FOOD to FECES

An interactive tour through the digestive system

(from: www.ellenjmchenry.com)

Description of activity: An imaginary, interactive "tour" through the digestive system where a leader reads a script that includes both information and activities about the digestive system.

Target audience: ages 8-12, though could be used with older if you take out (or adapt) the imaginary journey part

Time needed: about an hour if you do all the activities

Materials needed:

For the playing board ("map"):
- color copies of board pattern pages (made one board for up to 6 players), plus submarine token pattern
- scissors, glue stick

For activities #1 and #2 (taste buds):
- two types of crackers/cookies with identical texture but different flavors (such as vanilla/chocolate cookies)
  (NOTE: You only need one bite of each. The players don't have to consume a lot of sugar.)

For activity #3 (salivary glands):
- lemon juice

For activity #4 (salivary glands):
- small soup crackers, either regular or gluten-free (the kind that dissolves easily)
- a good supply of paper towels or paper napkins

For activity #6 (the stomach):
- pieces of paper (half sheets, and they can be scrap paper or newspaper--no need to waste fresh paper)
  (NOTE: If you are short on class time, you might want to prefold these.)

For activity #8 (the stomach):
- chicken gizzards (substitute raisins or prunes for texture if you can't get gizzards)
- paper towels and hand sanitizers to wipe fingers
  (NOTE: Paper bowls work well for passing around the gizzards and livers (Makes clean up easy.)

For activity #9 (the liver):
- chicken livers
- paper towels and hand sanitizers to wipe fingers

For activity #11 (the appendix):
- gummy worms (cut in half)

For activity #12 (making edible animal feces):

Edible brown dough (For recipe ideas, try http://kidsactivitiesblog.com/53932/edible-playdough-recipes. You can make anything brown by adding chocolate or carob powder.)

How to prepare:

1) Copy the six anatomy chart pictures and assemble them to make your "map" of the digestive system. Also, make a little "submarine" token for each digestive map you make. (This is the vehicle from the movie "Fantastic Voyage," a scifi film of the 1970s where some scientists get miniaturized and go inside a body.)

2) Read through the script and determine whether you will do most or all of the activities. Check the list above to see what you will need for each activity. Gather these materials.

3) Preview the suggested youtube videos listed below.

How this activity works:

The "submarine" will be placed on the numbers to keep track of where you are in the digestive system. Read through the script out loud to your students and do what it says as you go along. It's as easy as that! However, you can also just ad lib the tour yourself, using the script only as an approximate guideline. You can add or subtract to the script as you wish. Adjust the activity to fit the personality of your group.

Video suggestion:

I showed my class this video before we did this activity: **https://www.youtube.com/watch?v=-1aZj6v6dxc**
It is a computer animation of what an endoscope sees as it goes through the digestive system. You could also use the video as a follow-up activity.

START

Welcome aboard! You are inside the most advanced vehicle of the 21st century. After the hatch is sealed, our submersible will be shrunk down to one centimeter, which is small enough for our volunteer to swallow. He'll just swallow us like he would swallow a vitamin capsule. (Please note that the token we will be using on our map is three times as large as our actual size.)

Our journey should be fairly safe, because we will NOT be microscopic. If we were shrunk down to the size of a blood cell, our vehicle would be in danger of getting stuck in microscopic blood vessels. But no worries on this voyage-- we'll stay large enough that there's no chance of leaving the digestive system. The biggest danger we'll face is the acidic environment of the stomach, but the protective coating on the outside of our vehicle will keep us safe.

So, let's go! I'll give the signal for our volunteer to pick us up and put us in his mouth. We'll follow our progress on the map in front of you. We'll be starting at number one. Pick up the submersible token and place it on the number 1.

1: MOUTH

We're sitting on the tongue right now, with a great view of those upper teeth. If you look out the observation windows above you, the teeth will look like icicles the size of small mountains. The teeth are part of your digestive system because they begin the process of breaking down your food into smaller and smaller pieces. Eventually the pieces of food will be nothing but molecules, but right now we can still see them. The tongue moves around a lot, too, while the teeth are chewing. It's sort of a cooperative effort between the tongue and the teeth.

If you look down below, you will see bumps called **papillae**. *("pap-PIL-eye" or "pap-PIL-ay") (Show picture of papillae.)* You probably call them taste buds. Not all papillae are involved in tasting. Some are there just to give the tongue a rough surface. The papillae that do help in tasting have several hundred microscopic taste receptor cells at the base of the bump. There are five kinds of receptor cells: sweet, sour, bitter, salty and savory. When food molecules trigger one of these cells, it sends a signal to the brain. People used to think that receptor cells were located in certain areas of the tongue, such as salty on the sides. More research has shown that all the types of receptors are found all over the tongue.

If you are short on time, you can skip one, or both, of these next sections.

Look at the area labeled "nasal cavity." That big empty space up there actually helps you to taste. Some of the food molecules in your mouth get released into the air and float up the passageway at the back. Can you trace the path they would take? There's a very sharp U turn. Once those tiny molecules get up into the nose, they stick to cells on the surface of the cavity that act a lot like taste receptor cells. These smell receptor cells also send electrical signals to the brain when they are trigger by chemicals.

So taste isn't just from our tongue. It takes both tongue receptors and nasal smell receptors to allow us to tell the difference between apples and oranges. We can do a simple test to verify that this is true.

ACTIVITY #1: Have the students hold their noses while tasting two things that are similar in texture but different in flavor. For example, two cookies or crackers from a brand that offers two flavors such as vanilla and chocolate. The tongue will be able to detect sweetness and texture, but probably won't be able to distinguish the two flavors.

The taste buds must be moist in order to work properly. They can't detect chemicals if they are dry. We can try an experiment to see if this is true.

ACTIVITY #2: Have the students use the paper towels or napkins to soak up saliva on the tonuge. Just press the towel a number of times onto the tongue to soak up moisture. Then immediately put a piece of dry cookie or cracker onto it. You don't have to hold your nose, but you do have to try to hold your mouth open and try to prevent the tongue from getting wet with saliva. Can you taste the cracker? Now close your mouth and allow saliva to moisten the cracker. Does the sense of taste return as the moisture returns?

The mouth is supplied with a constant source of moisture: saliva. The saliva comes from three types of salivary glands. The **sublingual glands** are under the tongue. *(Make sure they find it on the map.)* "Sub" means "under," and "lingua" means "tongue." Use your tongue to feel these glands. *(Encourage students to take a few seconds to do this.)* The **submandibular glands** are under the jaw. "Sub" means "under," and "mandible" means "jaw." You can feel these from the outside using your fingers. *(Encourage students to feel for glands under jaw.)* The largest salivary gland is called the **parotid gland** and it is located on your jaw, up by your ear. *(Encourage students to feel these glands. They are much harder to detect.)* These glands sometimes get air pushed into them when you blow up a balloon, and it feels prickly. You also can feel these glands prickle when you taste something sour (or even just think about something sour.)

ACTIVITY #3: Hold up the picture of the lemon and the baby with the sour face. Does anyone feel their parotid glands tingling? Then let them dip their fingers into lemon juice and put a dab on their tongues. Now do their parotids tingle? Then have them hold their noses to test whether they can still taste the sourness of the lemon without any help from the sense of smell.

Salivary glands produce watery saliva that moistens our food and helps our taste receptors to function. But saliva is more than just water. Saliva contains chemicals called **enzymes**. An enzyme is a molecule that can break apart or put together other molecules. Some molecules act like scissors and others act like staplers. The main enzyme found here in the mouth is a scissor-type enzyme and its name is **amylase**. This enzyme can tear apart the starch molecules found in foods such as bread, rice, potatoes and pasta. Amylase can't digest greasy things like butter or oils, and it can't digest meats or dairy products. It can only break apart starches. But isn't it amazing that you begin digesting at least some of your food right there in your mouth?

ACTIVITY #4: Can you feel or taste the effects of amylase?

