BODY WORLDS ANIMAL INSIDE OUT

EDUCATOR'S GUIDE Grades

CLASSROOM ACTIVITIES

These classroom activities can be used as either pre-visit activities to prepare students for *BODY WORLDS: ANIMAL INSIDE OUT* or as post-visit activities to help with debriefing.





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EXHIBITION OVERVIEW

BODY WORLDS creator and anatomist, Dr. Gunther von Hagens, takes you on an anatomical safari with ANIMAL INSIDE OUT. As you explore this captivating exhibition, you will experience the intricate anatomy and physiology of a variety of the world's most spectacular creatures. ANIMAL INSIDE OUT contains more than 100 specimens that have been painstakingly preserved by the remarkable process of Plastination, invented by Dr. von Hagens. Students will be able to examine the anatomical intricacies of familiar and exotic animals like giraffes, camels and octopuses.

This exhibition is an unforgettable way for students to learn about animal science.

The exhibition explores:

Skeletons

From tiny insects to full-grown mammals, most animals have a skeleton of some sort. It could be an endoskeleton, which humans have, or an exoskeleton like that of insects and crustaceans.

Muscles, tendons and ligaments

From the large running and leaping muscles of a caribou, to the specialized muscles of a bull's heart that pump the blood and nutrients around its body, *ANIMAL INSIDE OUT* reveals the intricacy and details of the muscles and ligaments that most animals have.

The nervous system

A vast and complex network that connects the brain, spinal cord and all parts of the body. It channels data continuously and transmits commands. The nerve fibres that carry this vital information can be finer than a human hair and invisible to the naked eye.

Reproduction

After feeding, reproduction is the most essential activity of an animal. Evolution has developed a number of ways for animals to reproduce.

Respiration and digestion

By viewing the lungs and digestive tracts of animals, like the caribou, we can see how we share the same intricate details of many major organs.

Wildlife conservation and preservation

By learning how similar animals and humans are, visitors will be able to gain a new appreciation for the importance of animal welfare.

Caution for sensitive viewers:

ANIMAL INSIDE OUT features a few human organs and body parts, as well as a male body plastinate with eyes and genitals. This material is included for the comparison of human anatomy to that of other animals.



CURRICULUM LINKS

While visiting this exhibition, students will be using the processes and skills of science. Young children naturally have an interest in animals and this provides the motivation and inspiration for them to practice thinking like a scientist does. Students will be able to describe and compare their observations and ideas with each other and learn about the nature of science. For older students, direct experiences with the specimens will challenge them to practice important science skills and develop hypotheses and conclusions about animal science, diversity, change over time and the processes of science. Teachers can use student experiences in *ANIMAL INSIDE OUT* to support student learning in life science, as well as providing experiences for contextual reading and writing applications.

- » Grade 4 Unit B (Wheels and Levers)
- » Grade 5 Unit C (Classroom Chemistry)
- » Grade 7 Unit A (Interactions and Ecosystems)
- » Grade 7 Unit B (Plants for Food and Fibre)



FIELD TRIP INFORMATION

What is the purpose of the exhibition?

The purpose of *BODY WORLDS*: *ANIMAL INSIDE OUT* is to inspire a deeper appreciation and respect for the animal world. Thanks to the science of Plastination, visitors can examine the intricate anatomy and physiology (blood vessels, muscles, bones, organs and nerves) of some of the world's most spectacular creatures. Visitors will be better able to understand the inner workings of animals and all the systems that enable them to live, thrive and survive (e.g. nervous, muscular, circulatory, respiratory, digestive and reproductive).

What kinds of specimens are displayed in this exhibition?

ANIMAL INSIDE OUT includes full body plastinates as well as cross-sections, skeletons, blood vessel configurations and organs. The inclusion of human plastinates allows for the comparison of human anatomy to that of other animals in the exhibition, resulting in a new understanding and appreciation of the similarities between animals and humans.

Where did the specimens on display come from?

ANIMAL INSIDE OUT is made possible through cooperation with various university veterinary programs, zoos and animal groups. No animal was harmed or killed for this exhibition. Among the plastinates in the exhibition are human specimens, including a full body plastinate that came from the Institute for Plastination's consented body donation program.

