Quick and Dirty Big Picture: We carry around inside us an environment (an "internal environment") that bathes our cells. It can't change too much or the cells and organs are damaged. Things that try to change it in one direction are met with a response in the opposite direction, so that our cell bath stays relatively constant (so we maintain homeostasis).

Why Do I Need to Know This???: It makes the rest of Physiology make sense, that is, things happen in the body in order to maintain relative stability (in order to protect cells and organs, in order to keep us alive).

Highlights of What We'll Cover:

- Definition of homeostasis
- How we maintain homeostasis (negative feedback)
- Positive feedback and feed-forward mechanisms
- How the body systems contribute to homeostasis

Homeostasis Enlightenment

Define anatomy and physiology:

Physiology – The study of the _____ of the human body (how it works)

Anatomy – The study of the _____ of the human body (How it looks)

Homeostasis – _____ function of the body systems

- Important to understand because it's what the systems are trying to _____.
- It's the foundation for most physiological processes; a "cornerstone in physiology.
    - If you don't understand it, you won't get _____ in physiology…

What is it?

"homeo" = _____ "stasis" =_____

Homeostasis

Definition of homeostasis

- Dictionary – State of _____ … maintenance of internal stability.
  Steady state
- Physiologists' – Maintenance of a _____ constant internal environment

  (Fluctuates but _____)

How does the body maintain homeostasis?

- By producing a response _____ the disturbance.

Example of body temperature (How does the body stay at 37° C in the face of outside changes in temperature?)

External factors affect body – - Cold outside
*Causes drop in body temperature – response = _____

- Hot outside
*Causes increase in body temperature – response = _____

Counter-reactions to correct for the _____ (change in body temperature)

- Response _____ the disturbance

Internal environment incredibly constant-varies only _____ (normally) if _____

Maintenance of body temperature

{ _____ 37° C

Set point:

- "_____" where the body sets its thermostat

"Set point" for blood glucose, K^+ concentration in the blood, and blood pressure (regulated variables; fluctuate within _____ limits)

Negative Feedback:

- Body keeps these variables within narrow limits by producing a reaction _____ the disturbance –
    - A counter-reaction, corrects for the disturbances = _____ feedback (control)

Other examples of negative feedback control

Thermostat

thermostat

furnace

Control of blood pressure

Pressure receptors

Heart and blood vessels

Negative feedback – direction of response compared to disturbance

BP
Disturbance

BP
response

Negative feedback occurs often in body

- Regulated variable remains relatively _____ (fluctuates around the set point)

Dynamic Equilibrium:

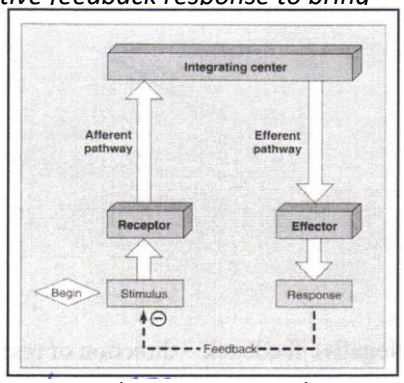
Insulin
---------- Blood Sugar Content
Glucagon

Pictured above is "Dynamic equilibrium" – alternate term for _____

- Emphasizes changes do occur "dynamic" (not a _____ state)

Extra tidbit: When you think about it, it's common sense! You can push the body too hard and the body is unable to maintain homeostasis. One extreme – the train just dropped you off alone in the wilderness, it's 4 miles to your cabin …… it's 40 degrees below zero and windy, you fall through the thin ice to your chest in water. You are able to pull yourself out but you have not thought to bring survival equipment (tent, sleeping bag, waterproof matches to make a fire, etc). Hypothermia and then death would occur because the body would be unable to maintain body temperature in this environmental extreme. Opposite extreme – 120 degrees in the shade, you are wearing a football uniform (means a limited evaporation area), haven't been replacing the fluid that you have lost, and you are practicing very strenuously (generating more heat) or you are running a marathon in severe heat. It's possible that you can't cool the body enough, you will "over-heat", and are out of the range of normal temperatures; can't maintain homeostasis.

Extra tidbit: In disease states some variable is out of the range of normal. For example, in diabetes mellitus (insulin dependent), blood glucose is abnormally high – the negative feedback response to bring down glucose (insulin) is not sufficient.



Components of negative feedback control system (in the body):

- Sensor – (_____)
- Path from sensor to control center (_____)
- Control/integrating center – compares input from sensor to set point, sends out command
  (usually central nervous system = _____, _____)
- Path from integrating center to effector (_____)
- Effector – causes effect/response (muscle or gland cells)

Note: afferent = to CNS
efferent = from CNS

Negative feedback – response _____ (corrects for) the disturbance

Positive Feedback:

- Direction of response is the _____ direction as disturbance.
- It doesn't counteract disturbance, it _____ the disturbance.
    - Occurs only rarely
    - Vicious cycle

During labor, a positive feedback cycle occurs.