Give each student a piece of cracker (or small cracker). Tell them to hold the cracker in their mouth without chewing. Kind of yucky, but don't chew. After a few minutes the cracker will get very mushy, but it will also begin to taste sweeter. This is because the amylase is breaking down the starches into simple sugars such as glucose. Glucose is less sweet than table sugar, though, so the sweetness will be mild.

Well, we've been in the mouth quite a while. It is time to move on! I think our volunteer is ready to swallow now. Everyone fasten your seat belts, as our vehicle will now plunge over the back of the tongue!

Move the token to number 2.

2: ESOPHAGUS

Hmm... that wasn't much of a ride. We're actually still in the upper part of the esophagus. We're going down very slowly. It's going to take us about half a minute to reach the bottom. What do you think would happen if our volunteer stood on his head right now? *(Allow students to guess. If someone guesses correctly, you can affirm that they are correct.)* If our volunteer was upside down right now, we'd still be moving along towards the stomach. Gravity is NOT the main force that gets food to the stomach. The force that pushes food along is called **peristalsis**. There are muscles all around this tube that we are in. The muscles are squeezing in rhythm, sort of like the way an earthworm moves. The squeezing goes in waves that gradually push the food along, inch by inch. It's slow but it is very efficient. Your food always gets down there eventually, and it doesn't matter if you are standing up, lying down, or even standing on your head.

ACTIVITY #5: A pantomime.

Let's simulate the action of peristalsis. Imagine that there is a rubber pipe in front of you, going up to the ceiling. Inside that rubber pipe is a ball that is stuck. Squeeze the rubber pipe right below the ball to force it up a little. Now use your other hand to squeeze it up a little more. Keep track of where that imaginary ball is! Alternate hands-- squeeze, squeeze, squeeze, squeeze, until the ball is too high to reach.

3: STOMACH

Now slide the submersible token down through the rest of the esophagus, under that bit of liver, and into the stomach. Leave the token right on top of the number 3.

Here we are in the stomach. This is certainly a part that you are familiar with, but you've probably never seen what the inside looks like. *(Show picture of stomach.)* Are you surprised that it is wrinkled? Those wrinkles help to give the inside more surface area. If you flattened out all those wrinkles, the area they'd cover would be much larger than just the size of the interior surface of the stomach. Also, the wrinkles may allow the stomach to stretch a bit. The stomach is smaller when it is empty, and larger after you eat a large meal.

ACTIVITY #6: A paper model of stomach wrinkles showing what they are good for

Give each student a half a sheet of paper. (Scrap paper or newspaper is fine.) When it is laying flat we can easily calculate its surface area by measuring length and width and multiplying. (You can actually do this if you want to, or skip it.) If we fold it back and forth making little ridges and valleys, we can reduce the area that the paper takes up on the table without reducing the amount of paper that is still exposed to the air above it. The surface area that is exposed to the environment stays the same, but the "footprint" of the paper gets smaller. If we fold these ridges completely shut, that actually eliminates surface area, so the folds can't be too right. The folds of the stomach are not too tight, not too loose.

Notice the patch above us where the muscles are exposed. The stomach is surrounded by very strong muscles that can squeeze much harder than the ones in the esophagus. The squeezing action helps to mash and grind the food. Our stomachs are constantly moving and churing.

ACTIVITY #7: Observing your abdominal muscles

Put your hand on your stomach. Can you feel your stomach moving and churning? No, you can't. Your stomach is behind the muscles of your abdomen. Tense your abdomen muscles. You have control over these muscles. You can squeeze them and then let them relax. Can you control the muscles around your stomach? No. They are called ***involuntary*** *muscles. The ones you can move are* ***voluntary*** *muscles. The muscles of your digestive system are constantly getting signals from the part of your brain that controls the automatic functions that you don't have to think about. What other automatic functions can you think of?*

A chicken's stomach, called the gizzard, also has a wrinkly interior and strong muscles.

ACTIVITY #8 (OPTIONAL): Observing gizzards (chicken stomachs)

Pass around some chicken gizzards, letting the students see the wrinkly texture inside. Also, have them notice how thick the muscles are around the gizzard. Chickens don't have teeth to grind their food, so they need to have a very strong grinder down inside. Often, birds will swallow tiny rocks that stay in the gizzard acting like grinding stones, helping to grind tough particles like hard seeds.

Look out the observation window at the surface of the stomach's wrinkles. You will notice that they look really slimy. They are covered in mucus. You thought mucus only came out your nose, right? The stomach has millions of cells that constantly make mucus. This is normal. The mucus is necessary to protect the stomach's surface cells from a very dangerous substance-- hydrochloric acid! Hydrochloric acid is more acidic than lemon juice. If you got it on your skin it would burn. The mucus repels the acid and protects the stomach cells. Where does this acid come from? Not from your food. Special cells in the stomach make this acid. The acid is necessary for some chemical reactions to occur.

Another type of cell in the stomach is making a digestive **enzyme** called **pepsin**, that tears apart protein molecules. Meat and fish are examples of foods that need pepsin to break them down. Pepsin only works in an acidic environment, so it's a good thing you've got those cells making acid, or your meat would never get digested! Now move the submersible token to number 4.

4: PYLORIC SPHINCTER

We are now sitting in front of a huge ring. The ring is a **sphincter** muscle. This type of muscle stays tightly contracted all the time, except when it decides to relax and open for a few seconds. *(Optional-- have the students make a fist and hold it like that, as a model of the sphincter. Relax and open the fist, then go closed again.)* There was a similar muscle at the bottom of the esophagus but it was open when we went through so we did not notice it. The sphincter at the bottom of the esophagus keeps stomach acid from splashing up into the esophagus. The esophagus does not have a mucus coating, so stomach acid feels terrible if it gets up into the esophagus. *(Optional-- have a show of hands of how many students have felt the burn of stomach acid in the esophagus from either a burp or from vomiting.)*

The pyloric sphincter is starting to open! Here we go! Move the token to the first number 5.

5: DUODENUM *(This is pronounced in a variety of ways. Some people say "du-ODD-den-um" others say "do-oh-DEE-num" or "duo-DEN-im." You choose. Consult youtube for examples of pronunciation.)*

We are now in the duodenum. The acid is behind us. Well, most of it. A little bit leaked through, but that will be taken care of by some clean-up chemicals along the way.

The duodenum is a tube that connects the stomach to the small intestine. But it is more than just a connecting tube. Some very important things happen here. That huge brown thing above us is the liver. It makes lots of different chemicals, including a green liquid called **bile**, which is used to digest fats. See that green ball under the liver? That's the gallbladder, and it's the storage tank for bile. When some greasy, fatty food comes along, the duodenum will signal to the gall bladder to squirt out some bile. You could think of bile as a green dish detergent that is really "tough on grease" as some detergent advertisers like to say.

ACTIVITY # 9: (OPTIONAL) Observing a liver

Pass round some chicken livers and let the students observe the color and texture. The liver is smooth all the way through, unlike many other organs that have identifiable parts. Your lives looks very much like this chicken liver. Can you see any blood vessels coming out of the chicken liver? If you have chickens gizzards and/or hearts, compare the size of the liver to these other organs. The liver is the larg

Move the token to the next number 5.

We are still in the duodenum, but now we've moved on to where the next inlet pipe is. See that hole over there? *(Imagine you are looking out the observation windows?)* That leads to the **pancreas**, that bumpy, yellowish looking thing you see on your map peeking out from behind the stomach. The pancreas makes several digestive enzymes, including amylase, the enzyme we met in the salivary glands. The pancreas also makes enzymes that work on fats and proteins. These enzymes are able to digest the food particles until they are nothing but simple molecules. These molecules are what your body will use for energy and to build its tissues such as muscle, skin and bone.

Move the token to the next number 5. We're about to leave the duodenum, but as we go by, notice those huge blood vessels above us, like a highway overpass. Trace them downward on the map, and see where they end up. *(the intestines)* Now trace them upwards. What do they connect to? *(the liver)* The reason for this connection between the intestines and the liver is that after the tiny food particles are absorbed by the small intestines, the blood vessels will bring the nutrients back to the liver to be processed. The liver controls how much sugar and fat will be allowed to float around in your blood. *(NOTE: The fats take a different route to the liver, but this is too complicated to explain here. The point is that the liver cotrols nutrients.)*

Move the token down to number 6. As you go toward the number 6, you'll be going under another "highway overpass." We'll be going through that overpass near the end of our journey.

