



Viscera and Villains

HOMESCHOOL EDITION • FREE SAMPLE

A TurnipInk curriculum: every lesson is a case to crack.

A year of life science, one mystery Case File a week

WHAT THE FULL PRODUCT INCLUDES

- 36 mystery Case Files, one per week, from the cell to whole ecosystems
- 4 Student Case File Workbooks, one per unit
- 4 Parent Manuals with prep, Day 4 scripts, answer copies and Sealed Reveals
- 4 Assessments files with optional weekly quizzes and unit tests, with keys
- 7 Paper Dissection models to print on cardstock, plus 8 No-Dissection Option days for families who prefer no specimens
- 4 unit book lists of science comics, graphic novels and true stories
- Course Syllabus, How to Use This Course and a Grade Tracker

These are sample pages. The full Case Files, parent scripts and answer copies come with purchase.

Name _____ Date _____

DAY 1: CASE BRIEFING AND THE CHECKLIST OF LIFE

About 40 minutes

CASE BRIEFING

SUSPECT ON FILE: THE MIMIC



THE MIMIC

Customs officers at the harbor have caught a man in a velvet coat: **The Mimic**, forger of fake life. His suitcase held five sealed jars, labeled only A to E. Four are decoys he built to act alive and trick the inspectors. One holds something truly alive, smuggled across the border to be released into a protected place. On Day 4 you and your parent will examine the jars and find the living one before he can let it loose. This week you'll train for it.

He builds costumes of life: things that move, grow and react. Don't let a costume fool you.

BEFORE YOU READ

What do you think every living thing does that a rock never does? List three things. (No wrong answers yet: you'll check your list against the reading.)

TODAY

- Read the Case Briefing above.
- Read **The Rock from Mars** on the next page. It takes about 10 minutes.
- Do the **Check Your Reading** pages. You may look back at the reading as often as you like.

THE ROCK FROM MARS

In 1996 a rock from Mars made headlines. How do you prove something was ever alive?



Rock ALH84001: about the size of a potato, about four billion years old, and from Mars.

On December 27, 1984, a team of scientists zoomed across the frozen surface of Antarctica on snowmobiles. They were hunting meteorites, rocks from space. A dark rock on white ice is as easy to spot as a raisin on a plate of rice. The team bagged one greenish lump, labeled it ALH84001, and shipped it to a laboratory, where it sat for years.

In 1993 a scientist took a second look and noticed that it had been filed under the wrong kind of meteorite. Its chemistry matched other rocks known to come from Mars! The rock had formed on Mars about four billion years ago. Millions of years ago, something enormous slammed into Mars and blasted chunks of it into space. This one drifted until it crashed onto Antarctica about thirteen thousand years ago.

In August 1996, a NASA team made a stunning announcement. Inside tiny cracks in the rock, their microscopes revealed shapes like little worms. The team suggested these might be fossils of Martian bacteria, tiny living things made of just one cell. The President of the United States discussed the rock on television. Had humans finally discovered life on another planet?

HOW DO YOU PROVE IT WAS ALIVE?

Here's the problem: a fossil won't wiggle, devour a snack or reproduce while you watch. Scientists needed a checklist describing what living organisms do. Science classes use a list of seven life processes, remembered by the name MRS GREN.

Movement: living things move, even if it is only a

plant turning toward light. **Respiration:** they release energy from their food. **Sensitivity:** they sense the world around them and respond. **Growth:** they get bigger. **Reproduction:** they make more of their own kind. **Excretion:** they get rid of wastes. **Nutrition:** they take in food, or make their own.

There's a catch. A forest fire moves, grows, "eats" wood, releases smoke as waste and even produces new fires by flinging sparks. Is fire alive? No. Here is the test fire can't pass. Every living thing is made of one or more **cells**, microscopic packages that contain everything needed to stay alive. Fire has no cells. Neither does a robot vacuum, however enthusiastically it chases crumbs.

