Student Names:

Sheep Brain Dissection Worksheet

. . . for here is the place where I must describe to you the method of dissecting the parts of the brain while it remains in its place in the animal body.

- Galen in De anatomicis administrationibus

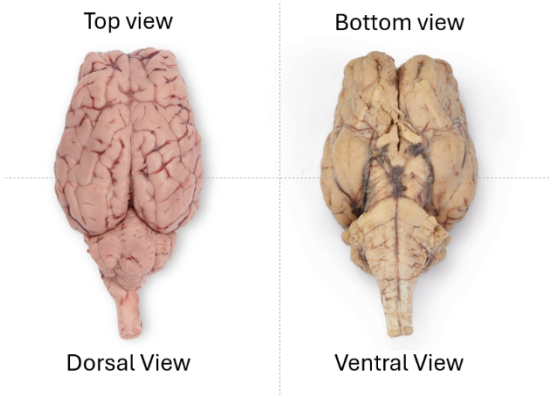


Figure 1

First Contact: Orienting the Brain

Before examining individual structures, take a moment to orient yourself. Hold the brain in both gloved hands. Notice its weight, texture, and general shape.

Then position it in the TOP VIEW (Fig 1 left) - rounded cerebral hemispheres face upward, the brainstem points toward you, and the cerebellum sits at the back. This is roughly how the brain would sit inside the skull.

Answer the following as you handle the specimen for the first time:

What is your first impression of the brain as a physical object? Does anything about its weight, size, or texture surprise you? If you only had touch and sight (no microscopes, no imaging, no electrical recordings), what would you guess this organ does?

What differences do you observe between the sheep brain and the human brain (See figure 2)?

