

# Adventures in

# ARCHAEOLOGICAL SCIENCE

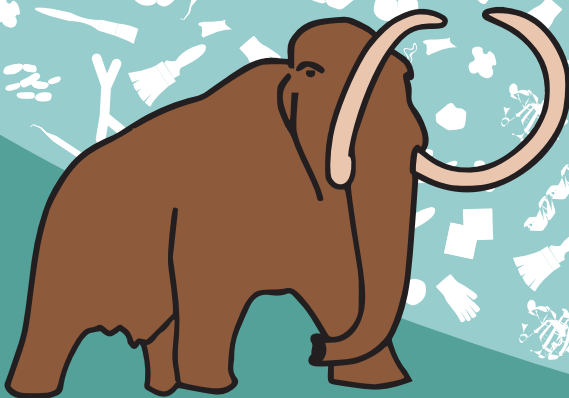
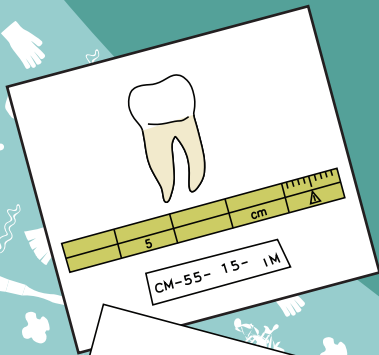
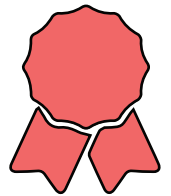


This book belongs to:

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Name

**Future Archaeological  
Scientist in Training**



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for the Science of Human History

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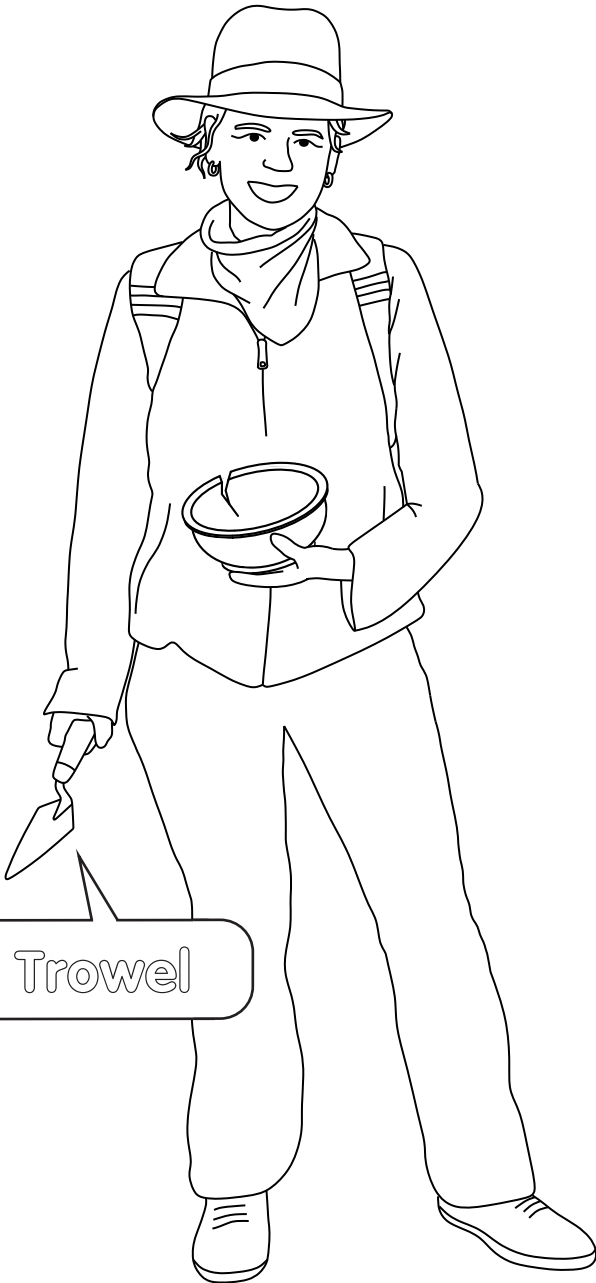


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# WHO WE ARE

Archaeological scientists are researchers who use scientific methods and cutting-edge techniques to study questions about the human past.



Trowel

## In the field...

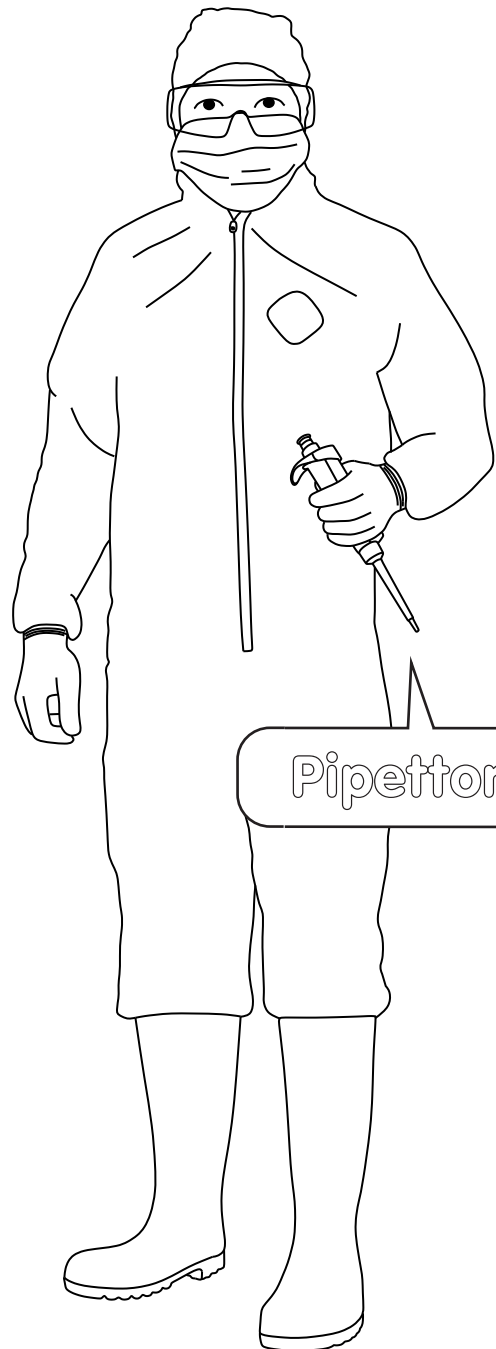
Scientists work closely with field archaeologists to excavate and collect samples for further study in a laboratory.

This may include sampling burials, collecting residues from ancient pots, identifying animal bones in middens (garbage pits), or sifting sediments for plant fossils.

## In the lab...

When handling ancient DNA, scientists must work in cleanrooms and wear special suits, gloves, and boots to protect the ancient samples from modern DNA contamination.

Scientists use a wide variety of instruments and equipment to study ancient samples.



Pipettor

# FIELD EXCAVATION

Archaeological scientists travel all over the world to investigate human history and prehistory. In addition to excavation tools, some places require specialized supplies and equipment. For example, in the Himalayas, archaeologists need trekking permits and mountain climbing gear.