Giraffe



Is this exhibition appropriate for children?

ANIMAL INSIDE OUT was designed for visitors of all ages to better understand animal anatomy. The content is factual, instructive and is presented in a non-sensational manner, but some content may require explanation by a parent or teacher. Along with informative displays that show animals' nervous, muscular, digestive, respiratory and circulatory systems, the exhibition also includes reproductive systems. Among the 100 specimens on display, you will see the following:

- » A blood vessel configuration of a horse's penis
- » A blood vessel configuration of a bull's testicle
- » A human placenta
- » A male caribou's reproductive organs
- » A caribou uterus
- » A fetus inside a caribou uterus
- » A cross-section of a duck developing an egg

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INTRODUCTION TO THE ACTIVITIES

The body's digestive system converts the food you eat into the energy you need to live. In these activities students will explore the journey food takes through the human digestive system and compare it to the digestive system of cows.

These activities are recommended for use as pre-visit activities, before your class trip to *BODY WORLDS*: *ANIMAL INSIDE OUT*, or as post-visit materials to help debrief your class after your field trip.



Objectives

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- » Describe the main components of the human digestive system.
- » Describe the main stages of digestion.
- » Explain the differences between the human and cow digestive systems.
- » Explain what energy is.
- » Describe how food is turned into energy.

Curriculum Connections by Grade

- » Grade 4 Unit B (Wheels and Levers)
- » Grade 5 Unit C (Classroom Chemistry)
- » Grade 7 Unit A (Interactions and Ecosystems)
- » Grade 7 Unit B (Plants for Food and Fibre)



Background

The digestive system is a group of organs working together to convert food into energy and basic nutrients to feed the entire body. Every organism needs energy and is dependent on a regular supply of food. Regardless of what it eats or how it feeds, an animal must digest its food. Digestion is the process of breaking down food so that it is small enough for the body to absorb. Complex animals have digestive tubes running between two openings, a mouth and an anus.

An elaborate adaptation has evolved in ruminant herbivores like cows and sheep. Ruminants are mammals that are able to obtain nutrients from plants by fermenting the plants (before digestion) with the help of symbiotic bacteria in a specialized stomach, called a rumen.



Carnivores have adapted differently with comparatively short digestive systems, as they are not required to break down tough cellulose. Carnivorous predators often have long fangs to help them capture prey.





Vocabulary

- » digestion—the mechanical and chemical breakdown of food into smaller components, like vitamins, proteins and other nutrients that can be absorbed into the bloodstream.
 Digestion is a process in which catabolism takes place; that is, the breaking down of large units (food molecules) into smaller units (like vitamins, proteins and nutrients).
- » energy—is the capacity to do work; to move matter against opposing forces such as gravity and friction.
- » carnivore an animal that eats meat (other animals).
- » **herbivore**—an animal that eats plants.
- » **omnivore**—an animal that eats both meat and plants.
- » adaptation—is a process that helps animals become better suited to survive in their environments. Adaptations can be physical changes in the animal's body or behavioural changes.

References

- » Digestive System of the Cow by John B. Hall, Extension Animal Scientist, Virginia Tech; Susan Silver, Graduate Teaching Assistant, Virginia Tech pubs.ext.vt.edu/400/400-010/400-010_pdf.pdf
- » Soda Can Calorimeter: Energy Content of Food flinnsci.com/api/library/Download/f9560a5fc7ef4a6b8f4598fea30626eb

Other Resources

- » Understanding the Human Body: Food and Digestion by Robert Snedden (2009, Wayland Publishers Ltd)
- » Digestion (Explorer Library: Science Explorer) by Tamra B. Orr (Kindle Edition 2013, Cherry Lake Publishing)
- » First Nations Education Steering Committee | Our Animal Neighbours
- » Beaty Biodiversity Museum | Educator Resources beatymuseum.ubc.ca/educator-resources
- » Advantages of Levers Bio Mechaincs http://biomechanics.fieldmuseum.org/sites/biomechanics.fieldmuseum.org/files/ BioGuide-Levers_0.pdf

ACTIVITY 1 MATCH THE ORGAN

Activity Length 15–20 min.

