A.1.2. Physiological Concepts

A. What are Physiological Concepts?

1. There are in physiology, a few **concepts** or ideas that are important to start with before going into further (physiological) details.	2. On this page, we will discuss **three** of these concepts: a. Homeostasis b. Set point c. Feed-back (positive or negative)

B. Homeostasis

1. **Homeostasis** is the ability of the body to keep its internal environment **stable** (that is; equilibrated or constant).	2. Homeostasis = "homeo-" which means home or body and "-stasis" which means static or stable.
3. What do we mean with "internal environment"?	4. These are all the conditions inside the body such as temperature, pH (=acidity), pressure, volume etc.
5. So, homeostasis is the capacity of the body to keep its inside organs and tissues **stable** as to temperature, pH, blood pressure, blood sugar, and many other variables.	6. One of the most familiar homeostatic systems is that of the body temperature control. A normal body temperature is set at 37 ^{o}C (= 98 ^{o}F)
7. The temperature **outside** the human body however can vary from very cold to very hot! In all these different external temperatures, the temperature **inside** the body must remain constant at 37 ^{o}C.	8. How does the body do that?

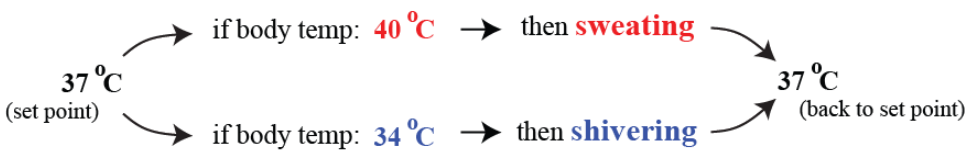
C. Homeostasis Temperature Control

1. The point of this regulatory system is to keep the temperature inside the body constant at 37 ^{o}C, irrespective of the outside temperature.	2. But, if the outside temperature is lower than 37^{o}C then the body will lose heat, through the skin, and through the respiration (breathing out the warm air). This would then **lower** the temperature inside the body.
3. To push the temperature inside the body back to 37 ^{o}C, the body must **generate** heat.	4. The most common way to generate **heat** is with its metabolism (=biochemical reactions inside the cells of the body).

5. All biochemical reactions always generate some heat. This will increase the body temperature.	6. If the outside temperature is very low, then other mechanisms to generate heat are also put in action. A good example is **shivering**. This generates a lot of heat!
7. But what happens if the outside temperature gets too **high**, above 37°C?	8. Then the opposite happens, the body must **lose heat** to get back to 37°C. Again, there are several mechanisms to do that, such as sweating, evaporation, etc.
9. In summary, the **homeostatic** temperature control system works by either generating heat or by losing heat, as required.	10. But, how does the body know that it has to lose or has to generate heat? That is the function of a **set point** together with a **feedback** loop!

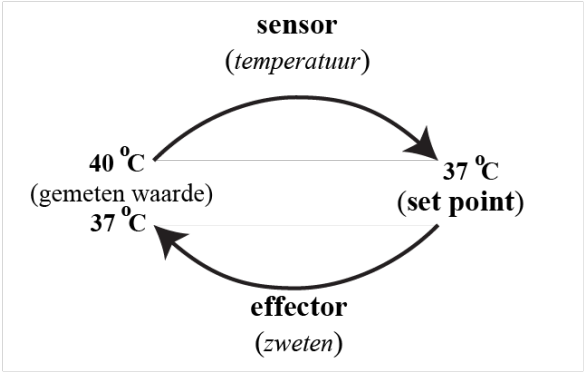
D. Set point and feed-back loop

1. A **set point** is the value at which the body wants to keep something constant and stable, in this case the temperature.	2. Such a set point is often located in the **brain**, although nobody has yet been able to identify the exact location of this particular set point.
3. The homeostatic system, also called a 'control system', always uses this set point as a constant reference for its action.	4. So, if the body temperature threatens to be **too low**, then the body will generate more heat. The opposite will happen if the body gets **too hot**.
5. But how does the body know its internal body temperature is too low or too high? For this, the body needs **temperature sensors**.	6. These body sensors measure the temperature in different parts of the body, inside the chest, the abdomen, the brain and in the skin.
7. These sensors **constantly** tell the brain set point whether the body temperature is ok, or too low, or too high.	8. If the temperature is too far off from the set point, then the brain **decides** to either increase metabolism, or to start sweating or shivering, or whatever is necessary to get the body temperature back to normal.



9. In other words, there is a loop from the sensors, through the set point to the action (shivering, metabolism etc.).	10. This loop is called '**feedback'**!!

E. Negative and Positive Feedback Loops

1. This is an important **concept** in physiology: a feedback loop.	2. A sensor measures, constantly, the body temperature, pressure, pH or whatever. These values are transmitted to specialized centers, often in the brain.
	
3. In that center, the measured value is **compared** to the set point of that variable such as the temperature.	4. If the value is too high, then **effectors** are stimulated that will **lower** the value (temperature). If the value is too low, other effectors will be stimulated to **raise** the value.
5. Please note that the system works in such a way as to reduce the fluctuations, in this case in temperature. In other words, the control systems work to **restore** the situation to the set point, i.e., the normal value.	6. This is called **negative** feedback. 'Negative' because it **minimizes** the fluctuations of the variables such as temperature in the body.
7. The opposite is also possible. This is the case in a **positive** feedback loop.	8. For example, hypothetically, if the temperature had increased, and if the system had stimulated the wrong effector, such as metabolism or shivering, then the temperature would **further** increase!
9. That obviously is not compatible with life. In fact, in biology, there are very few examples of **positive** feedbacks.	10. Most control loops in the body are **negative** feedbacks.

F. Other examples of negative and positive feedback loops

1. The most famous example of negative feedback system is the **heating** in your house. The value of the thermostat in the living room is the **set point**. If the temperature in the room gets too cold, then the heater (= the **effector**) will be turned on and will heat the room until the set point is reached again.	2. Another example, outside of biology, is the **cruise control of your car**. When it is set at a chosen speed (= the set point), the car will automatically accelerate or decelerate if the speed gets too low or too high.
3. An example of a **positive** feedback is seen in blood clotting. When a blood vessel is damaged, platelets will stick to the injured vessel and release a chemical attracting even more platelets to the same site. This will attract more and more platelets and increase the clotting process (until the bleeding has stopped).	4. Other examples of positive feedback can be found elsewhere; such as your money in a **bank account with a nice interest**. As the interest value raises the total amount, over time, more and more interest is accrued!
5. Some scientist think that the current **global warming** is an example of increasing CO_2 emissions that, in turn, further raises the earth temperature; a **positive feedback loop**!	6. By the way, there are situations in the body when the **set point can be changed**! This is for example the case when one runs a **fever**. Then the set point is raised, because the body needs extra metabolism to battle an infection, and this increase in set point will then 'automatically' increase the body temperature.

G. Interesting to know!

1. Oh yes; not all animals have a stable body temperature.	2. Those animals that have a stable temperature in their internal environment are called **homeotherm** or endotherm (=warm blooded).
3. This is the opposite of animals that cannot regulate their body temperature: **poikilotherm** (= cold-blooded), such as frogs.	4. These poikilotherm bodies cannot regulate their body temperature at all!
5. As usual, this is a first introduction into the concept of 'homeostasis' and its components. As always in Physiology, there is much more known about this concept. If you are interested, I would encourage you to read a recent review written by Billman about this concept (*see Physiology Literature*).	