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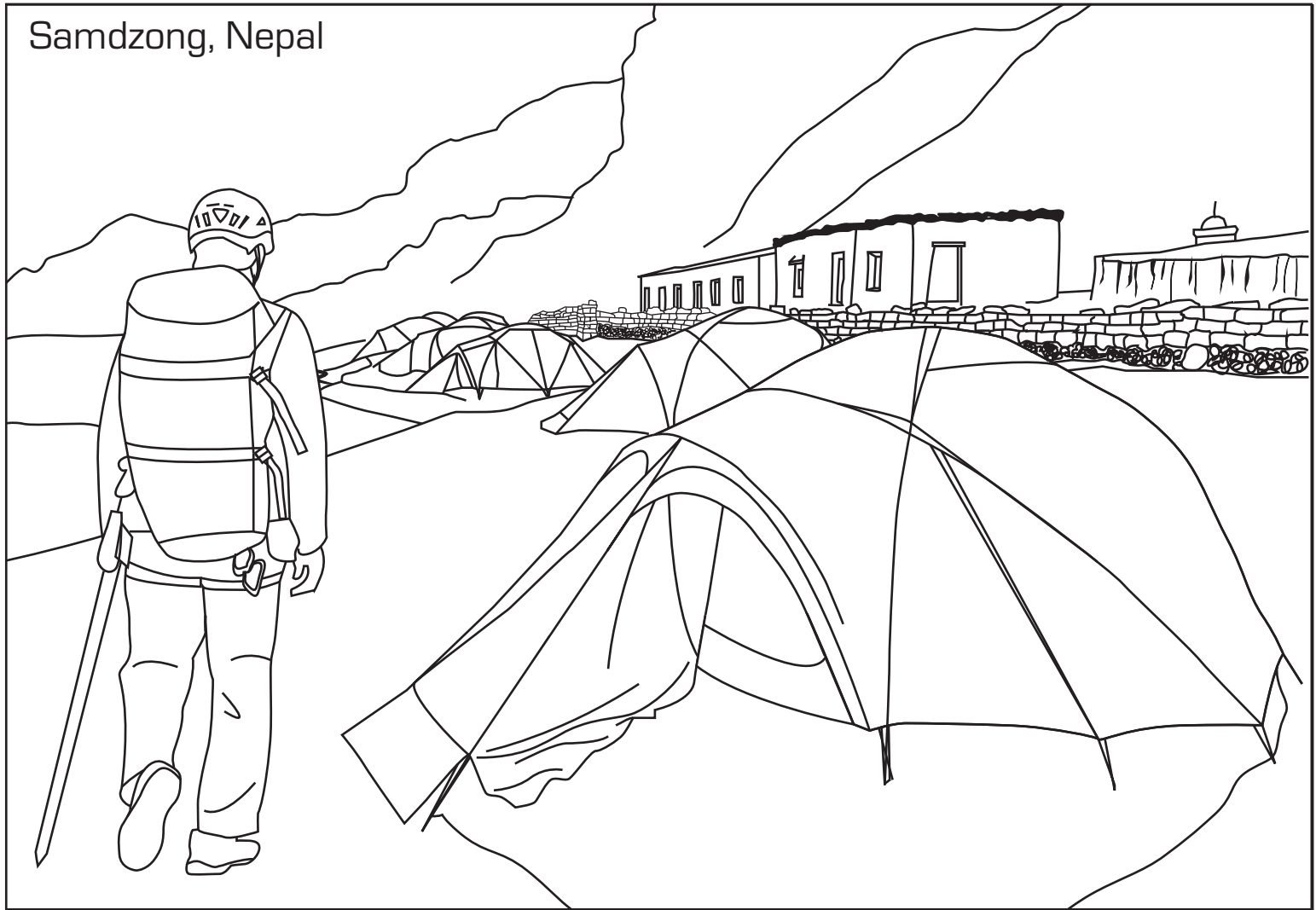
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## Dental Calculus

Also known as tooth tartar, dental calculus is the only part of your body that fossilizes while you are alive. It entraps food and bacteria, and it can be used to reconstruct health and diet.

## Bones and Teeth

Bones and teeth contain fragments of DNA that can be used to trace the migrations of ancient peoples and reveal traits, such as hair and eye color, as well as genetic adaptations. The teeth of people who died during epidemics may also contain the DNA of the pathogens that infected them.

## Animal Bones

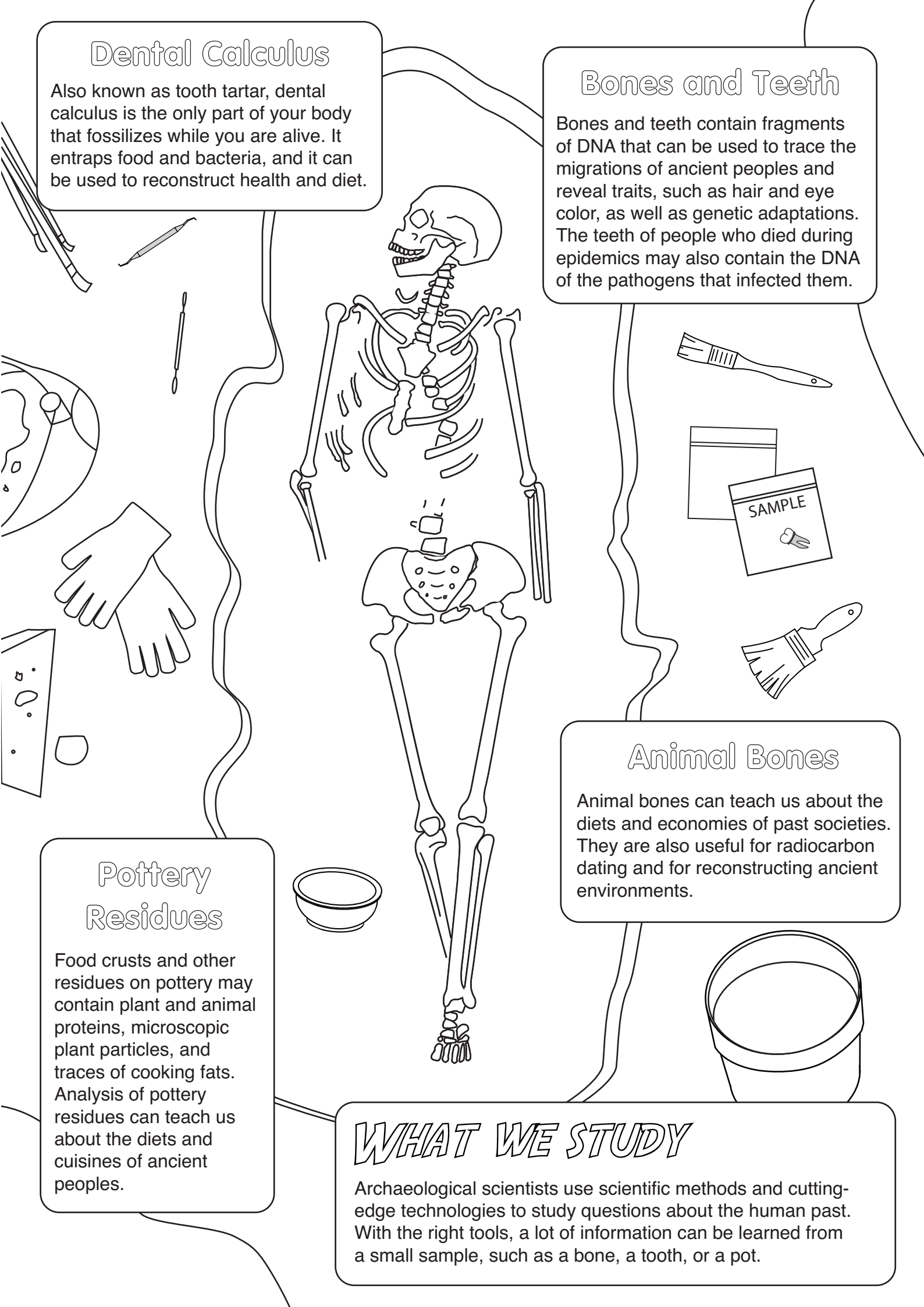
Animal bones can teach us about the diets and economies of past societies. They are also useful for radiocarbon dating and for reconstructing ancient environments.

## Pottery Residues

Food crusts and other residues on pottery may contain plant and animal proteins, microscopic plant particles, and traces of cooking fats. Analysis of pottery residues can teach us about the diets and cuisines of ancient peoples.

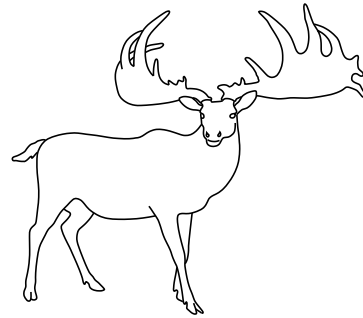
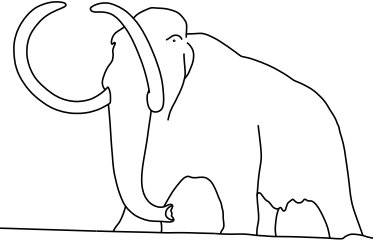
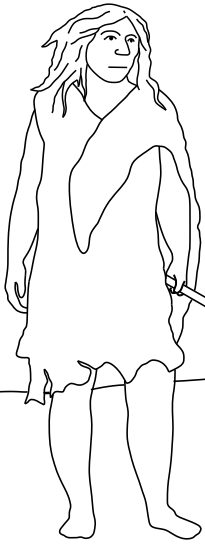
## WHAT WE STUDY

Archaeological scientists use scientific methods and cutting-edge technologies to study questions about the human past. With the right tools, a lot of information can be learned from a small sample, such as a bone, a tooth, or a pot.