A handy way to sort things uses three groups. **Living** things are made of cells that are still working. **Once living** things, like a wooden chair or last year's leaves, are made of cells that have stopped working for good. **Never living** things, like a glass marble or a metal spoon, were never made of cells at all.

One more warning: a living thing doesn't display all seven signs every minute. A dry seed in a packet looks about as energetic as a pebble, yet planted in damp soil it sprouts. Looks dead is not always dead.

SO, WAS IT ALIVE?

Scientists returned to the rock with the checklist in mind. The worm shapes turned out to be far smaller than the smallest cells known on Earth, probably too small to contain what a cell needs. Other teams demonstrated that similar shapes can form in rock with no life involved. Today most scientists think ordinary chemistry created them, though nobody can prove it for certain.

Telling living from non-living is easy until something tries to fool you. Keep the checklist handy.

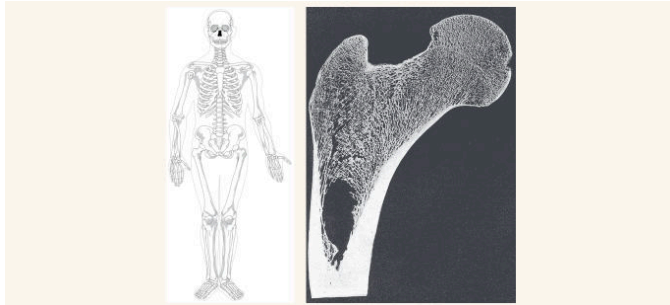
WAIT, WHAT?!

Only a few hundred rocks from Mars have ever been found on Earth. Some museums let you touch one: a piece of another planet!

Sources: NASA Astromaterials Curation (ALH84001); McKay et al., *Science* 273 (1996); National Research Council, *Size Limits of Very Small Microorganisms* (1999).

YOUR LIVING FRAME

Bones look like dead sticks of chalk. Inside you, they are busy, growing, healing and rebuilding every day.



A whole human skeleton, and the top of a thigh bone sawn open to show the spongy bone inside.

The bones in a museum drawer are dry and dead. The bones inside you are not. They are living tissue, with blood vessels and nerves running through them, and they are kept busy by three kinds of cell.

THE BONE CREW

Osteoblasts build new bone. **Osteoclasts** break old bone down. They aren't villains: every building site needs a demolition crew. **Osteocytes** are bone cells locked inside the hard bone, keeping it healthy and sensing how hard it is being pushed. Because the crew never stops working, a broken bone can heal, and your whole skeleton is slowly rebuilt, bit by bit, all your life.

FIVE JOBS

Your skeleton **supports** you, like the frame of a house. It **protects** soft organs: the skull guards your brain, and the ribs guard your heart and lungs. It helps you **move**, because muscles pull on bones like levers. It **stores** minerals, especially calcium, like a bank your body can withdraw from. And soft red marrow inside some bones **makes blood cells**, millions of them every second.

TWO INGREDIENTS

Bone is built from two ingredients mixed together. The first is **minerals**, mostly calcium and phosphate, the same family of stuff as chalk and eggshell. The second is **collagen**, a stringy protein, the same stuff as the gristle in meat. Every bone you have contains both. Why does a bone need two such different ingredients? That's a question you'll answer for

yourself.

CARTILAGE AND GROWING

Cartilage is not bone. It is smooth, firm and bendy, and you can feel it in the tip of your nose and the top of your ear. Cartilage caps the ends of bones in joints so they don't grind, and it forms cushions between the bones of your spine. It has no blood vessels, so injured cartilage heals very slowly.

Before you were born, most of your skeleton was cartilage. Bit by bit, cells turned most of it into bone. A newborn has about 300 bones, but many fuse together, so an adult has 206. Thin layers of cartilage called **growth plates** stay near the ends of long bones, and that's where bones get longer. In the late teens or early twenties, they turn to solid bone, and you stop getting taller.

INSIDE A LONG BONE

Saw a thigh bone in half and you'd see a thick, hard outer wall of **compact bone**, wrapped in a thin skin called the periosteum. The hollow shaft is filled with soft **marrow**. The rounded ends are full of **spongy bone**, a lattice of tiny struts with spaces in between.