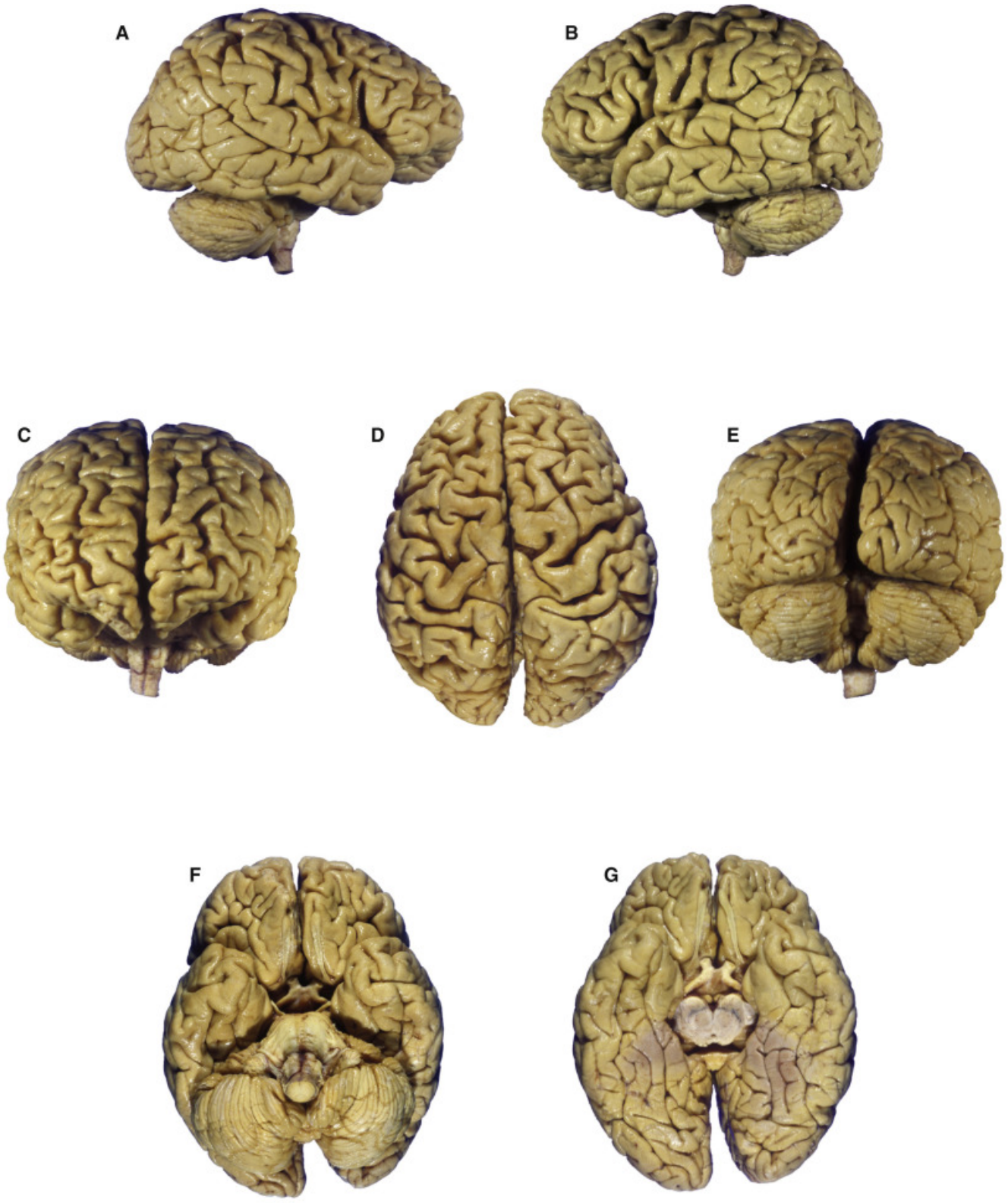


Figure 2

Cerebrum

"Cerebrum" comes from the Latin for "brain." The longitudinal fissure — the deep groove separating the two halves — was well known to ancient anatomists.

Function - The cerebral hemispheres are the largest part of the brain and are responsible for higher cognitive functions including language, reasoning, planning, sensory processing, and voluntary movement.

Identification - Look at the brain from above (dorsal view). Identify the two large, rounded cerebral hemispheres and the deep longitudinal fissure running between them from front to back. Note that the hemispheres are roughly symmetrical.