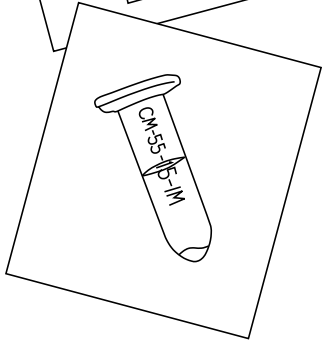
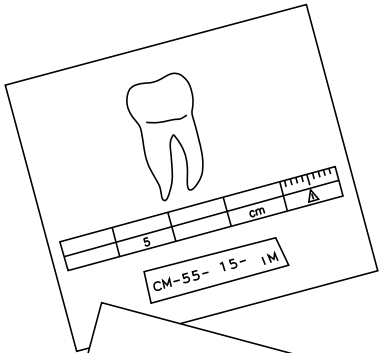
### *DID YOU KNOW?*

Neanderthals went extinct approximately 40,000 years ago, but Neanderthal DNA lives on in the genomes of most non-African humans.



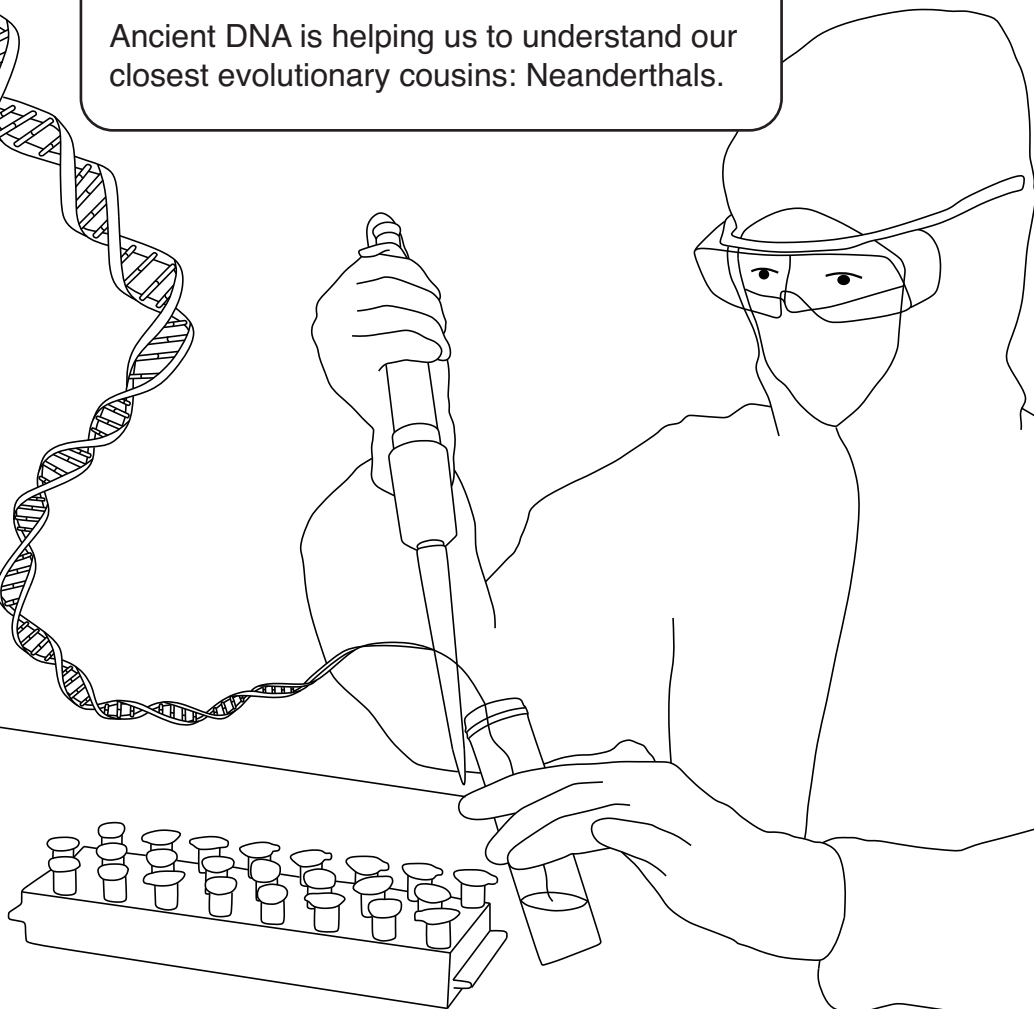
## *HUMAN ORIGINS*

Ancient DNA is helping us to understand our closest evolutionary cousins: Neanderthals.



## *Evolution*

By studying the teeth and bones of ancient humans, we can find out how our ancestors lived, and how we as humans came to be the species we are today.



# ANCIENT MIGRATIONS

Scythians, Central Asia  
Iron Age, 700 BC

Ancient DNA recovered from bones and teeth can be used to reconstruct prehistoric migrations. When combined with isotopic analyses, such as radiocarbon dating and strontium and oxygen isotope analysis, these migrations can be traced through time and space.



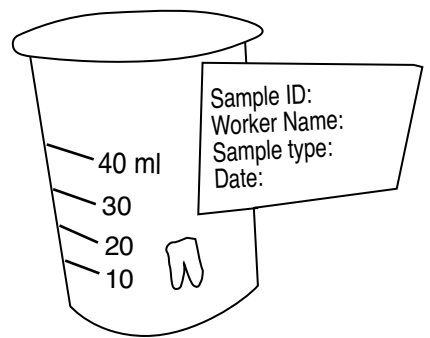
## DID YOU KNOW?

Radiocarbon, or  $^{14}\text{C}$ , is an unstable isotope of carbon that is taken up by plants from the air during photosynthesis. Animals incorporate radiocarbon into their tissues when they eat plants. Radiocarbon decays over time.

By measuring the amount of  $^{14}\text{C}$  in an ancient sample, it is possible to estimate how long ago an organism was alive.



## Radiocarbon Dating

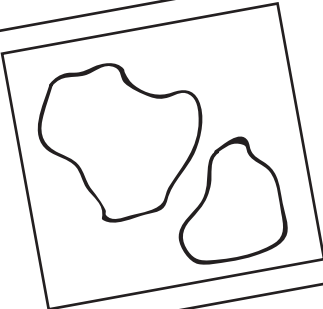


Radiocarbon dating is a technique that can be used to determine the ages of people, animals and plants up to 40,000 years old!

# ANCIENT DIET

Scientists can use microscopes to find tiny bits of food on ancient pots and human teeth. This “microfossil” analysis has taught us about the foods eaten by the ancient Maya of Mesoamerica more than 2,000 years ago.