Those struts are not random. In 1866, an anatomist named Hermann von Meyer showed his drawings of the struts inside a thigh bone to Karl Culmann. Culmann was an engineer who used math to map the lines of force inside curved structures like cranes. He saw that the struts followed the same lines his math predicted for a crane carrying a load. Bone puts its material exactly where the forces push, which makes it strong without being heavy.

WAIT, WHAT?!

Bit by bit, your body rebuilds roughly your whole skeleton about every ten years. The bones you have now are not the ones you were born with.

Sources: OpenStax Anatomy and Physiology 2e, ch. 6; NIH NIAMS, Bone Health; Skedros and Baucom, J. Theor. Biol. 244 (2007).

Name _____

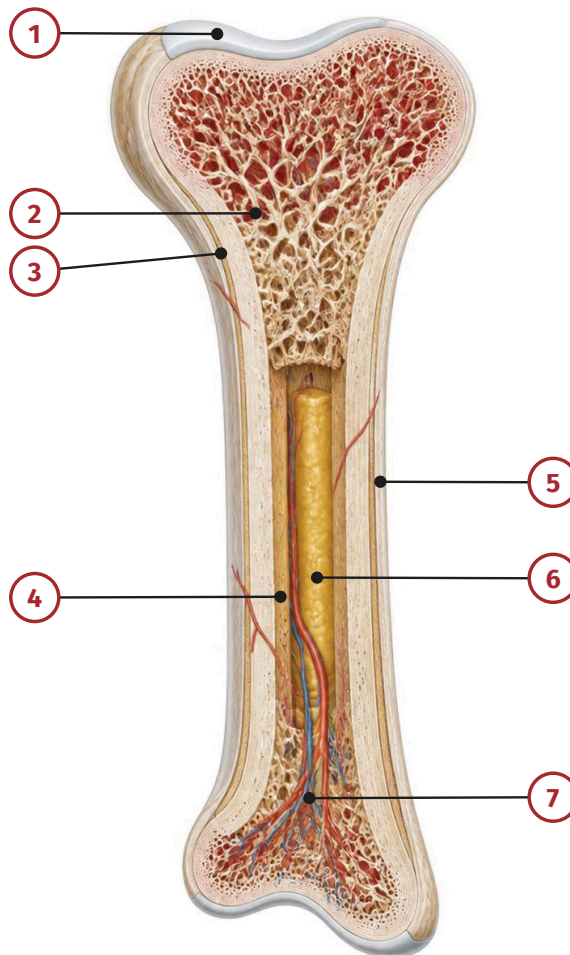
Date _____

WORD BANK

One word is not used.

articular cartilage blood vessel bone marrow compact bone medullary cavity
periosteum spongy bone tendon

- 5 Label the inside of a long bone, a thigh bone cut open down its length. The articular cartilage is the smooth cap on the end, and the medullary cavity is the hollow middle of the shaft.



