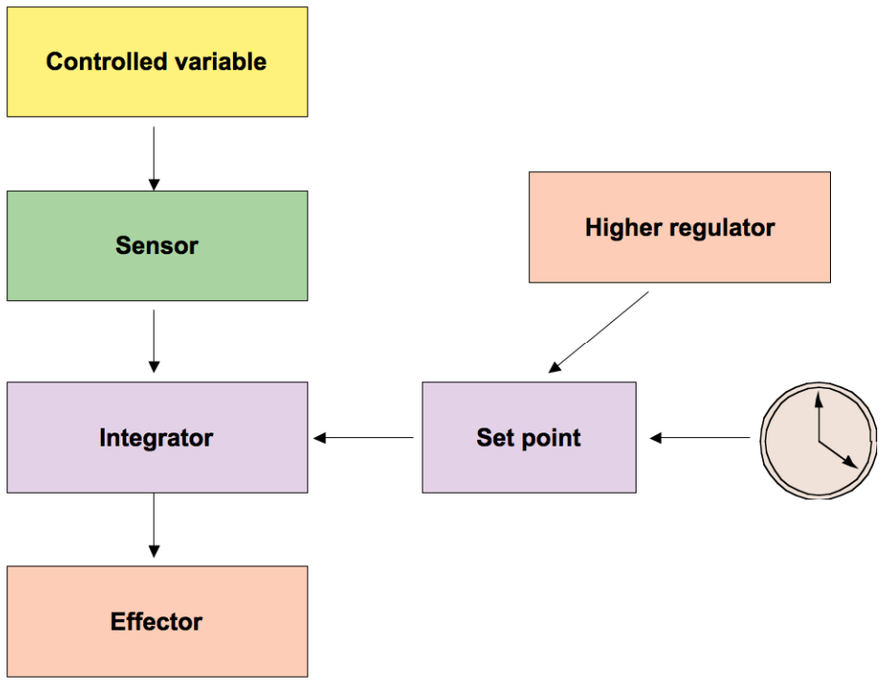
*when things are not homeostatic*

# Regulated change

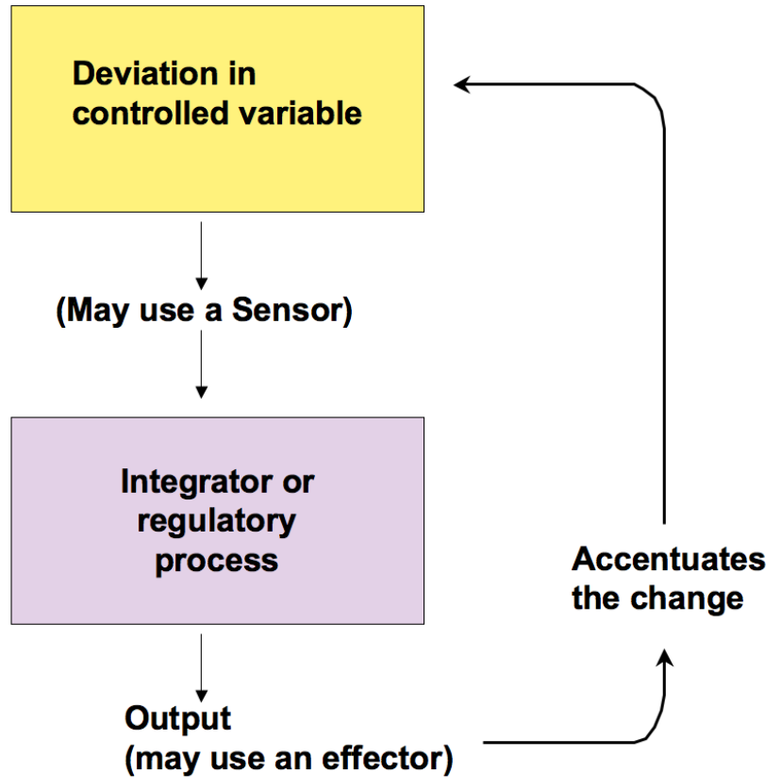
## Dormancy



## Reset System




## Positive Feedback




*when things are not homeostatic*

# Examples of positive feedback

*when things are not homeostatic*

# Regulated change

Dormancy

Reset System

Positive Feedback

1

2

3

*when things are not homeostatic*