Activity Type Memory Game

Introduction

In this activity students match the correct organ to its description.

Materials

Per pair of students:

» 1 deck of cards (located at the end of this activity)

Preparation

» Print and cut out the deck of cards.

What to Do

- 1. Ask students to form pairs.
- 2. Hand out the card decks (1 per pair of students).
- 3. Ask students to shuffle the cards.
- 4. Students lay out cards face down on table (graphic and description facing the table).
- 5. Taking turns, one student will turn over any two cards. If they match, that student takes those cards. If they don't match, the student puts the cards face down.
- 6. Then the next student goes.
- 7. The winner is the student who finds the most matches.

Extensions

Hand out glasses of fruit juice and discuss with the class the types of food in the juice and how the food becomes absorbed in the small intestine.

Food goes into the stomach where it is broken down by acid and enzymes (chemicals that break down food) into smaller pieces, so that it turns into a fluid which moves easily. It then passes into the small intestine. The small intestine is made of three sections: the duodenum, jejunum and ileum. Inside the small intestine, food continues to break down, so the body can absorb all the nutrients it needs. Enzymes from the pancreas help break down the food. The lining of the small intestine is folded so that there is a lot more surface area on the inside than on the outside. It is also covered by villi which look like tiny fingers. All over the villi are microvilli so that the surface area inside the intestine is made even bigger. As food reaches the end of the small intestine it goes through a valve into the large intestine. The valve is a ring of muscle, which stops the contents of the large intestine going back into the small intestine.

Students create a model of the digestive system out of recycled or craft materials. Their model should have each part labelled with an explanation of its function.

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Teeth grind and tear the food into small pieces. Saliva then wets and softens the food and begins to dissolve carbohydrates (sugars). Once the food is properly mashed and wet, it is pushed by muscle action into the pharynx (throat) and down the esophagus, which leads to the stomach.

Food is mixed and broken down by acids. This organ protects itself from these acids with a layer of mucus. Some things, such as water and sugars, can be absorbed right out of this organ and into the bloodstream. The things that need more digestion have further steps ahead of them. When the food turns into a liquid, it passes into the small intestine. This organ has a large surface area containing villi—tiny little structures like very short hairs that stick out. Nutrients from food pass through the villi and into the bloodstream. The bloodstream carries the nutrients to your cells so they can live. Once all the useful nutrients have been taken from food, the unusable parts pass into the large intestine, or colon.

In this organ, water is extracted from waste and the material hardens into feces. Feces passes out of your body when you go to the restroom.

This organ makes enzymes that help digest proteins, fats and sugars.

This organ makes bile, which helps the body break down fats.

This organ stores bile until it is needed.

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ACTIVITY 2 HOW DO COWS DIGEST FOOD?

Activity Length 45–60 min. Activity Type Exploration

Introduction

In this activity, students learn about the complex digestive system of a cow.

Background

The cow has four stomachs and undergoes a special digestive process to break down tough and coarse plants. When the cow first eats, it chews the grass just enough to swallow it. The food travels to the first two stomachs, the rumen and the reticulum, where it is stored. Later, the cow coughs up bits of the plant material called cud and chews it completely before swallowing it again. The cud then goes to the third and fourth stomachs, the omasum and abomasum, where it is fully digested. Some of this digested food enters the bloodstream and travels to the udder, where it is made into milk, while the rest goes towards the cow's nourishment.

Materials

» A Cow's Digestive System – YouTube video youtube.com/watch?v=svw5KA8YIAA

Per student

» Print out of Venn diagram (located at the end of this activity)

Preparation

» Set up the the video on a screen.

What to Do

- 1. Play the video.
- 2. Ask students to compare the human digestive system to the one of cow's, by using the Venn diagram.
- 3. Suggest that students also look at similarities and differences between carnivores, omnivores and herbivores.

Key Questions

- » Why do cows have more than one stomach?
- » What foods make up a cow's diet?