1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

Name _____

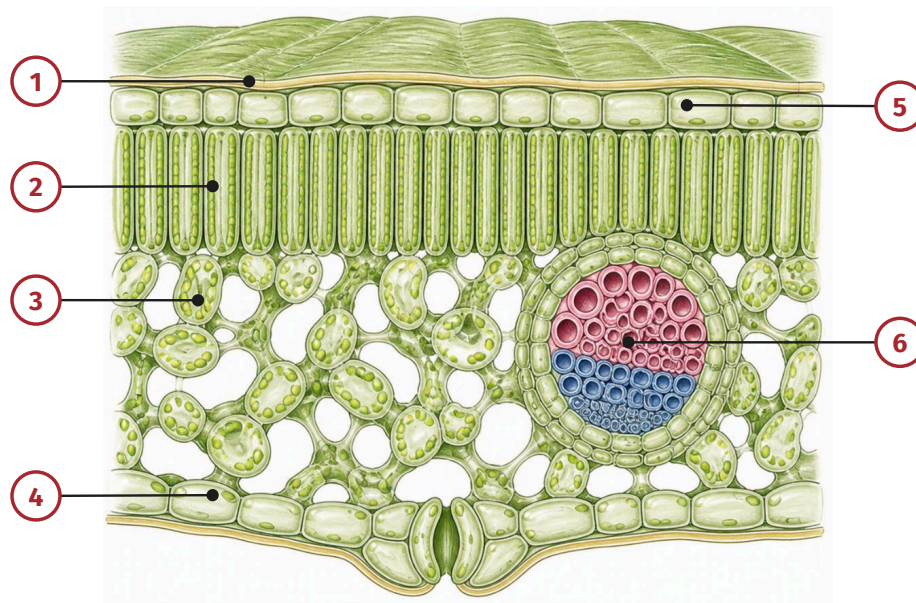
Date _____

WORD BANK

One word is not used.

cuticle lower epidermis palisade layer root hair spongy layer
upper epidermis vein

- 4 Label this slice through a leaf. The cuticle is a waxy, waterproof coat over the top of the leaf. An epidermis is a thin skin of cells, and a leaf has one on each side. The palisade layer has tall cells packed with chloroplasts. The spongy layer is full of air spaces. A vein carries water in and sugar out.



1. _____

4. _____

2. _____

5. _____

3. _____

6. _____

Name _____ **Date** _____

DAY 3: BUBBLES IN THE LIGHT

About 45 minutes

YOU NEED

- 2 clear glasses of water with a pinch of baking soda stirred into each
- A handful of fresh spinach leaves
- A sunny window (or a bright lamp) and a dark cupboard
- A magnifying glass and a spoon

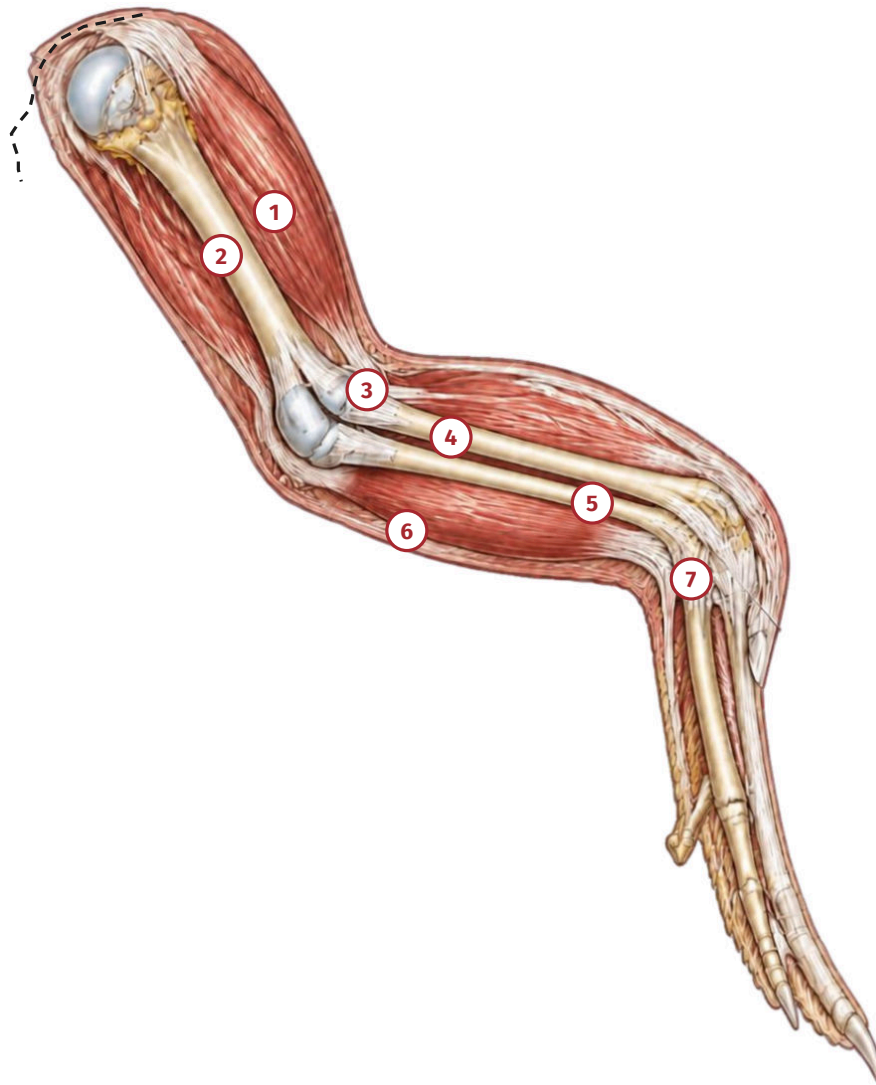
- 1 Push 3 or 4 spinach leaves under the water in each glass. Weigh them down with a spoon if they float.
- 2 Put one glass in bright sun or right under a lamp. Put the other in a dark cupboard.
- 3 Wait one hour. Read or do something else.
- 4 Look closely at the leaves in both glasses with the magnifying glass.
- 5 What did you see on the leaves in each glass?