_____

_____ – a hormone involved during labor.

- release _____ with stretch of cervix
- causes strong uterine _____ which
- pushes the baby against the cervix and stretches the cervix _____ which causes
- more oxytocin _____ which causes
- strong uterine contractions which …

Positive feedback cycle also occurs during the nerve impulse

Feed-forward Mechanisms:

Besides negative and positive feedback; there are feed-forward mechanisms

- Response _____ change
- (_____) of change
- Controlled variable fluctuation even _____ (narrower limits)

Example: GI tract – food in mouth _____ secretion of hormone to deal with nutrients after digested and absorbed (it happens further down in the GI tract)

Extra tidbit: Specific example of feed-forward mechanism: while food is still in the mouth, the body releases the hormone insulin from the pancreas in anticipation of the increase in blood glucose that will occur after the food is absorbed. Insulin limits the increase in blood glucose.

Also, behavioral adaptations can reduce _____fluctuations

- Wearing coat in _____

Extra tidbit: When you think about it, it's common sense! Having a tent and sleeping bag and waterproof matches would help the person who fell into the water in the wilderness – he could have lived! Less uniform to allow sweating and drinking fluid to replace fluid loss would have helped the football player maintain homeostasis. Behavioral adaptations can prevent the controlled variable from changing as much. If it is cold outside, most people have learned that wearing a coat will keep them warmer (it works better than just shivering). So we are protecting our internal environment with a behavioral adaptation. The change inside, in the face of a disturbance from outside, is reduced with the behavioral adaptation. Curling up in a cold room is another example of a behavioral adaptation to reduce heat loss.

"Internal Environment":

- Extracellular fluid = fluid that _____cells
  - ("extra"= _____)

- Cells get _____, dump _____ into it

Extra tidbit: We are not like single-celled organisms that can move away from their wastes (they throw wastes outside and move on). Our waste is released inside us and we have to deal with it. We have to regulate the "trash" in our extracellular fluid – our "internal environment". We use negative feedback control to keep our internal "trash" within acceptable limits.

- Intracellular fluid = fluid _____ cells
  - ("intra"=_____)

- Extracellular fluid = _____ (interstitial or tissue fluid) + _____

Extra tidbit – Also part of ECF: Lymph, and some special fluids (fluids in special places): synovial fluids (in joints), serous fluid (in body cavities), CSF (fluid the brain and spinal cord float in), humors of eye (fluids in the eyeball). It's really easy if you think about it, they are not part of the ICF.

Body Systems:

- Collection of _____ which together perform a _____ for the body

Contributions to homeostasis (some examples)

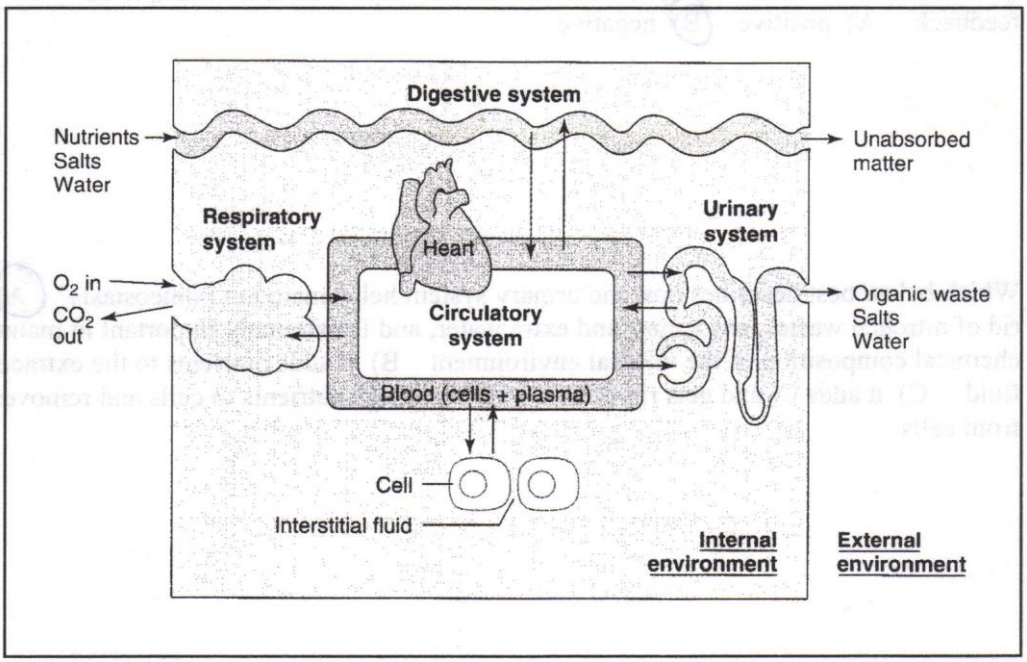
1. Digestive – adds nutrients to _____ (as our cells use them)

2. Respiratory – adds _____ to _____, gets rid of _____ from _____ (as our cells use/produce them)

3. Cardiovascular – brings _____ to cells,

   removes_____ from cells

4. Urinary – gets ride of _____ wastes and _____ ions and water (extremely important in maintaining the chemical composition of the internal environment!)