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ACTIVITY 3 HOW IS SOLID FOOD TURNED INTO STORED ENERGY?

Activity Length 60–90 min.

Activity Type Activity

Introduction

Take a closer look at the chemical processes that happen in the body when food is digested. In this activity, students learn to determine how much energy is stored in a food item and how to measure the stored energy, by constructing and using a calorimeter (instructions and illustrations below).

Background

The commonly used unit for measuring the energy content in food is called a Calorie (with an uppercase C). A Calorie is really a kilocalorie, or 1,000 calories (lowercase c). In many countries around the world the unit Calorie is associated with food, but this unit has been superseded in the metric International System of Units by the joule. A calorie is the amount of energy, or heat, it takes to raise the temperature of 1 gram of water by 1 degree Celsius. One calorie equals 4.1858 joules.

Humans need energy to survive—to breathe, move, pump blood, think—and we get this energy from food. The number of calories in a food item is a measure of how much potential energy that food has. A calorimeter (*calor* = Latin for heat) is a device that measures the heat generated by a chemical reaction, change of state, or formation of a solution. There are several types of calorimeters but the main emphasis of all calorimeters is to insulate the reaction to prevent heat loss.

In the following calorimetry activity, food burns and its stored energy is quickly converted into heat energy and products of combustion (carbon dioxide and water).

As the food burns, a can of water above the flame absorbs the food's heat energy and the water's temperature (T) rises.

By measuring the change in temperature (Δ T; is the Greek letter Delta which means change in) of the known volume of water, students will be able to calculate the amount of energy in the food tested, because the heat gained by the water will equal the heat lost by the food item.

Materials

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Per groups of 3–4 students

- » Large coffee can
- Small coffee can (any metal can would work)
- » Large cork
- » Paperclip
- » Glass or aluminum rod or thick wire
- » Hole punch (or a big nail)
- Snack food to be burnt in calorimeter (Doritos, cheese puffs or marshmallows)
- » Distilled water
- » Safety goggles
- » Gloves
- » Scale

- » Thermometer
- » Graduated cylinder
- » 10x10cm piece of wax paper
- » Lighter (for teacher)
- Print out of data table (1 per student)

Preparation

- 1. Use the hole punch to create two holes, one on each side of the top of the cans.
- 2. Position the small can inside the large can and slide the rod or wire through the holes of both cans.



What to Do

- 1. Using a scale, determine the weight of the wax paper. Record the weight (wwp) in the data table.
- 2. Choose a snack food item.
- 3. Put the food item on the wax paper.
- 4. Determine the weight of the food (wf1). Subtract the weight of the wax paper. Record the food weight.
- 5. Using the graduated cylinder, measure out 100ml of distilled water from the water bottle and pour it into the small metal can.
- 6. Measure the temperature of the water (T1). Record the temperature.
- » **Note:** make sure to leave the thermometer in the water for a while before reading the temperature.
- 7. Unfold the paper clip and insert it into the cork.
- 8. Gently wrap the paper clip attached to the cork around the food. It is better to have the food at a slight angle. If the food breaks, use another one; however, you will have to reweigh the new food item.
- Place the cork with the food on a non-flammable surface (outdoors or under fume hood).
- 10. Put on your safety glasses and call the teacher.
- 11. Ask your teacher to help you light the food. It may take a while for the food to catch on fire.

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- 13. Allow the food to burn until it goes out.
- 14. If the lit food burns out quickly (less than a minute), get the teacher to relight the food.
- 15. Once the food has finished burning, carefully stir the water with the thermometer and then measure the temperature again (T2). **Caution!** The cans and water will be warm! You may have to leave the thermometer in the water for a while in order to get the highest reading. Record the new temperature.
- 16. After the burnt food has cooled, transfer it onto the wax or parchment paper and weigh it. Record the new weight (wf2) and don't forget to subtract the weight of the wax paper.
- 17. Calculate the amount of calories in the food item using the following equation: Energy lost by food (E_{food}) = Energy gained by water (E_{water})

The energy gained by the water can be calculated as follows:

