

Feedback Loops

Information Flow

Instructor's Guide

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SOPH 304

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Introduction

When to Use this Video

- In Soph 304, at home, in class, or in recitation, before or during Lecture 13 and 29.
- Prior knowledge: Students should be aware that the body is a tightly regulated environment.

Learning Objectives

After watching this video students will be able to:

- Identify the general components of a feedback loop.
- Provide examples of negative and positive feedback loops in the body.
- Describe how feedback loops are vital to healthy function and survival.

Motivation

- Engineers often study electronic control loops. Regulation and control is also exceedingly important in biology. This video helps highlight the multidisciplinary nature of feedback loops.
- Students will recognize that feedback loops play a major role in healthy human function; failure and instability of these systems make us vulnerable to illness and disease.

Student Experience

It is highly recommended that the video is paused when prompted so that students are able to attempt the activities on their own and then check their solutions against the video.

During the video, students will:

- Categorize given physiological processes as involving negative or positive feedback loops.
- Identify the receptor, control center, and effectors in blood glucose regulation.
- Identify the parts of the feedback loop that break down in Type I and Type II diabetes.

Key Information

Duration: 10:32

Narrator: Leah Okumura

Materials Needed:

- paper
- pencil

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Video Highlights

This table outlines a collection of activities and important ideas from the video.

Time	Feature	Comments
01:13	Chapter 1: Negative and Positive Feedback Loops	Definition of negative and positive feedback loops, and specific examples in the body.
01:37	Thermoregulation example	
02:38	Childbirth example	
03:02	Student Activity	Determine which physiological processes from a given list involve negative or positive feedback.
03:52	Chapter 2: Components of a Feedback Loop	Describes the various components generally involved in a feedback loop.
04:51	Thermoregulation example (cont'd)	Revisit thermoregulation example in greater detail and identify the specific components of the feedback loop.
05:58	Chapter 3: Feedback Loops and Disease	Conveys how complications and disease can arise from failure of feedback mechanisms in the body, specifically in the case of blood sugar regulation.
07:10	Student Activity	Identify the receptor, control center, and effector in blood glucose regulation.
07:41	Type I and Type II Diabetes	Introduces the two common forms of the disease
08:38	Student Activity	Identify the components of the negative feedback loop that break down in Type I and Type II diabetes.

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Video Summary

This video discusses negative and positive feedback loops, how they tie into the body's mechanism of internal regulation, and what happens when these mechanisms fail. Thermoregulation, contractions during childbirth, and blood glucose regulation are used to illustrate how feedback loops pass information in the body to maintain homeostasis or elicit a particular biological response.

Soph 304 Materials

Pre-Video Materials

When appropriate, this guide is accompanied by additional materials to aid in the delivery of some of the following activities and discussions.



1. Ask all students to stand up and balance on one foot until you tell them to stop. After a minute or two, have them sit back down in their seats. Ask the students how they felt during the activity. What was their body trying to do? Their bodies were trying to keep them upright, maintaining their balance. Use this activity to introduce the concept of homeostasis.



2. Provide photos/examples of people visiting or living in extreme environments (i.e., Sahara desert vs. Antarctica vs. high Andes). Have students discuss how and why humans are able to survive and live in such a wide range of environments.



3. Following the above activities, review the concept of homeostasis:

- Why is it important for living things to maintain a relatively stable internal environment?
- What things/processes in a human body need to be kept within a particular range?
- How does the body respond to changes in the external/internal environment?
- What happens when homeostasis is disrupted in the body?

Post-Video Materials



1. During lactation (milk production), the suckling by the baby stimulates the nerves of the areola of the breast. This leads to the production and release of oxytocin from the pituitary gland in the brain. Oxytocin in turn causes contraction of smooth muscle surrounding the milk duct, causing milk to flow. The flow of milk increases the suckling by the baby and more oxytocin is produced.

- Identify the feedback system described above as positive or negative.
- Identify the receptor, control center, and effector in this feedback system.



2. Ask students for examples of other tightly regulated processes that have previously been discussed in class. Have students work in pairs to determine the type of feedback loop involved (positive or negative) for one such process, and identify the specific components of the loop.



What happens should the regulation fail? Is there a specific disease that arises from the failure of the feedback loop?



3. Have students sort the processes from Activity 2 by levels of organization in the body (e.g., metabolic, gene, cellular, organ, system, etc.). Lead students to realize that feedback loops can be found in the regulation and control of biological processes at every level (e.g., gene expression to cellular growth to blood pressure).

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Negative and positive feedback loops are the mechanisms through which our human body tightly regulates and controls the various biological processes essential for life. Medical conditions and diseases often arise from the disruption and failure of the feedback systems in the body. Students should begin to recognize how medical interventions (e.g., drugs, lifestyles changes, implants, etc.), by repairing a faulty feedback system, are used to treat or alleviate a particular medical condition. Students should be able to identify the specific components of the feedback loop that the treatment acts upon.

Example: State-of-the-art insulin pumps, for example, can monitor blood glucose levels and inject insulin as needed to maintain relatively constant blood glucose levels in diabetic patients. Why do diabetics require insulin injections? What is the purpose of a self-monitoring insulin pump? Which components of the feedback loop are being replaced by this treatment?

References

The following website provides an excellent explanation of homeostasis with respect to temperature and blood glucose feedback systems:

- <http://www.biologymad.com/homeostasis/homeostasis.htm>

The following article contains multiple examples of positive feedback systems in the body:

- Abdel-Sater, K.A. (2011). Physiological Positive Feedback Mechanisms. *Am. J. Biomed. Sci.* 3(2), 145-155.

The following lecture from MIT's OpenCourseWare discusses how red blood cells help maintain homeostasis in low-oxygen environments:

- Gardel, Claudette, Eric Lander, Robert Weinberg, and Andrew Chess. 7.012 Introduction to Biology, Fall 2004. (MIT OpenCourseWare: Massachusetts Institute of Technology), <http://ocw.mit.edu/courses/biology/7-012-introduction-to-biology-fall-2004> (Accessed 25 Oct, 2013). License: Creative Commons BY-NC-SA

Lecture 29: Stem Cells/Cloning 1

MIT OpenCourseWare
<http://ocw.mit.edu>

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