Comprehension Checks

1. Anatomy is the study of the function of the body. Physiology is the study of the structure of the body. A) True B) False

2. Which below best describes homeostasis? A) maintenance of the composition of the intracellular fluid (the fluid within cells) B) use of primarily positive feedback to keep variables as far from their set points as possible C) a relatively constant internal environment in which variables are allowed to fluctuate, but within limits D) a completely constant internal environment (a fixed state) E) not an important concept in physiology

3. In a very cold external environment, the temperature of the body decreases and shivering occurs (a "counter-reaction") which generates heat in the body. This is an example of _____ feedback. A) positive B) negative

4. Which below best describes how the urinary system helps maintain homeostasis?
A) it gets rid of nitrogen wastes, extra ions, and extra water, and is extremely important in maintaining the chemical composition of the internal environment B) it adds nutrients to the extracellular fluid C) it adds oxygen and gets rid of carbon dioxide
D) it brings nutrients to cells and removes wastes from cells

Homeostasis Objectives/Homework

1. Define physiology. (Compare it to anatomy).

Homeostasis is the maintenance of a relatively stable internal environment. Negative feedback allows correction for disturbances that can threaten homeostasis.

2. Understand the importance of the concept of homeostasis in physiology. Define homeostasis. Describe how the body maintains homeostasis – use body temperature as an example.
3. Describe set point. Understand how counter-reactions correct for a disturbance in negative feedback control systems.
4. Draw a diagram of negative feedback control of blood sugar content.
5. Describe the concept of dynamic equilibrium.
6. Describe the components of negative feedback control systems. Know why it is called "negative" feedback.

Positive feedback responses occur in the body (rarely), they are in the same direction as the original disturbance.

7. Describe positive feedback including how often it occurs in the body. Understand the positive feedback cycle that occurs during labor.

Feed-forward mechanisms, behavioral adaptations protect homeostasis.

8. Describe feed-forward mechanisms (including the effect on a controlled variable's levels). Describe how behavioral adaptations can (like feed-forward mechanisms can) reduce fluctuation of the controlled variable.

The "internal environment" has a specific meaning.

9. Define the internal environment. List the subdivisions of the extracellular fluid.

The body systems, in some way, all contribute to homeostasis.

10. Know the examples given in class of how the body systems help maintain homeostasis.

Homeostasis Quiz (Select the single **BEST** answer)

1. Which body system below contributes to homeostasis?
    a. Urinary
    b. Cardiovascular
    c. Both A and B
    d. Neither A nor B
2. Homeostasis is the maintenance of a relatively constant _____ fluid.
    a. Extracellular
    b. Intracellular
3. A negative feedback response _____ the disturbance; a positive feedback response _____ the disturbance
    a. Reinforces; counteracts
    b. Counteracts; reinforces
4. In feed-forward mechanisms, a response occurs _____ the change in the controlled variable, which tends to _____ fluctuation of the controlled variable.
    a. After, increase
    b. After, decrease
    c. Before, increase
    d. Before, decrease
5. When blood pressure increases, sensory receptors (pressure monitoring nerve cells) are stimulated and cause a response to _____ blood pressure. This is an example of _____ feedback
    a. Increase, positive
    b. Increase, negative
    c. Decrease, positive
    d. Decrease negative
6. Negative feedback occurs rarely in the body; it is less common than positive feedback
    a. True
    b. False
7. During labor, stretch of the cervix causes _____ oxytocin release, which causes _____ uterine contractions, which causes _____ oxytocin release. This is an example of _____ feedback.
    a. Less, more, less, negative
    b. More, less, more, negative
    c. More, more, less, positive
    d. More, more, more, positive
    e. More, more, more, negative
8. The intracellular fluid is
    a. Interstitial fluid
    b. Plasma
    c. Both A and B
    d. Neither A nor B

9. In a negative feedback control systems, the path from the sensor (receptor) to the control (integrating) center is called the
    a. Afferent pathway
    b. Efferent pathway
    c. Effector
10. Which statement below is true about homeostasis?
    a. Homeostasis is a fixed, completely unchanging state.
    b. Homeostasis is a dynamic equilibrium in which variables are allowed to fluctuate, but within narrow limits.
    c. Homeostasis is most often maintained by positive feedback responses.
    d. In order to maintain homeostasis, regulated variables are normally kept as far from their set point as possible
11. Which below is part of the extracellular fluid?
    a. Plasma
    b. Interstitial fluid
    c. Both A and B
    d. Neither A nor B
12. *Extra Tidbit: Which of the following is NOT an example a feed-forward mechanism?*
    a. *Release of gastric (stomach) secretions when you see food.*
    b. *Release of adrenaline before a marching band concert.*
    c. *Release of insulin from the pancreas in anticipation of the increase in blood glucose*
    d. *They're all examples of feed-forward mechanisms.*