6: JEJUNUM of the SMALL INTESTINE *(jeh-JOO-num)*

Notice that the small intestine is divided into two sections. The first one is called the **jejunum**. The second one is the **ileum**. Move the submersible token to the number 6 on the jejunum.

Look out the observation windows at the walls of the jejunum. They look hairy, don't they? Those tiny hairs are called **villi**. The word villi means "fingers." Every tiny villi has a super tiny blood vessel inside it called a **capillary**. As the mushy, slimy, food slop (which is called **chyme**) *(kime)*, oozes in and around those little fingers, the nutrient molecules come out of the slop and go into the blood. *(Optional-- have students hold up all their fingers and wiggle them, simulating villi. Tell them to imagine sloppy goop running through their fingers. Wiggle those villi in the chyme!)*

The sloppy chyme moves along through the jejunum by peristalsis, the same action we saw up in the esophagus. There was peristalsis in the duodenum, too, but we were so interested in the enzymes that we didn't mention peristalsis. There are circular muscles going around the jejunum, and there are also long muscles, running lengthwise. These muscles work together to create the peristalsis motion.

ACTIVITY # 10: Group pantomime of peristalsis along the intestines

These instructions will make more sense if the students are sitting around a table or approximately in a circle. Tell them to imagine that there is a long tube, like a hose, laid out in front of them. You could even pretend to lay it out. It goes in a large circle so that each person is sitting in front of part of the ring. This will be an intestine and the students will demonstrate peristalsis. Choose one person to start the action. Imagine that there is a ball right there in the hose. The first person squeezes the hose, moving the ball to one side. They pretend to squeeze it again, moving the ball further along. When the balls moves in front of the next person, they take over and begin squeezing the ball bit by bit toward the next person. This continues, as everyone imagines the ball going through the hose, being squeezed along. When the ball gets back to the person who started it, you are done. You can play another round if you have time.

Move the token to number 7, the ileum.

7: ILEUM of the SMALL INTESTINE

We've traveled over ten feet (three meters) so far! We are now in the ileum. The diameter of this section is smaller and you will notice that the villi fingers on the walls are much shorter. Also, notice some white patches on the walls. These are called Peyer's patches and they are full of white blood cells that help fight infections. *(Show picture of Peyer's patches.)*

Here in the ileum, some important vitamins are absorbed from the chyme. Also, tiny fat molecules move out of the chyme and into little lymph vessels which are right next to the blood vessels. The fat molecules take a different path to the liver, not the direct route that the sugars and proteins take.

If it was possible to flatten out all the villi, like we flattened out that folded paper, how much surface area do you think the small intestines would cover? *(Allow students to guess.)* The area of a tennis court!

Move the token to the last 7. Here we are in front of another sphincter ring. When it opens, we will zip on through to the large intestines. Ready...... go!

8: CECUM *(see-kum)* **and APPENDIX**

This very short bottom section is called the cecum. Lots of good bacteria live here. *(Show picture of bacteria.)* Notice the appendix sticking off the bottom. It has millions of beneficial bacteria living inside of it, which are kept safely tucked away, stored for emergency use. If you get an infection of bad bacteria in your intestines, after the infection is over, a fresh supply of good bacteria can come out of the appendix.

ACTIVITY # 11: The scientific name for the appendix is the "veriform" appendix. "Veriform" means "looks like a worm." Hand each student half of a gummy worm to snack on. Half of a gummy worm is approximately the size of the appendix. Maybe a bit too large, but close enough for our purposes.

Move token to number 9.

9: COLON or LARGE INTESTINE

We are beginning the final stage of our journey. We will go up, over and down through the large intestine, which is also called the **colon**. This part of the large intestine is called the **ascending** colon. Ascending means "going up." How does the stuff go up against gravity? *(peristalsis)*

Move the token to number 10.

This part is the **transverse** colon. Transverse just means "across." The main job of the colon is to take most of the water out of the chyme. When chyme becomes solid, we call it feces. *(fee-sees)*

If you look out the observation windows one last time, you will see lots of tiny red lines. Those are blood vessels. The blood vessels are absorbing water. The water can be recycled and used around the body, but if there is too much, it will be processed by the kidneys and made into urine.

If the walls of the colon get irritated or infected, the blood vessels won't be able to do their job very well. This means that water will not be removed, and the feces will remain sloppy. We call this diarrhea.

Move the token to number 11.

By the time the feces get down here, they should be fairly solid. They will continue to dry out as the move to the last area.

Move the token to 12.

12: RECTUM

Well, our voyage is almost over! We're in the storage area, called the rectum. This is where the feces build up until there is so much of them that special nerves send a signal to your brain telling you that you need to visit a bathroom. This is one way that your body is different from a cow's body. Cows are not able to hold their feces. When the feces come down, they just immediately plop out. Cows would make terrible indoor pets!

To get out of the digestive system, we have to go through one last sphincter muscles. The name of this one, **anus**, just means "little ring." How many sphincter muscles did we see in the digestive system? *(4)*

The last sphincter is opening. Here we go! Good-bye, and thanks for coming on this tour!

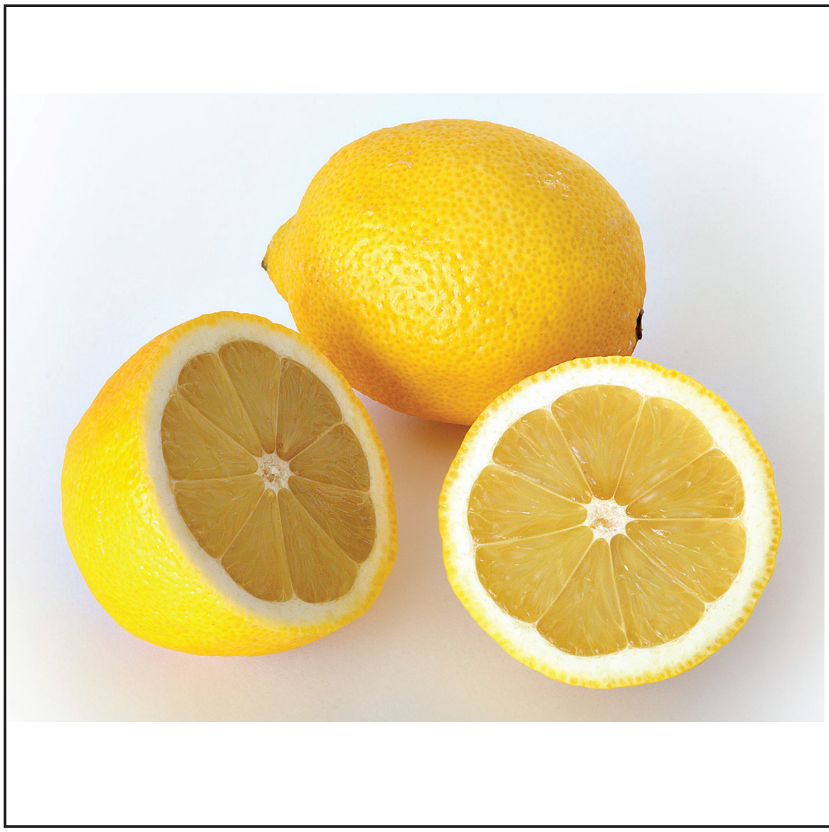
ACTIVITY #12: Edible scat (C'mon, kids love stuff like this!)