Copan, Honduras  
Classic Maya, AD 300

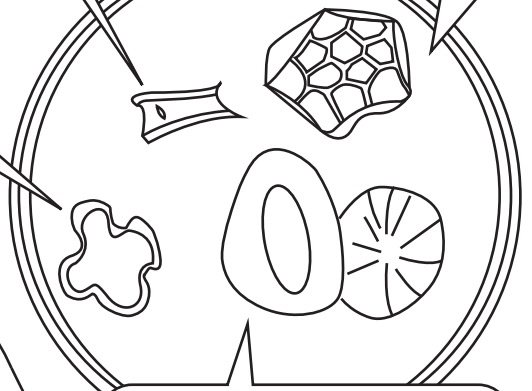


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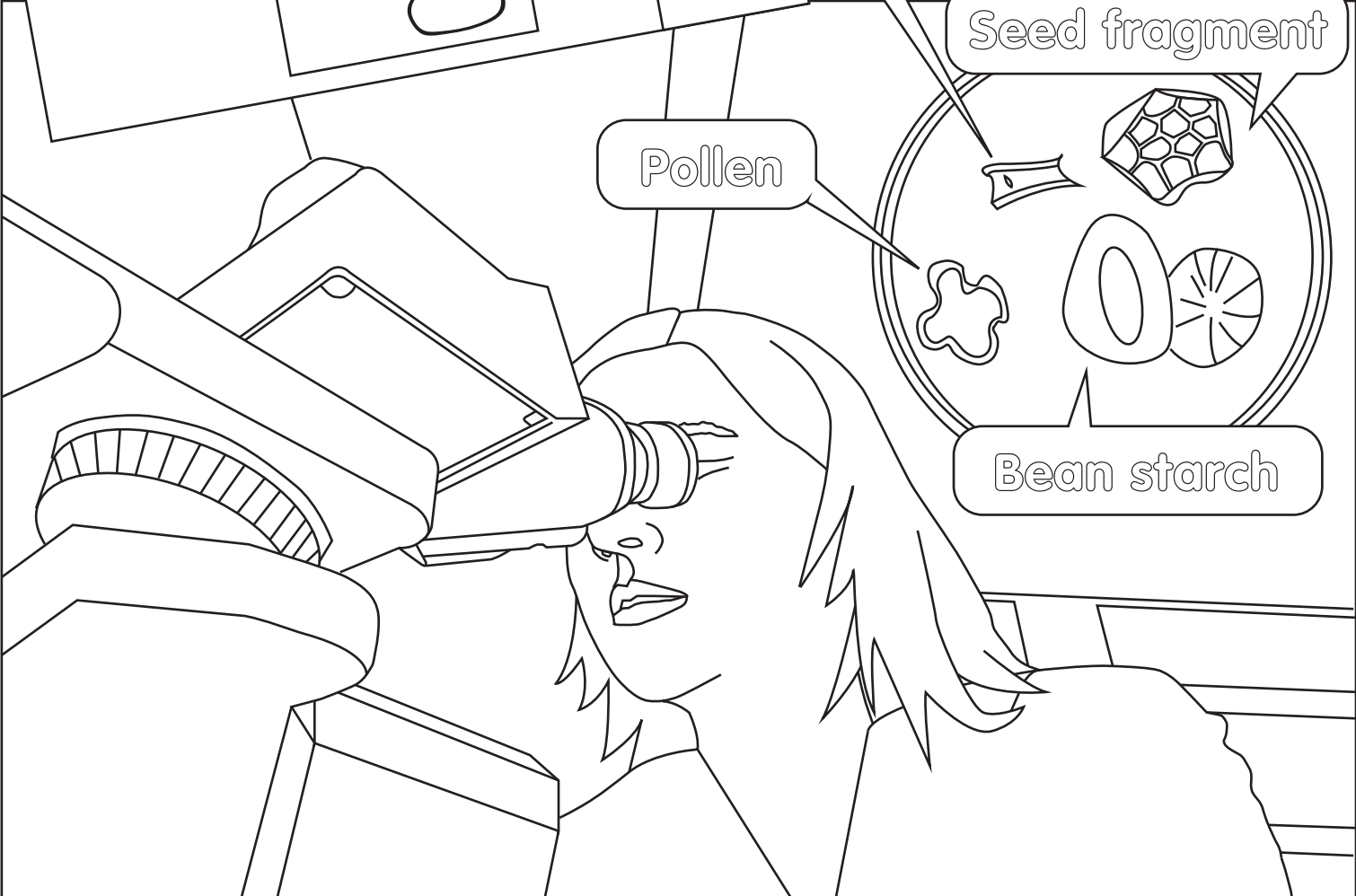
Maize phytolith

Seed fragment

Pollen



Bean starch



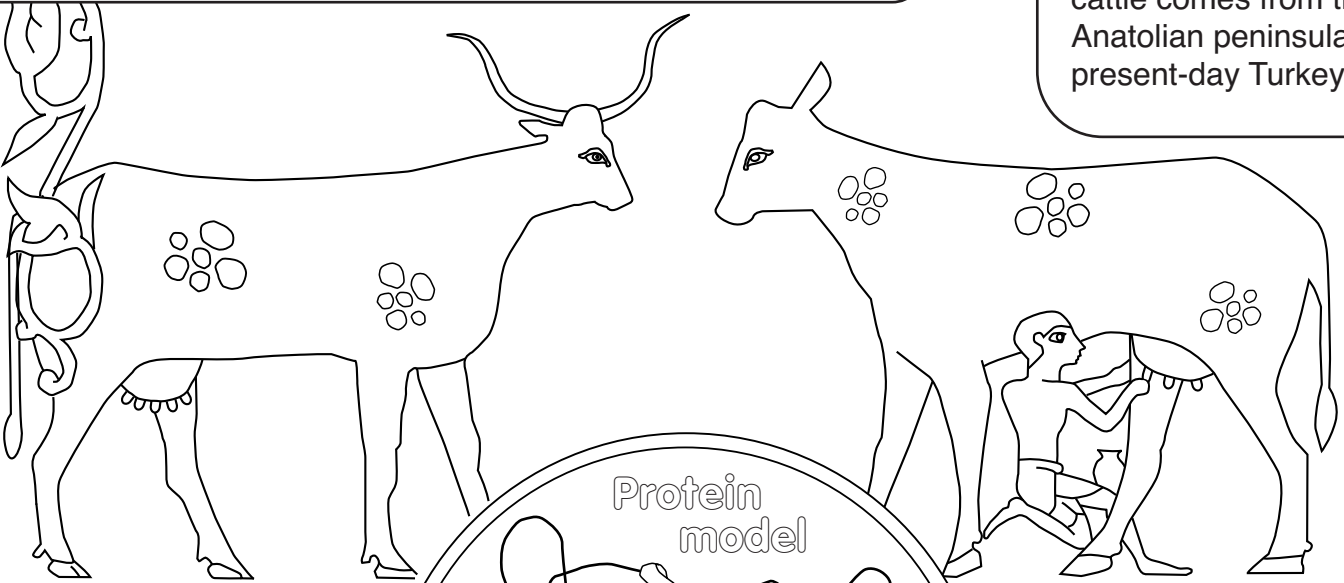


# DOMESTICATION

For more than 10,000 years, humans have been selectively breeding plants and animals for particular traits. Cattle were among the first food animals to be domesticated, and early people used them for traction, meat, milk, and hides.

