

# Conceptual framework and misconceptions associated with the core principle of Homeostasis

720.4

Jenny McFarland, Joel Michael, Mary Pat Wenderoth, Harold Modell, Ann Wright & William Cliff

Edmonds Community College, Rush Medical College, University of Washington, PERC, Canisius College, Niagara University

## Overview

1. An outline of a **conceptual framework** for the core concept of homeostasis
2. **Common student misconceptions** that interfere with students' understanding of homeostasis
3. An example of how to **write a conceptual assessment question** from misconceptions

Physiology faculty identified misconceptions, we linked them to the conceptual framework and are using these to generate questions for a **conceptual assessment of physiology (CAP)** instrument (i.e., a concept inventory).

Work supported by NSF TUES grant DUE-1043443

## Methods:

- Two surveys for physiology faculty using SurveyMonkey.com were open for one month each.
- **October 2011:** 38 physiology faculty evaluated the items in our homeostasis conceptual framework as 'essential' to 'not important' for their students to understand. (Michael & McFarland 2011).
  - **December 2011:** 35 physiology faculty described *common student misconceptions* regarding: Homeostasis, Flow down gradients and Cell-cell communications.
  - Respondents included medical school, university, college and community college physiology faculty.

## Conceptual Framework

### Homeostasis Definition:

Organisms maintain a relatively stable internal environment while living in a changing external environment by actively responding to changes.

### What students should understand:

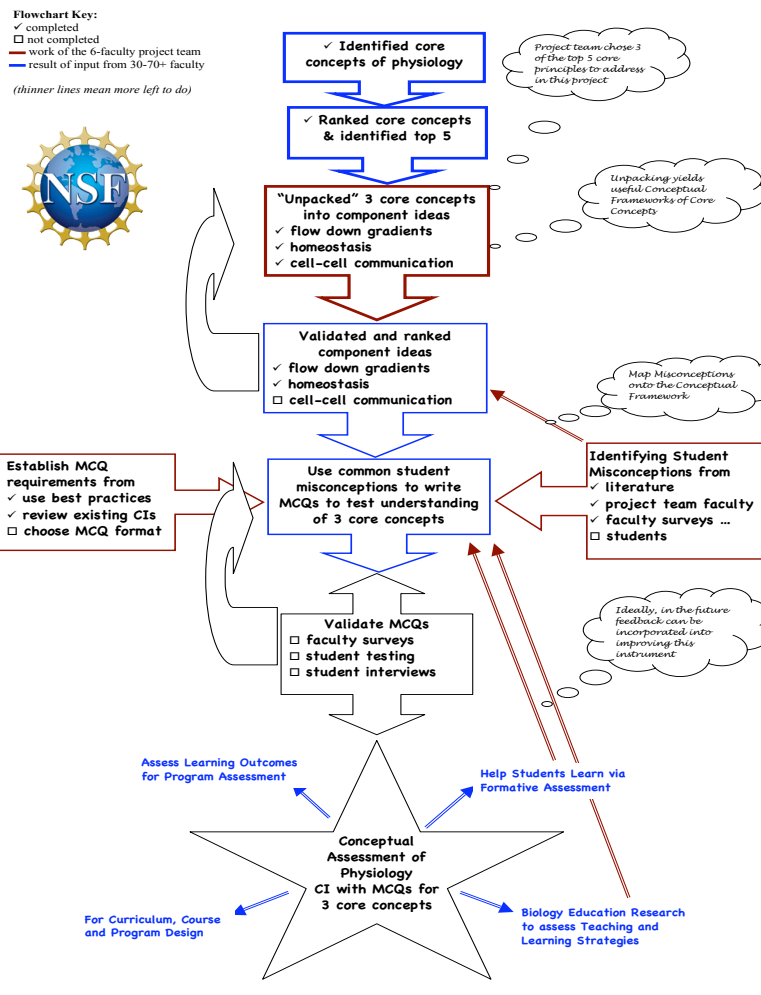
- If a homeostatically regulated variable is perturbed, it will be brought back to within its normal range.
- The process involves a negative feedback system that requires a sensor, a controller and effector(s).

### Conceptual Framework – main component ideas:

- I. The organism maintains a more or less stable internal environment
- II. A substantial change to a regulated variable will result in a physiological response to restore it toward its normal range
- III. Homeostatic processes require a sensor ("what can't be measured can't be regulated")
- IV. Homeostatic processes require a control center
- V. Homeostatic processes require effectors

\* See *handout* for a more complete framework.

## CAP Project Overview: Progress toward a Conceptual Assessment of Physiology



## References

- Michael & McFarland (2011). The core principles ("big ideas") of physiology: results of faculty surveys. *Advances in Physiology Education*, 35: 336-341.
- Michael, Modell, McFarland & Cliff (2009). The "core principles" of physiology: what should students understand? *Advances in Physiology Education*, 33: 10-16
- Modell, H. I. (2000). How help students understand physiology? Emphasize general models. *Advances in Physiology Education*, 23: 100-107.

## Homeostasis Misconceptions

**Naïve misconceptions** (does not demonstrate understanding)

1. Negative feedback is bad while positive is better for the body [I]\* *\*refers to conceptual framework*
2. Negative feedback means less [II]
3. The body always does what is best for itself [I]
4. Keeping things 'normal' [II]

### Anatomical misconceptions

5. Distance matters; receptors & controllers must be close [V]
6. The sensor and effector are in different locations [I]

### Regulated variable misconceptions

7. If a variable doesn't change, then it must be regulated [I & III]
8. If you can change a variable, then it is 'regulated' [I]
9. If a person can measure a variable, then there must be a sensor for it [I]
10. Only variables held absolutely constant are regulated. [I & IV]
11. Any variable that changes is regulated. [I & III]
12. Only one variable is controlled at a time. [I & III]

### Incomplete understandings (some understanding of concept)

13. Regulatory mechanisms are "on" or "off"- like a light switch [V]
14. The body's interior is static, not dynamic. [IV]
15. The set-point is discrete rather than a range of values [IV & V]
16. Only the nervous system regulates homeostasis. [IV]
17. Regulatory molecules, e.g. hormones, cannot be regulated.

## Question Development using Misconceptions & Framework

We use student misconceptions and the conceptual framework to develop questions to assess conceptual understanding. The following question was written for regulated variables (misconceptions 7 & 9). This question assesses understanding of framework component ideas I and III.

### Conceptual Question

The blood concentration of molecule X was observed for 2 hours and found to be unchanged during that time. What other information would you need in order to determine whether or not the concentration of molecule X was homeostatically regulated? Assume that the organism's environment is not changing during the period of observation.

- A. Is molecule X needed for the normal function of many cells?
- B. Are there sensory receptors for molecule X within the body?
- C. Is molecule X under the active control of hormones?
- D. Is molecule X itself a hormone or regulatory chemical?
- E. If measured for days at a time, does the blood concentration of molecule X not change measurably?