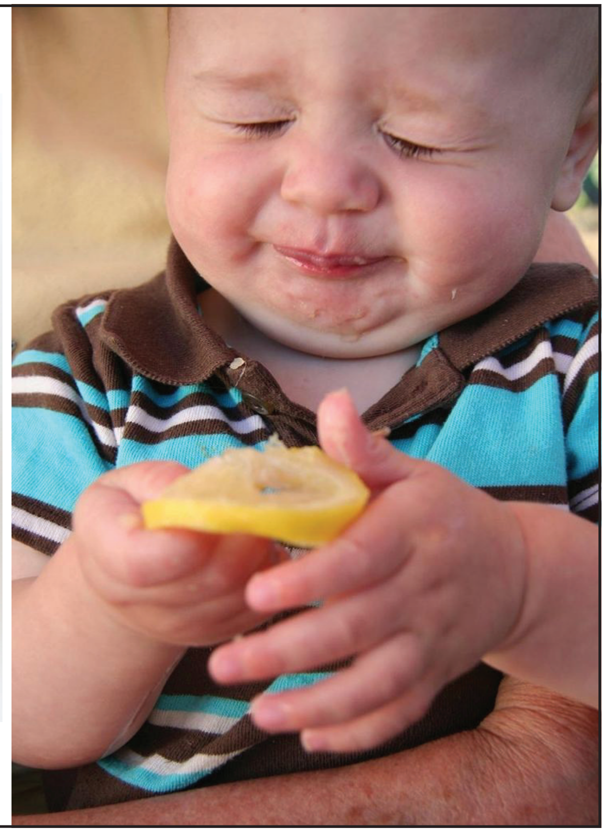
Provide students with lumps of brown edible dough and let them make some various sizes and shapes of animal scat. Use the picture as a guide.

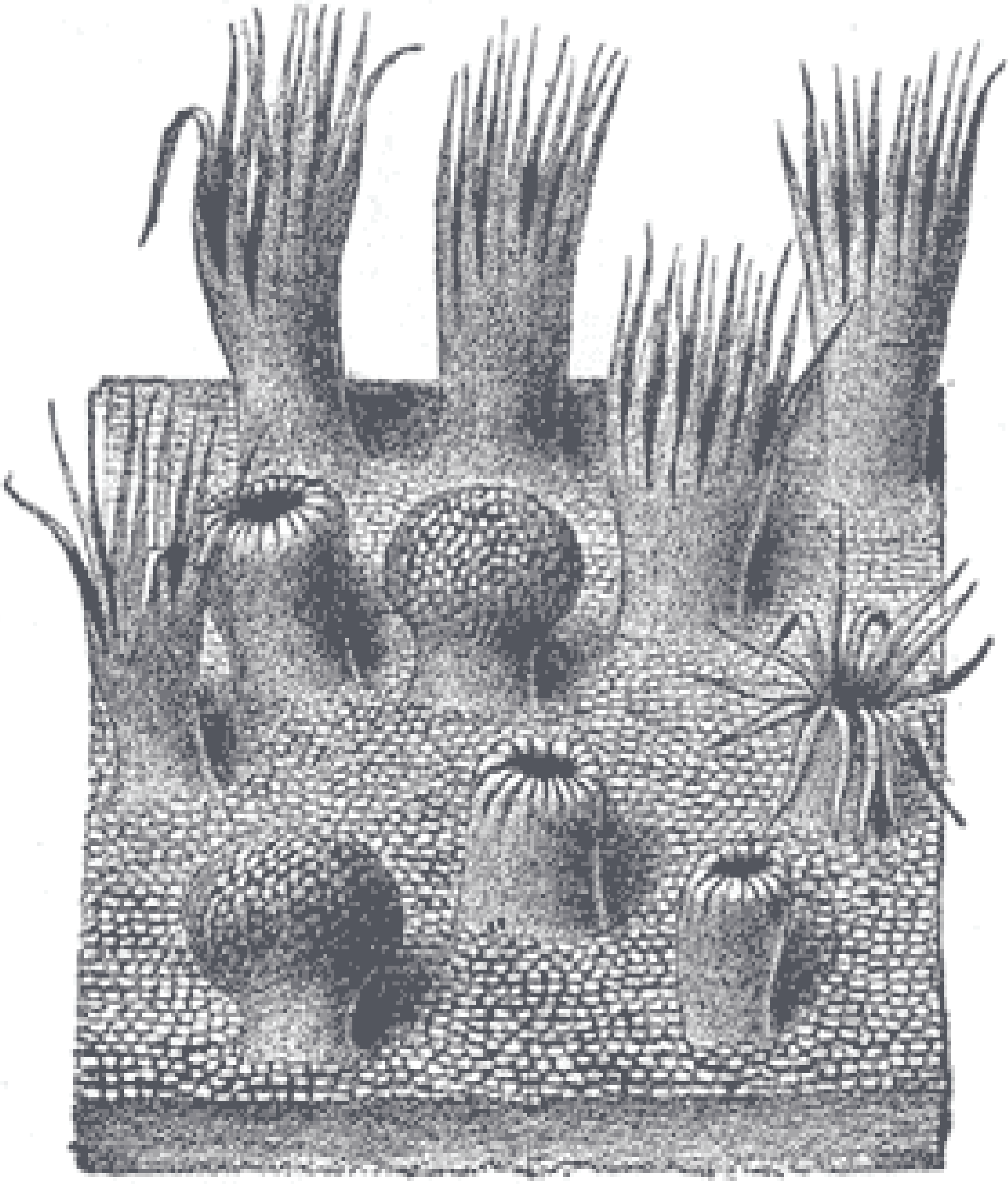
Animal feces are often called "scat." (Cow and horse feces are usually called "dung" or "manure.") Some animals, such as dogs and cats, make scat that looks much like human feces. Other animals, such as rabbits and deer, make small round pellets. It is thought that the production of pellets comes from a sphincter action in the colon that opens and closes quickly as the feces pass through, releasing little bits, one by one, into the rectum. (This process has been likened to a sausage maker.) Rats and mice make long pellets so their colons must not open and close as quickly. Cows (as was mentioned) have no control at all over the release of their feces. Most animals have at least some control.

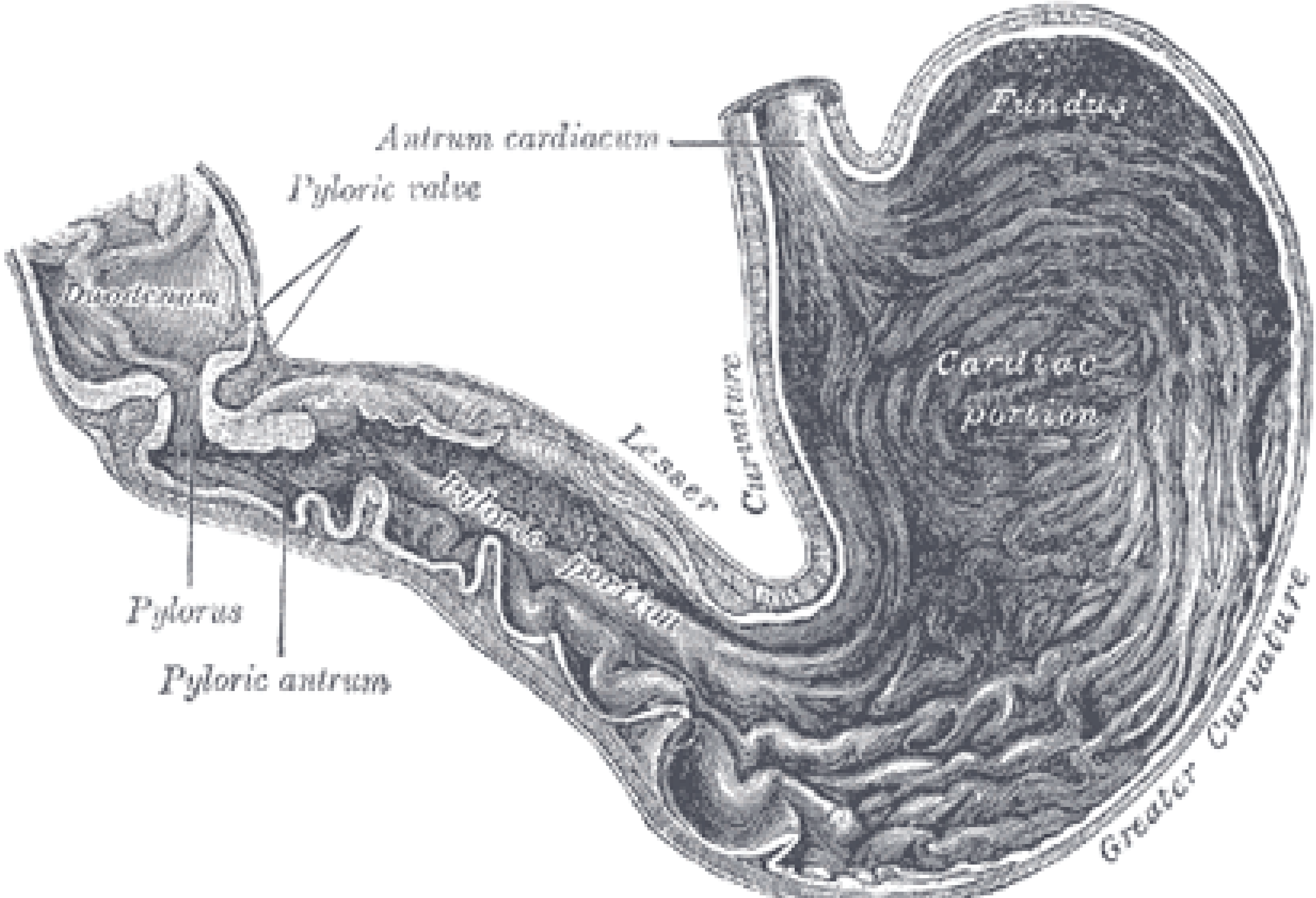
Cut out, fold in half, glue body of sub, fold out semicircles to side to make circular base to stand on.
(This is the vehicle from the movie “Fantastic Voyage.”)