## DID YOU KNOW?

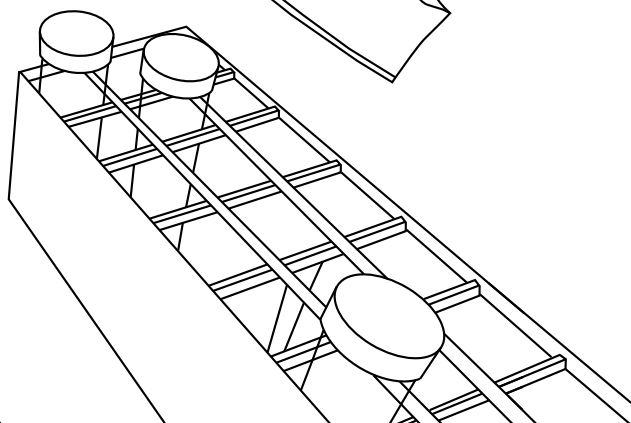
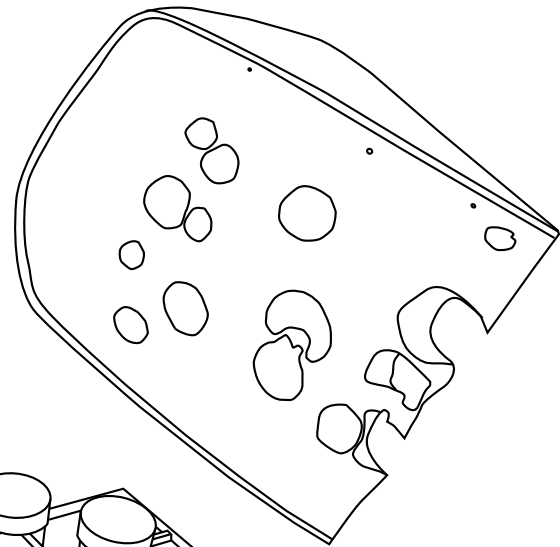
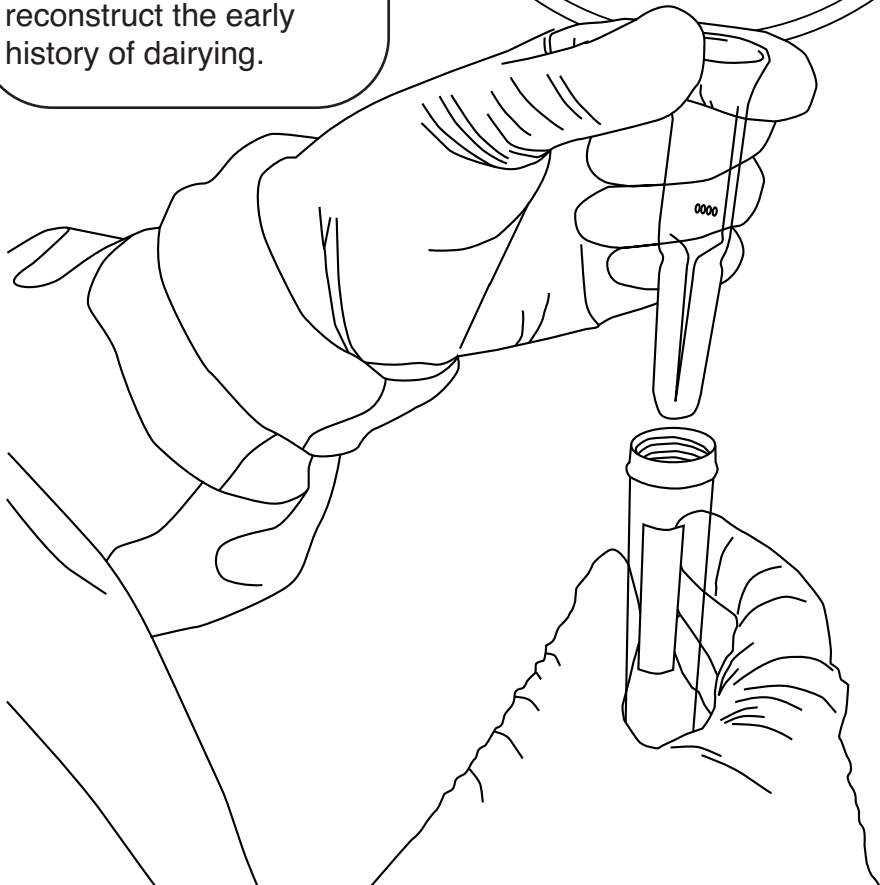
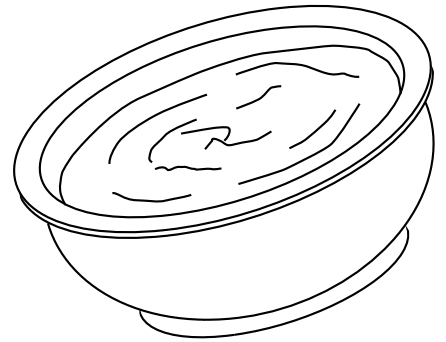
Cattle were domesticated from aurochs, a large wild bovid species that is now extinct. The earliest evidence for domesticated cattle comes from the Anatolian peninsula, in present-day Turkey.



Protein model

## Dairy Origins

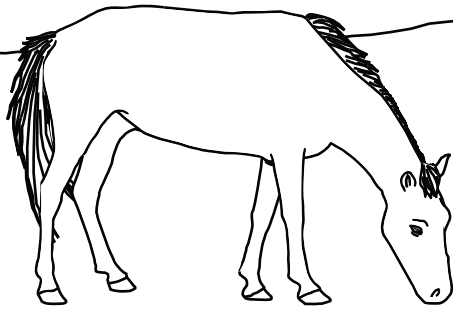
The origins of dairying are not well known, but archaeological scientists are using a technique called mass spectrometry to detect milk proteins on prehistoric teeth and thus reconstruct the early history of dairying.



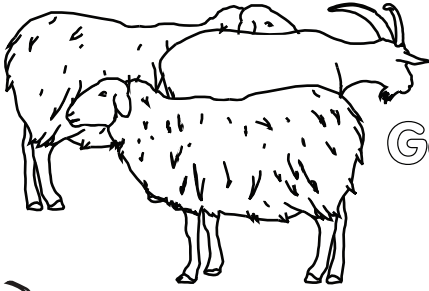
# Mongolia

A wide variety of animals live on the grassy Mongolian steppe, including horses, cattle, yaks, sheep, goats, reindeer, and camels. Nomadic herders produce dairy products from the milk of each of these animals.

Horse

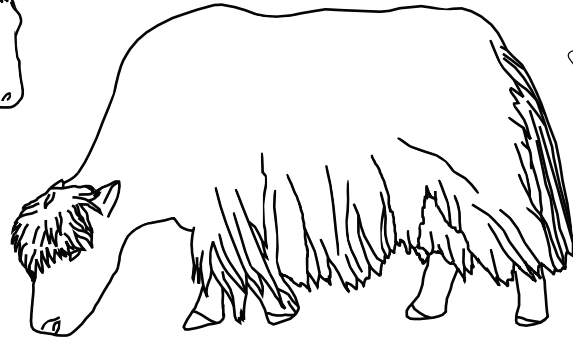


Sheep

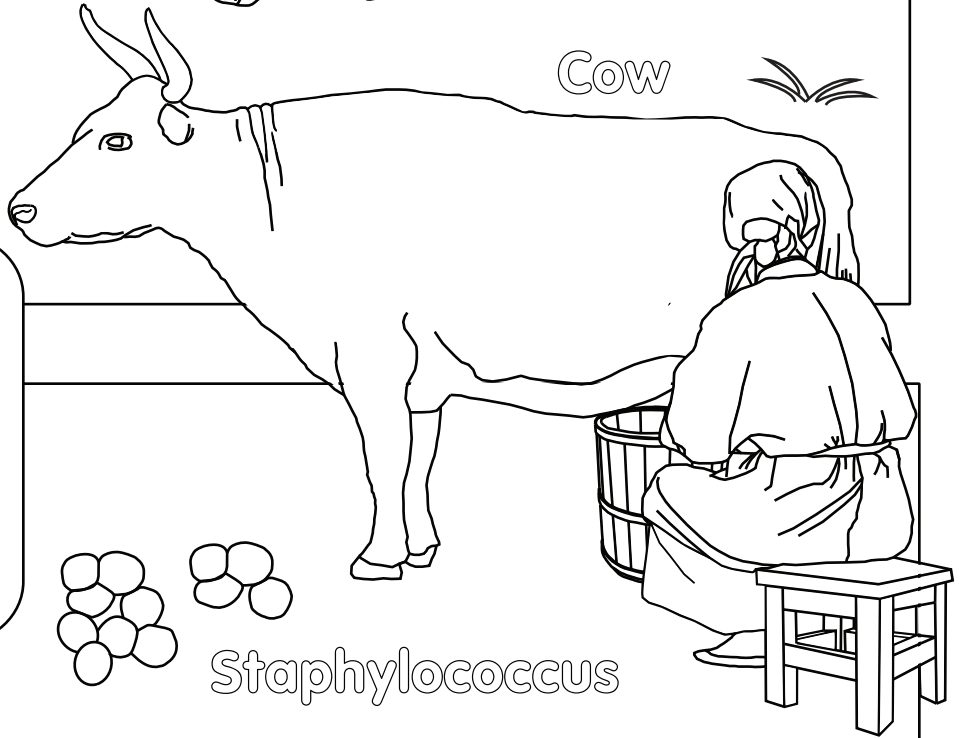


Goat

Yak

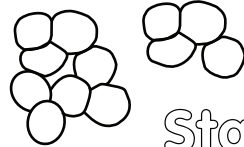


Cow

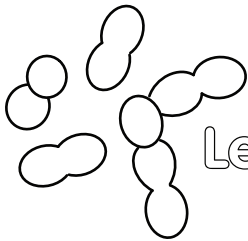


## DAIRY FOODS

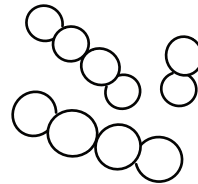
Dairy foods are an extremely important part of daily life in Mongolia. From archaeological research we know this tradition stretches back to at least 3,500 years ago.