- $E_{water} = m x c x \Delta T$
- m = mass of the water (100ml = 100g)
- c = 1.0 cal/g °C
- ΔT = change in water temperature
- 18. Determine the change in temperature of the water by subtracting the initial water temperature (T1) from the final water temperature (T2). Example: (T1) 28.00 °C – (T2) 26.00 °C = (Δ T) 2.00 °C
- 19. Insert the values in the equation Ewater = m x c x T
 Example: E_{water} = 100g x 1.0 cal/g °C x 2.00 °C = 200cal

Key Questions

- » What is energy?
- » How do you know how much energy you need?
- » How does the body use the energy?
- » What happens to energy your body doesn't need?

Extensions

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- Convert the heat gained from calories to food Calories (kilocalories) by dividing your answer above by 1,000.
 Example: 200 cal. ÷ 1,000 = 0.200 Cal.
- Determine how much of the food burned by subtracting the final mass of the burned food (wf2) from the initial mass of the food (wf1).
 Example: (wf1) 4.5g (wf2) 4.4g = 0.1g
- » Calculate the energy content per gram of the food sample. This is done by dividing the heat gain of the water (in Calories), by the change in mass of the food sample.

Example: 0.200 Cal. ÷ 0.1 g = 2.00Cal./g

Convert the calories into joule by multiplying with 4.1858.
 Example: 2.00Cal./g x 4.1858 = 8.37kJ

ACTIVITY 3 DATA TABLE

	1	2	3
food item			
mass of water	100 g	100 g	100 g
с	1.0 cal/g °C	1.0 cal/g °C	1.0 cal/g °C
weight of wax paper (wwp)			
water temperature (T1)			
water temperature (T2)			
T = T2 – T1			
weight of food (wf1)			
weight of food (wf2)			

Ewater = m x c x Δ **T**

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AMAZING FACTS

Human intestines are at least 7.5 metres long in an adult. Be glad you're not a full-grown hOrSe their coiled-up intestines are 27 metres long! Digestion from mouth to anus takes about 72 hours compared to 6 to 8 hours for humans.

Horses don't have gall bladders, bile from the liver flows directly into the small intestine.

Some animals like seahorses, lungfishes and platypuses have no stomach. Their food goes from the esophagus straight to the intestines.

Chickens and other birds don't have teeth. They have a gizzard that stores small stones which are used to grind hard foods like seeds.

The owl swallows its prey whole, including the bones. When it has digested the edible parts of its food, the bones and the other non-digestible parts are pushed out through its mouth in a small ball called a pellet.

> Horses can't throw up. This is because the esophagus in a horse has a ONE-WAY MOVEMENT. It prevents feed from coming back up.





Giant squid can Snatch prey up to 10 metres away by shooting out their two feeding tentacles, which are tipped with hundreds of powerful sharp-toothed suckers.

Sharks have been swimming the seas for 400 million years that's longer than the dinosaurs walked the Earth.

Sea scallops grow rapidly during the early years of life. Between the ages of 3 and 5, they commonly increase 50% to 80% in shell height and quadruple their meat weight.

The maximum speed of a SNAİl is 100 metres per hour.

Mackerel,

unlike any other species, are likely to die if their incredibly thin and specialized skin is touched by human hands. It is theorized that this might be due to the Oils in human hands.

Most Cuttlefish are capable of changing colours and can bury themselves in the ocean sand very quickly.





TELUS WORLD of SCIENCE Edmonton Frogs don't need to drink the way humans do-they absorb water through their permeable skin!

> Mallards can travel up to 105 kilometres per hour.

Giraffes are the tallest mammals on Earth, ranging in height from 4.3 to 5.5 metres. An adult bull giraffe can feed on the leaves of trees over 5.8 metres above the ground!

The combination of the Cat'S INNER EAR (vestibular apparatus) and tail gives the cat its incredible balance and acrobatic prowess.

Caribou have long, COArSe hair with hollow COres, which keeps them insulated in colder climates. Caribou are very Strong SWimmers and can travel across wide, rapid and frigid rivers.

> A bull'S heart is around 5 times heavier than a human heart.

> > Caribou