Papilllae on tongue


Antrum cardiacum
Pyloric valve
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Fundus
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Lesser Curvature
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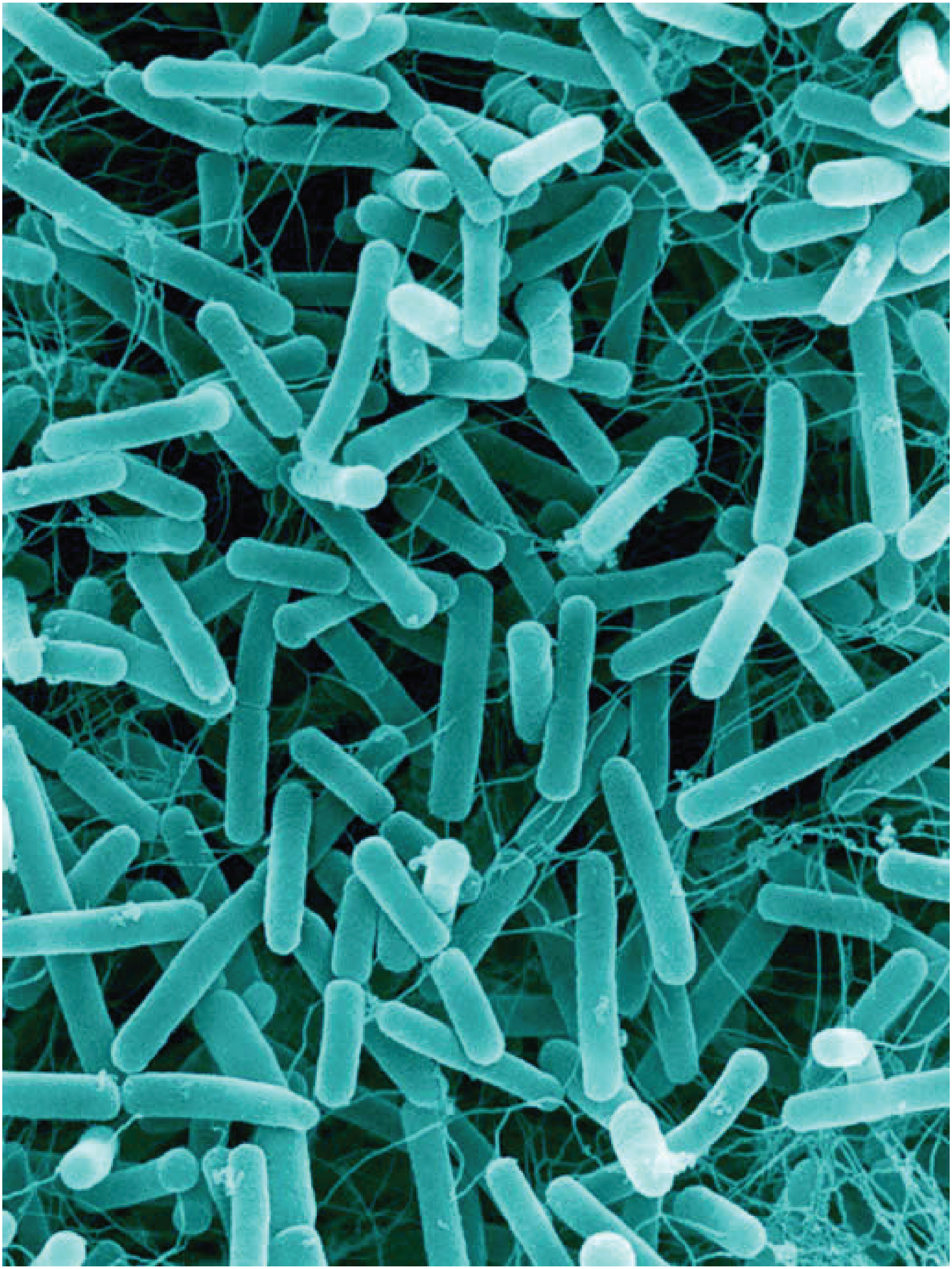