Staphylococcus



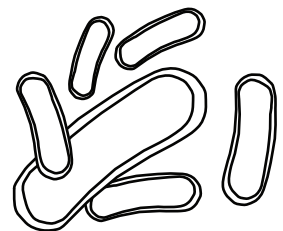
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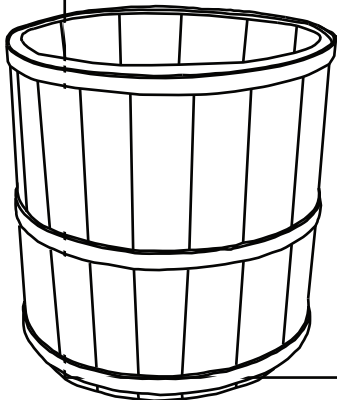
Lactococcus

## Dairy Microbes

Microbes - especially bacteria and yeasts - play an important role in creating a wide variety of familiar dairy foods, such as yoghurt, butter, and cheese, as well as less familiar foods, such as Mongolian aaruul (dried curds) and airag (horse milk beer).



Lactobacillus





# ANCIENT DISEASES

Bones, teeth, and tooth tartar preserve valuable information about the health of past people. For example, DNA and proteins preserved in tooth tartar help scientists understand the history of gum disease and dental decay.

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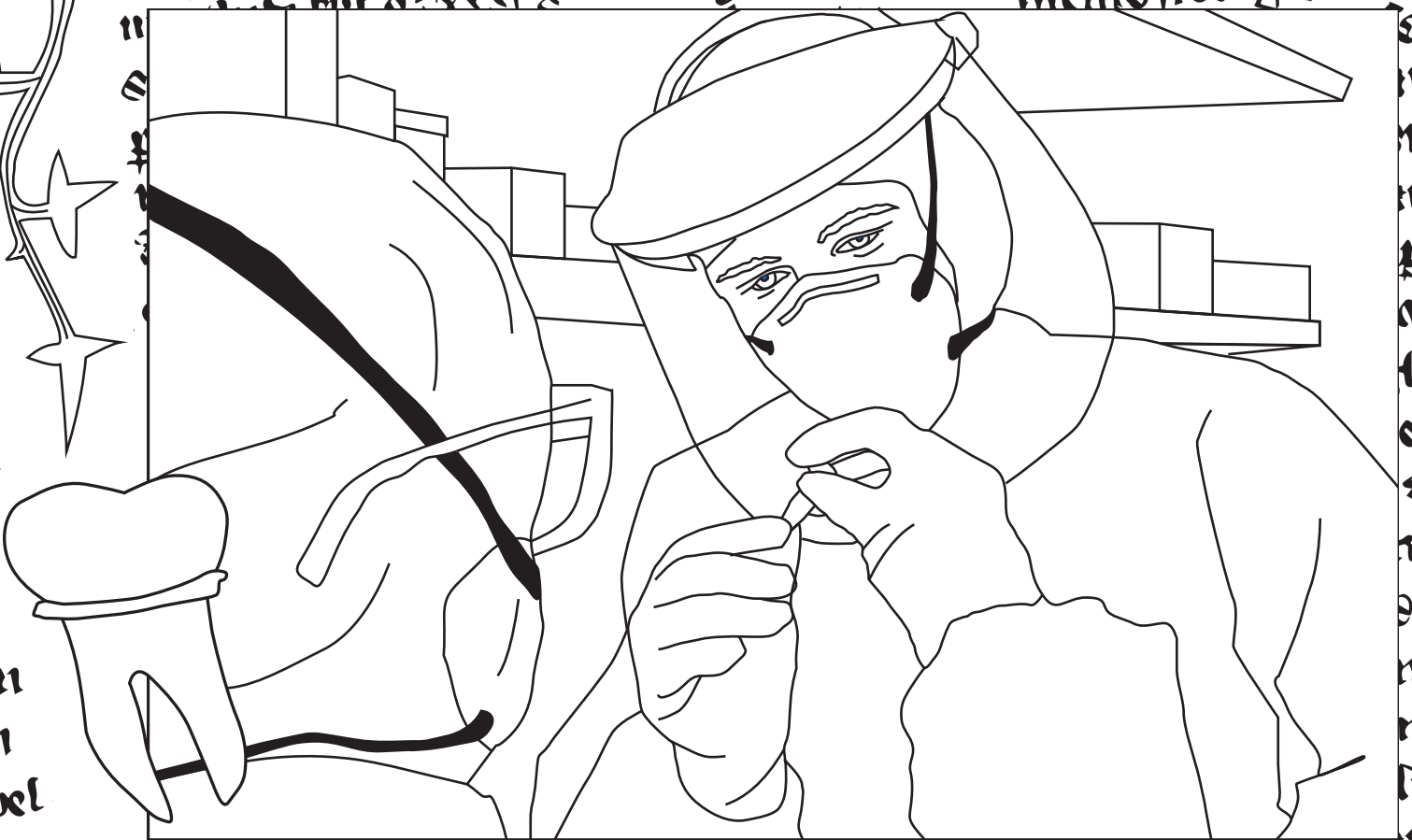
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**Omne Bonum**  
The Omne Bonum is a 14<sup>th</sup> century encyclopedia about life in the European Middle Ages that is held at the British Library. It includes entries on dentistry and medical care that help us better interpret medieval health and disease.

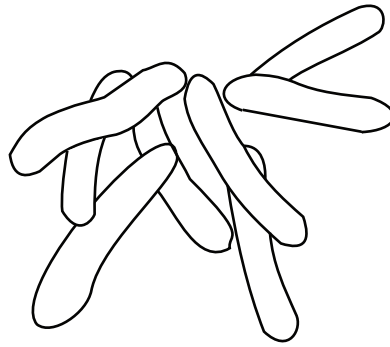
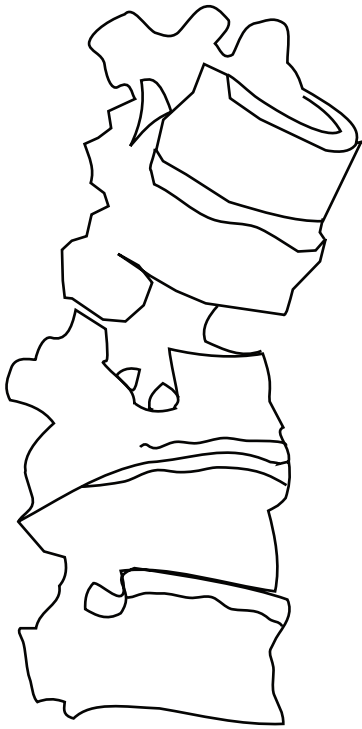
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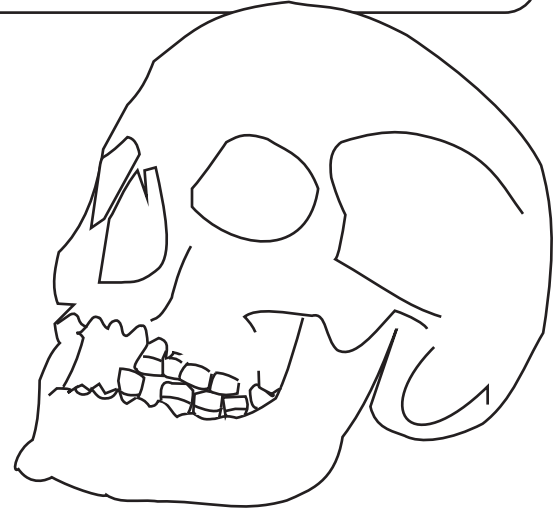
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# TUBERCULOSIS & LEPROSY

Tuberculosis and leprosy are caused by related bacteria: *Mycobacterium tuberculosis* and *Mycobacterium leprae*. Both can infect bone, and traces of DNA left behind in the skeleton are helping scientists reconstruct the history of these ancient diseases.