- 6** What gas do you think was in the bubbles?

- 7** Why was there a difference between the two glasses?

8. Look at the underside of a leaf with the magnifying glass. Draw what you see.

PAGE 2: THE BASE (print on cardstock)



Outbreak at the Bureau

Unit 3: Kingdoms of Life

CASE FILE

21

OBJECTIVE Your student swabs places around the house onto nutrient agar plates, grows what they collect for three days at room temperature, and counts the colonies. A control plate that is never opened and a split hands plate (an unwashed fingertip against one after a 20-second soap wash) make it a fair test. The results tie back to Reading A: one bacterium too small to see doubles, again and again, into a colony of millions you can see.

Before You Begin

- ☐ This is an ADD-ON, not a replacement. The regular Days 1-4, the hand-out, the case and the Sealed Reveal all run exactly as written; nothing in the case depends on this lab, and you can skip it.
- ☐ It can start any day this week. Swab on Day 1 or Day 2 (about 30 minutes), check the plates for 5 minutes a day, and read them on Day 4 or the days after (about 15 minutes). Plates swabbed on Day 1 are ready by Day 4.
- ☐ Order the kit about a week ahead (see Getting Ready). Read the Safety Rules before you buy: they are the heart of this plan.
- ☐ If anyone at home has a weakened immune system (for example during chemotherapy or after a transplant), skip this lab, or keep the sealed plates well away from them.
- ☐ Print the Optional Lab student pages (3 pages).

Have Ready

- A nutrient agar plate kit: pre-poured petri dishes with sterile swabs. 8 plates covers the full lab (a control, a hands plate and up to 6 sites).
- A permanent marker, clear tape, a timer, soap, paper towels
- A dark cupboard or a shoebox at room temperature, away from food
- For the clean-up (adult): household bleach, a bucket or large zip bag, rubber gloves, two trash bags

Everything else to buy, print and set up: the Materials and Prep sheet.

Getting Ready

The Kit

read before class

What to buy. Search for "nutrient agar plates, pre-poured, with sterile swabs". Science suppliers (such as Home Science Tools or Carolina) and online stores sell them, usually in packs of 5 to 10 plates for about \$15-30. Plain nutrient agar is all you need. Skip any incubator sold with it: this lab never uses warmth.

When to order. About a week before you want to swab. When the kit arrives, store the unopened plates upside down (lid down) in the fridge, unless the kit says otherwise, and use them by the kit's date.

On swab day. Take the plates out about an hour early so they warm to room temperature (cold plates collect drops of water). Each agar surface should be smooth and clear. If a plate already has spots or fuzz, don't use it: put it with the plates for clean-up.

Fewer plates? With 5 or 6 plates, swab fewer sites. Never skip the control plate: without it, the results mean nothing.