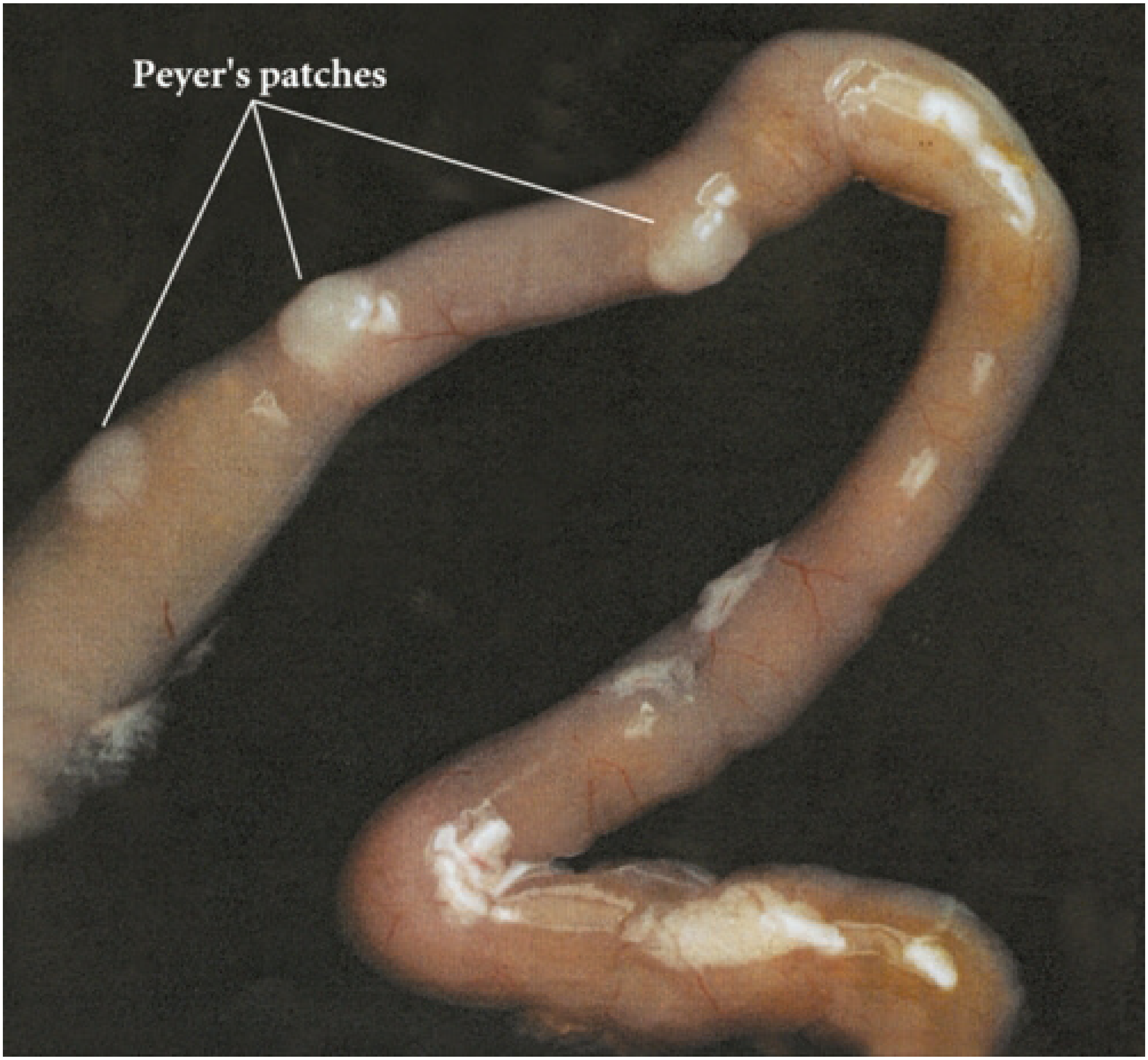
Peyer's patches

Mammal Scat of North America

Specimens shown twice actual size

WORTH A DAM
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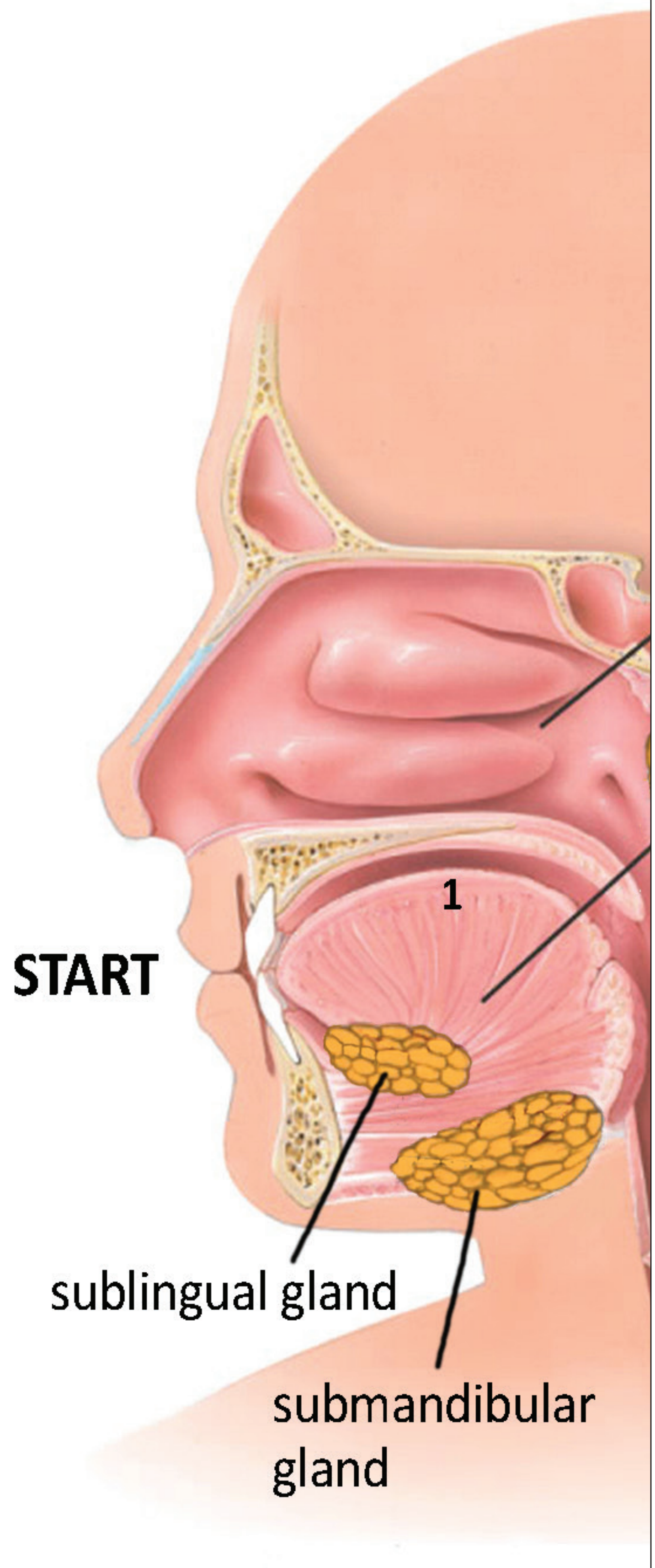
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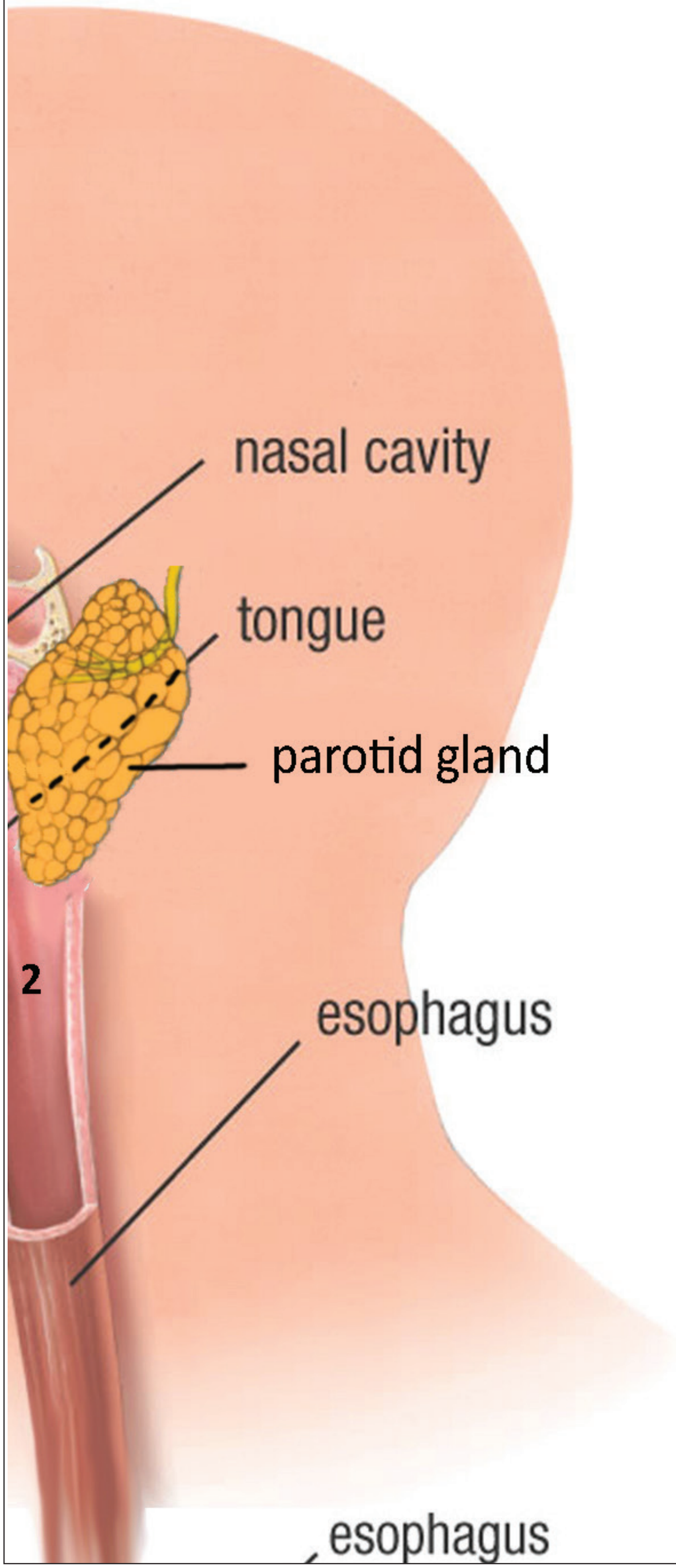
submandibular
gland