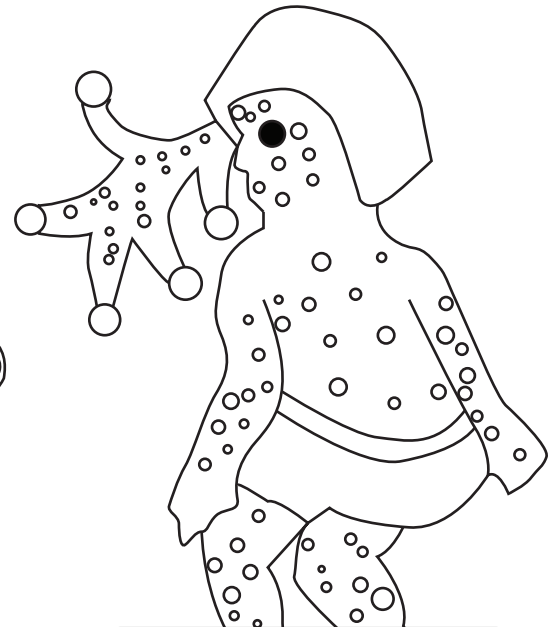


*Mycobacterium leprae*



# COCOLIZTLI

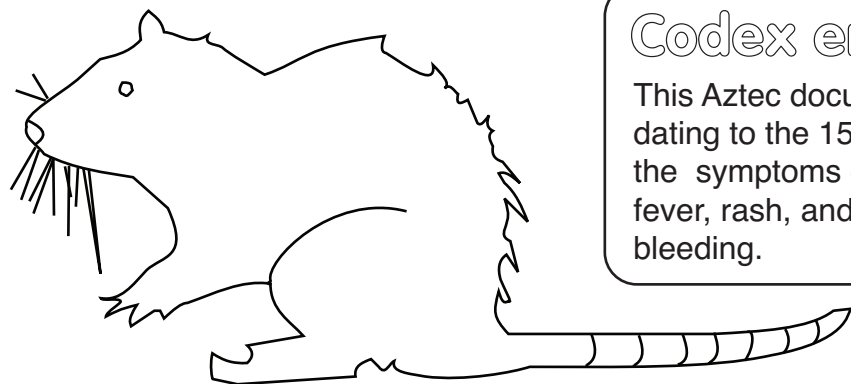
An unidentified epidemic - named *cocoliztli* by the Aztecs - killed 60-90% of the population of Mexico between AD 1545 and 1550. Recently, DNA from the pathogen *Salmonella enterica* Paratyphi C was identified in the teeth of epidemic victims.



*Salmonella enterica*

## Dr. Schnabel

Doctors treating plague victims in the 17<sup>th</sup> century wore bird-like masks to protect them from "bad air."

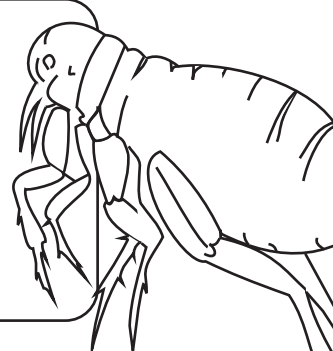


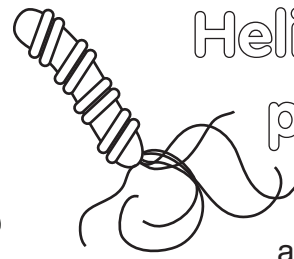
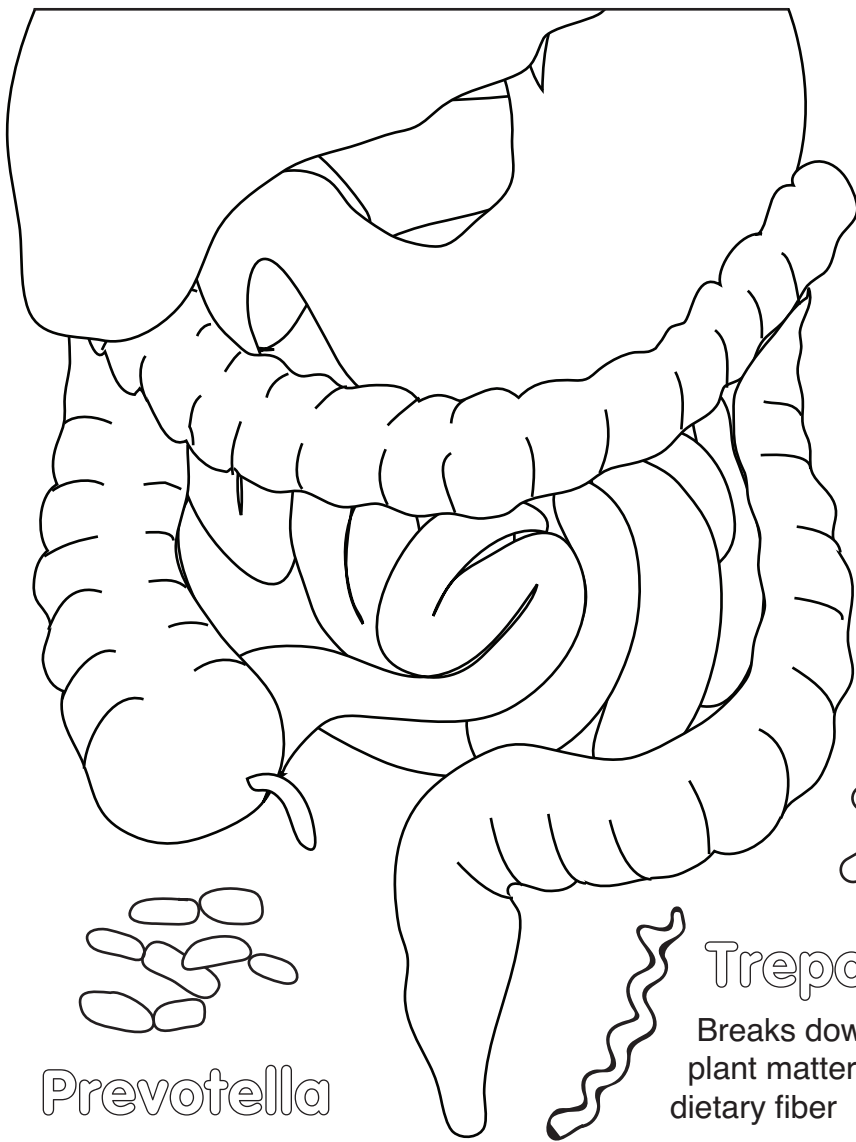
## Codex en Cruz

This Aztec document dating to the 1550s depicts the symptoms of *cocoliztli*: fever, rash, and severe bleeding.

# PLAGUE

Plague is caused by the bacterium *Yersinia pestis*, which spreads by infecting fleas that live on rats. Humans bitten by these fleas develop bubonic plague. Plague was the cause of the Black Death (AD 1346-1353) that killed half the people of Europe.





**Helicobacter pylori**

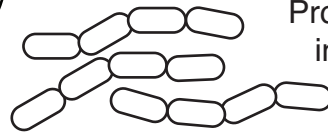
Lives in the stomach and can cause ulcers and some cancers



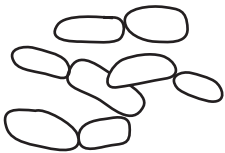
**Bifidobacterium**

Helps babies digest milk

**Faecalibacterium**



Produces food for intestinal cells



**Prevotella**

Helps digest fibrous plants

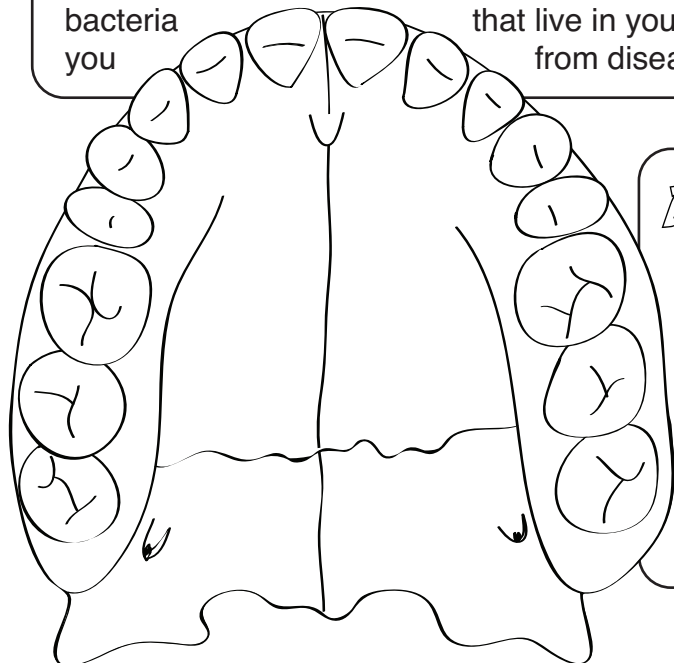


**Treponema**

Breaks down plant matter and dietary fiber

## ANCESTRAL MICROBIOME

Your body is home to **trillions** of bacterial cells, and together they are called your microbiome. The bacteria that live in your intestines help you digest food and strengthen your immune system. The bacteria on your skin help keep you clean, and the bacteria that live in your mouth help protect you from disease.