nasal cavity
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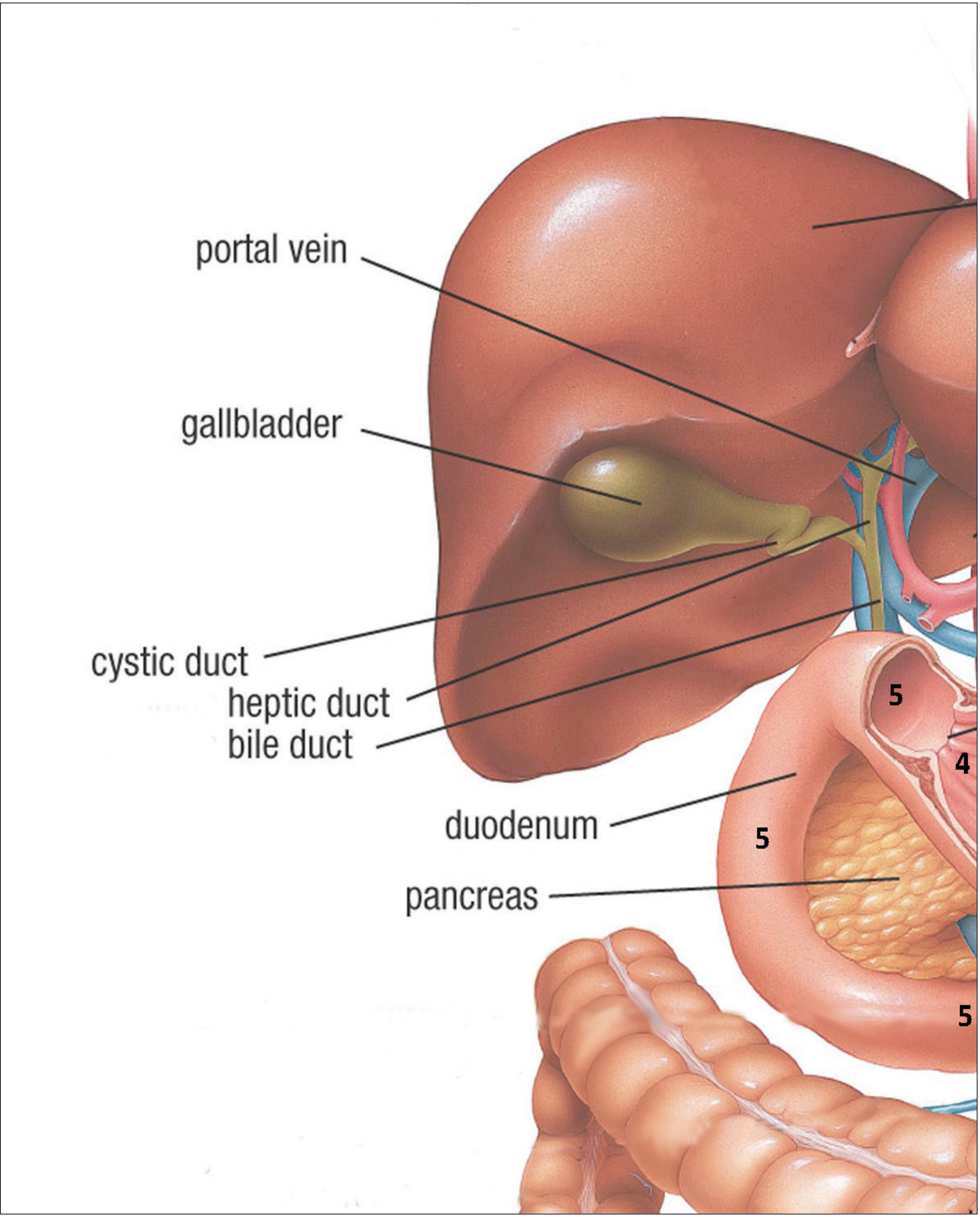
2
esophagus
esophagus


portal vein
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cystic duct
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bile duct
duodenum
pancreas
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4
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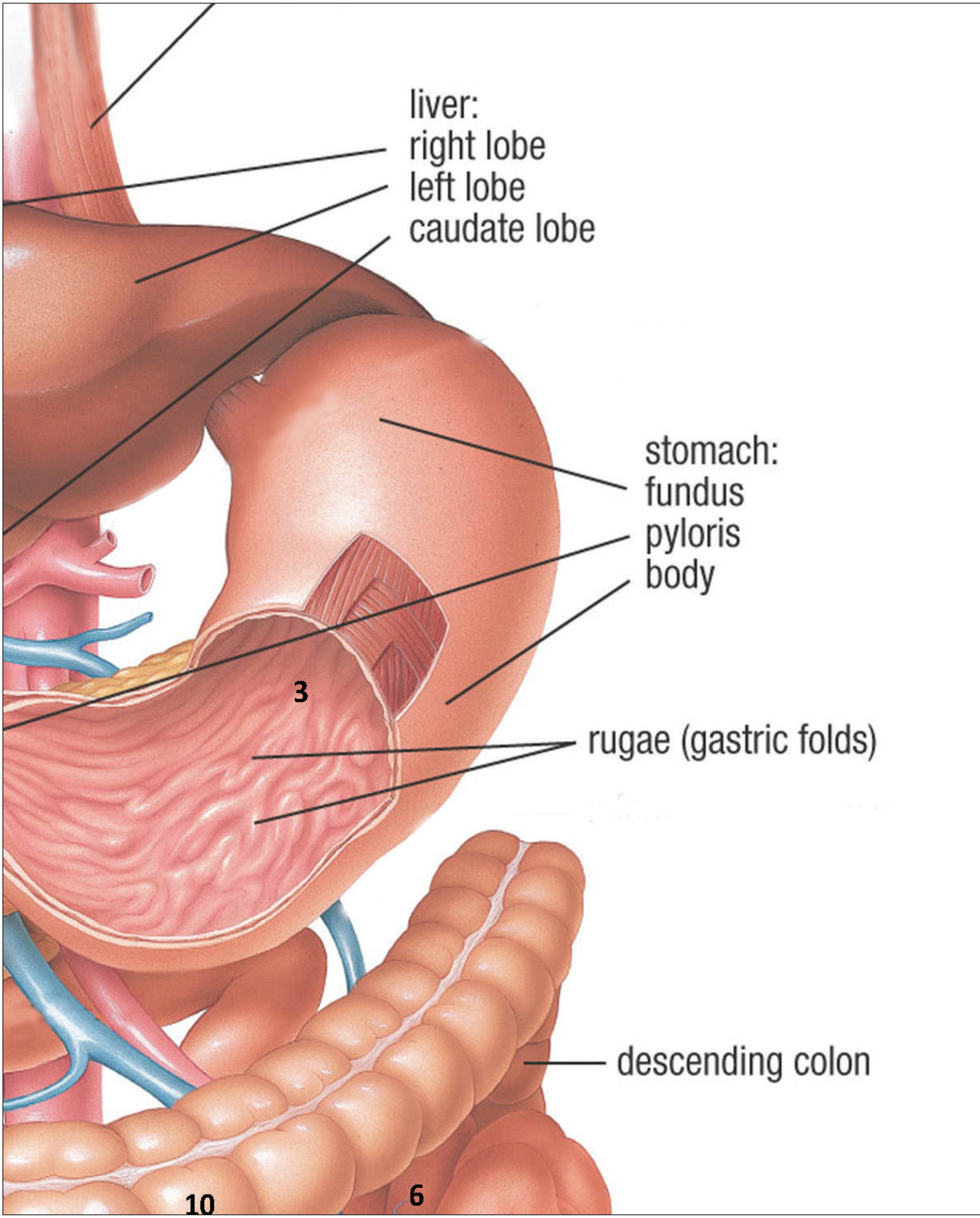
5