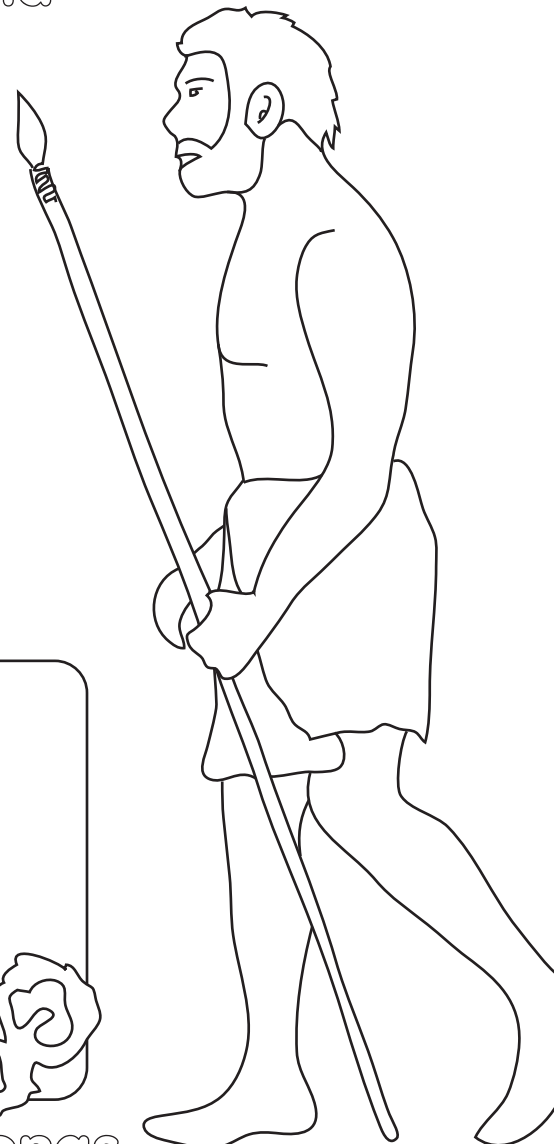


### DID YOU KNOW?

Scientists are studying dental calculus and paleofeces in order to define the ancestral microbiome and to better understand the causes of diseases.



**Porphyromonas**



# FORAGERS

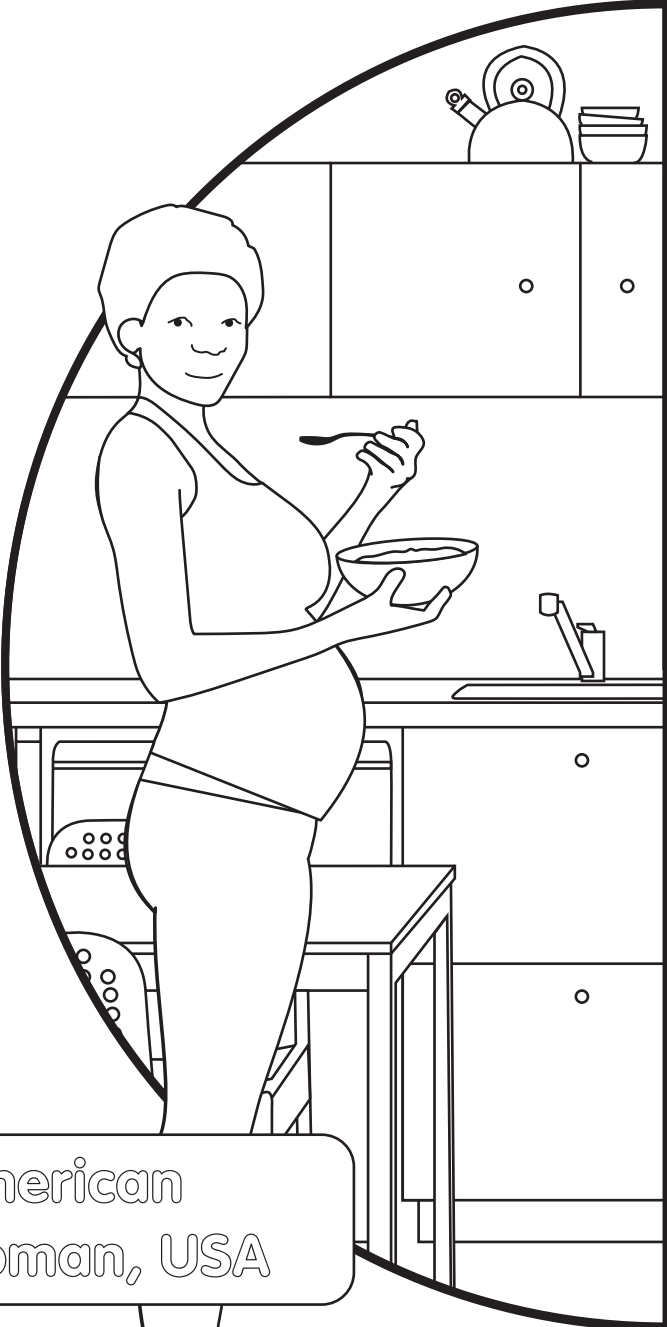
Foragers, also known as hunter-gatherers, eat wild foods, and their diets are seasonally variable.

Before the onset of agriculture around 10,000 years ago, all humans on earth were foragers.

Foragers today have more diverse gut microbiomes than people in industrialized societies.



Hadza woman and baby, Tanzania



American woman, USA

# INDUSTRIALIZED SOCIETIES

Industrialized societies consume mainly agricultural foods, and food production is a specialized activity performed by only a few.

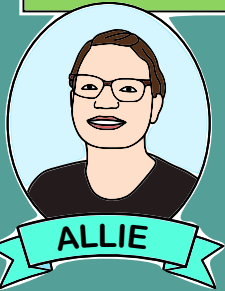
Mechanization, preservation, and storage are key aspects of industrialized food chains, and foods often travel long distances before being consumed.

People in industrialized societies today have less diverse gut microbiomes, which may put them at greater risk for some chronic inflammatory diseases.

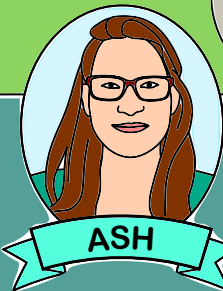




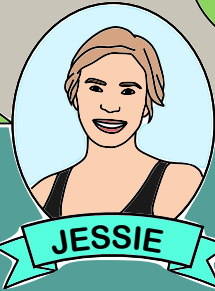
# Max Planck Institute for the Science of Human History



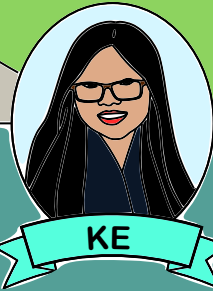
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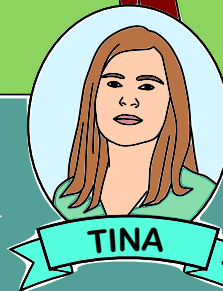
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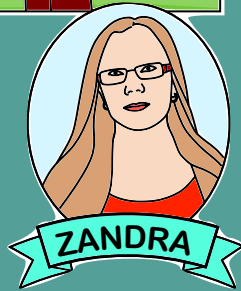
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## Adventures in **ARCHAEOLOGICAL SCIENCE** Coloring Book

Learn how archaeologists and scientists work together to answer questions about the human past! Join us as we explain **who we are** and **what we study**, from the **origins of humans** to **medieval plagues**. Learn about **ancient migrations** and **radiocarbon dating**. See how scientists reconstruct **ancient diets** from microscopic plant remains. Unearth **domestication** fun facts and the science behind **dairy** foods. Explore **ancient diseases** and **epidemics** and discover the **ancestral human microbiome**.

Produced by scientists at the Max Planck Institute for the Science of Human History  
for the **Long Night of Science**  
24 November 2017, Jena, Germany