liver:
right lobe
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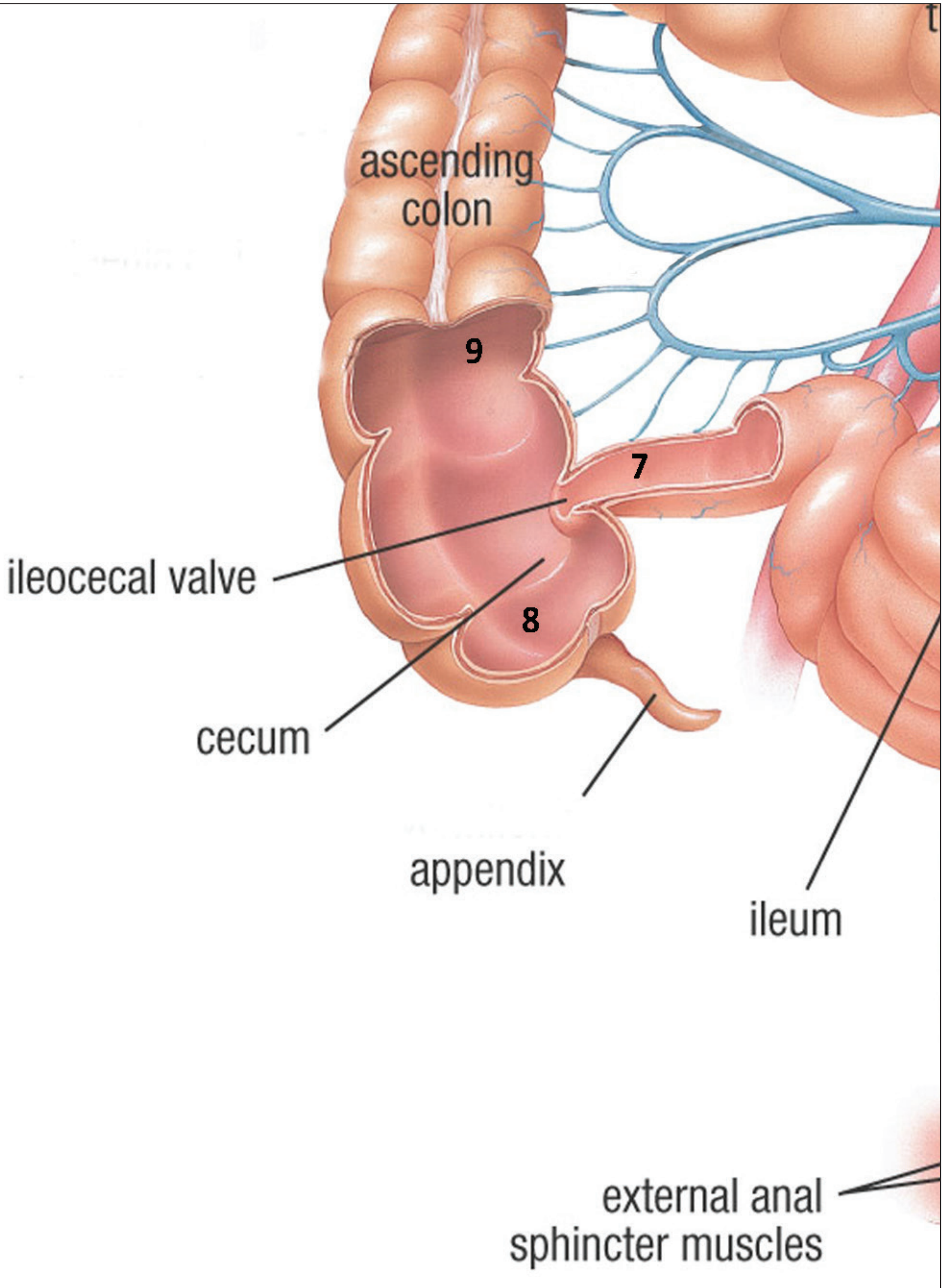
caudate lobe
stomach:
fundus
pyloris
body
3
rugae (gastric folds)
descending colon
10
6



t
ascending
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9
7
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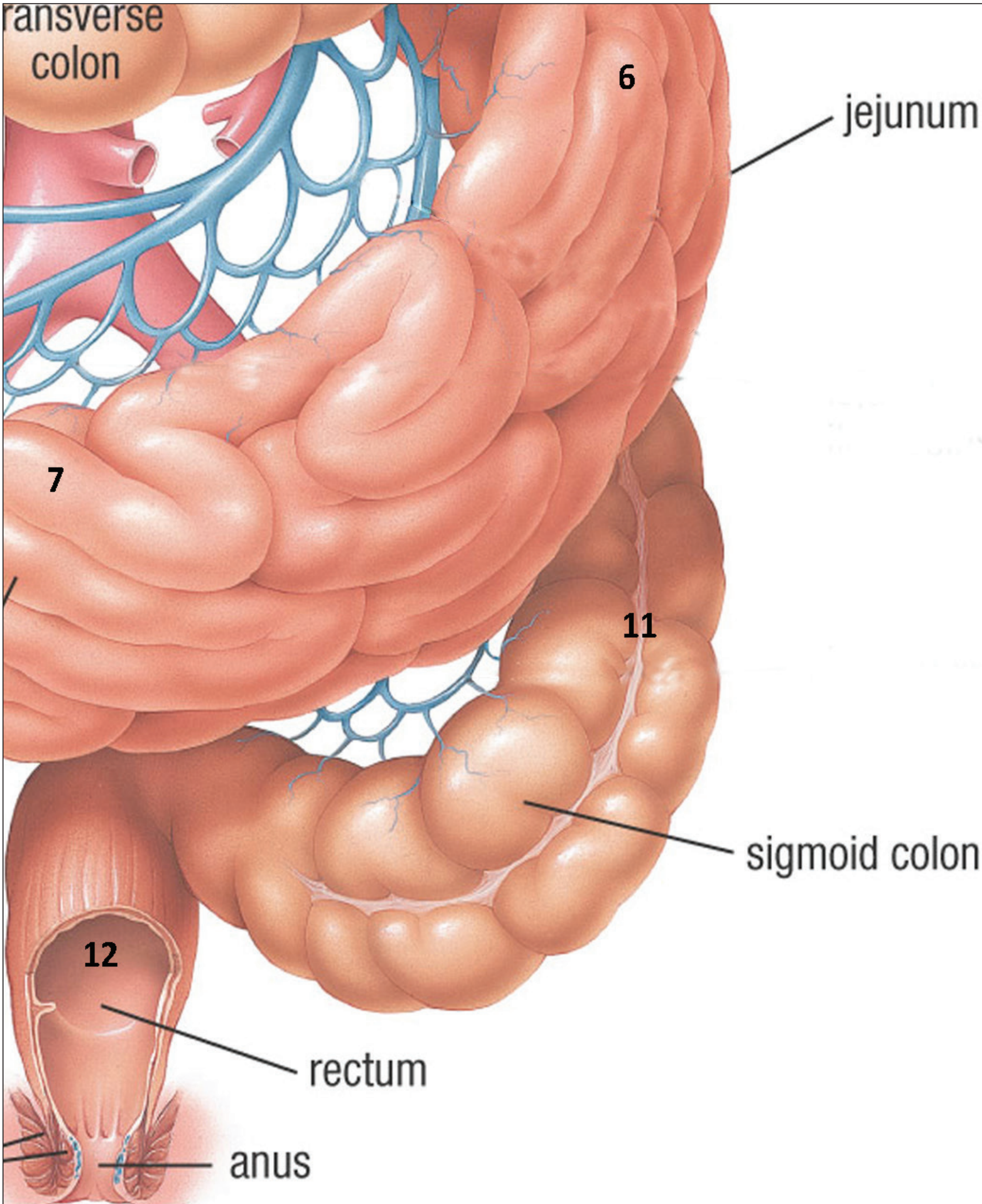
ileum
external anal
sphincter muscles



FINISH