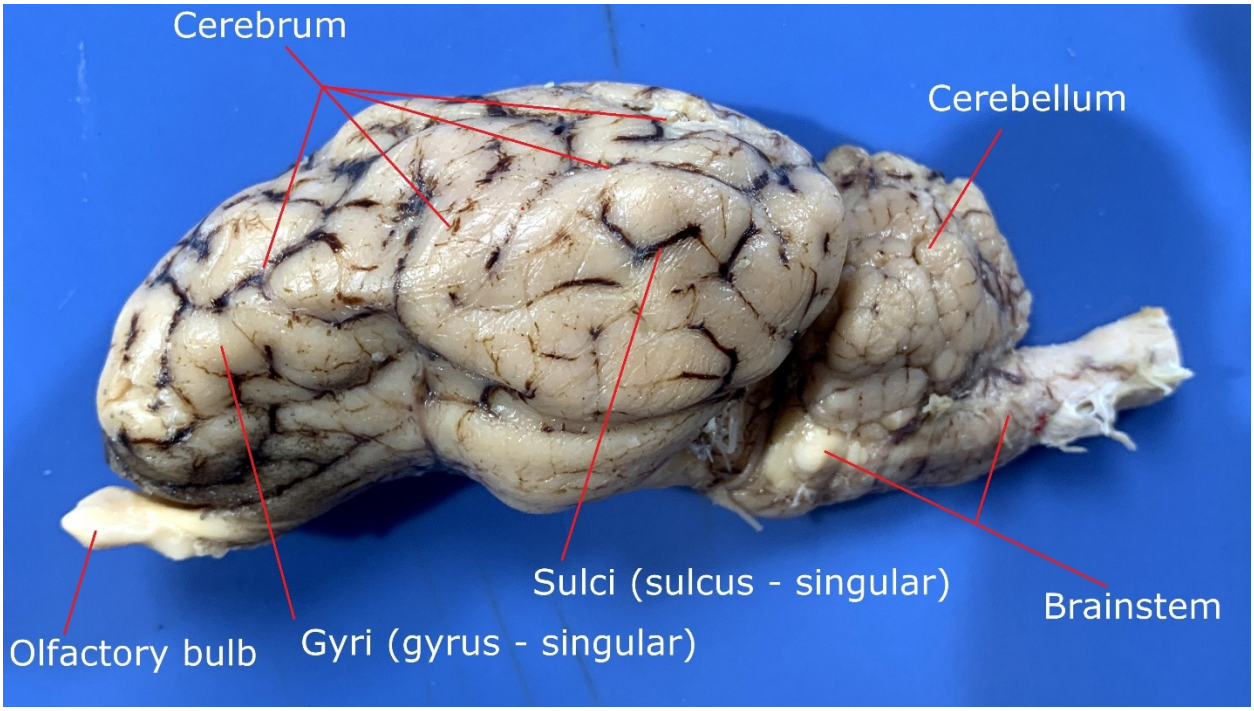


Figure 3

Cerebellum

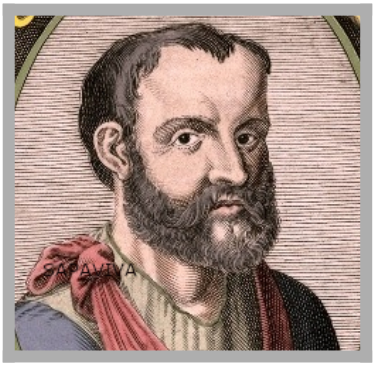
Name Origin – “Bella” in latin means “Little” . Thus “Cerebellum is Latin for "little brain." Named because it appears as a distinct, smaller brain structure at the back and bottom of the cerebrum. Its densely folded surface gives it a markedly different texture.

Modern Function - Coordinates voluntary movement, balance, posture, and motor learning. Despite being much smaller than the cerebrum, the cerebellum contains more neurons than the rest of the brain combined.
What to Look For - Locate the cerebellum at the posterior and inferior part of the brain. It

may be loosely attached to the cerebrum — handle carefully. Note the transverse fissure separating it from the cerebrum.

General Description of the brain's appearance and texture by Galen

Gently feel the difference in texture and firmness between the cerebellum and cerebrum. What do you observe?



And the anterior part of the encephalon had to be softer because it was intended to be the source of the soft nerves which lead to the instruments of sensation, and the posterior part had to be harder, since it is the source of the hard nerves which are sent to the entire body.

Always, the further back one goes, the harder the brain becomes; moreover, the parts at its base are harder than the rest. Since the close association of a soft body with a hard one would be not harmonious, Nature sets each apart, placing between them the hard membrane that will also surround the whole encephalon which is made up of these two parts [cerebrum and cerebellum].

Historical Reflection: *Galen wrote that the posterior brain "had to be harder, since it is the source of the hard nerves which are sent to the entire body." He associated softer tissue with receiving sensory impressions and harder tissue with generating motor commands. Touch both structures. Can you feel a difference in firmness? What do you think of the logic that tissue hardness should determine function?*

Meninges and Dura Mater

Name Origin - From the Greek meninx, meaning "membrane." Galen distinguished between the dura mater (Latin: "tough mother") and the pia mater ("tender mother"). These names were likely coined by medieval Arabic translators, reflecting the protective role of the membranes.

Modern Function Three protective layers surround the brain: the dura mater (tough outer layer), the arachnoid mater (web-like middle layer), and the pia mater (delicate inner layer clinging to the brain surface). They protect the brain, contain cerebrospinal fluid, and house blood vessels.

What to Look For - Do you see a white tough membrane, almost plastic like in texture around the brain? If yes, that's the dura mater. If not, the dura mater has been removed. Then look for traces of the thin, translucent pia mater clinging to the brain surface.

Historical Reflection: *In his lecture On the Brain, Galen described the pia mater as "embracing" the brain — an image that captures how intimately it clings to the surface. He also described the veins visible after removing the dura: "you will see the outgrowths of all the veins which are dispersed into the three parts of the brain. Some are on the surface, so that their divisions are apparent; some dive into the depths." Can you see any of the vascular features Galen described?*

What does the existence of multiple protective layers suggest about the importance of the organ within?

Gyri and Sulci (Cerebral Convolutions)

Name Origin - "Gyrus" (plural: gyri) is from the Greek gyros, meaning "ring" — the raised ridges on the surface. "Sulcus" (plural: sulci) is Latin for "furrow" — the grooves between ridges. Together they form what earlier anatomists called the "convolutions."

Modern Function - The folding dramatically increases the brain's surface area, allowing more gray matter to fit within the skull. Specific gyri and sulci serve as landmarks corresponding to distinct functional regions.

What to Look For - Examine the surface closely. Run your gloved finger along the ridges (gyri) and grooves (sulci). Compare the pattern and tightness of folding on the cerebrum with that of the cerebellum.

Historical Reflection: *Erasistratus proposed that the complexity of convolutions correlates with intelligence. Galen rejected this after examining a donkey's large, convoluted brain — and donkeys, to Galen, were famously unintelligent. He concluded that the "temperament" of brain tissue matters more. Look at the sheep's convolutions. How do they compare to images of the human brain (Figure 2)?*

Look at the brain convolutions across different species (Figure 4). Note the number of convolutions AND the depth of convolutions. What do you observe? Does Erasistratus's or Galen's hypothesis seem reasonable?

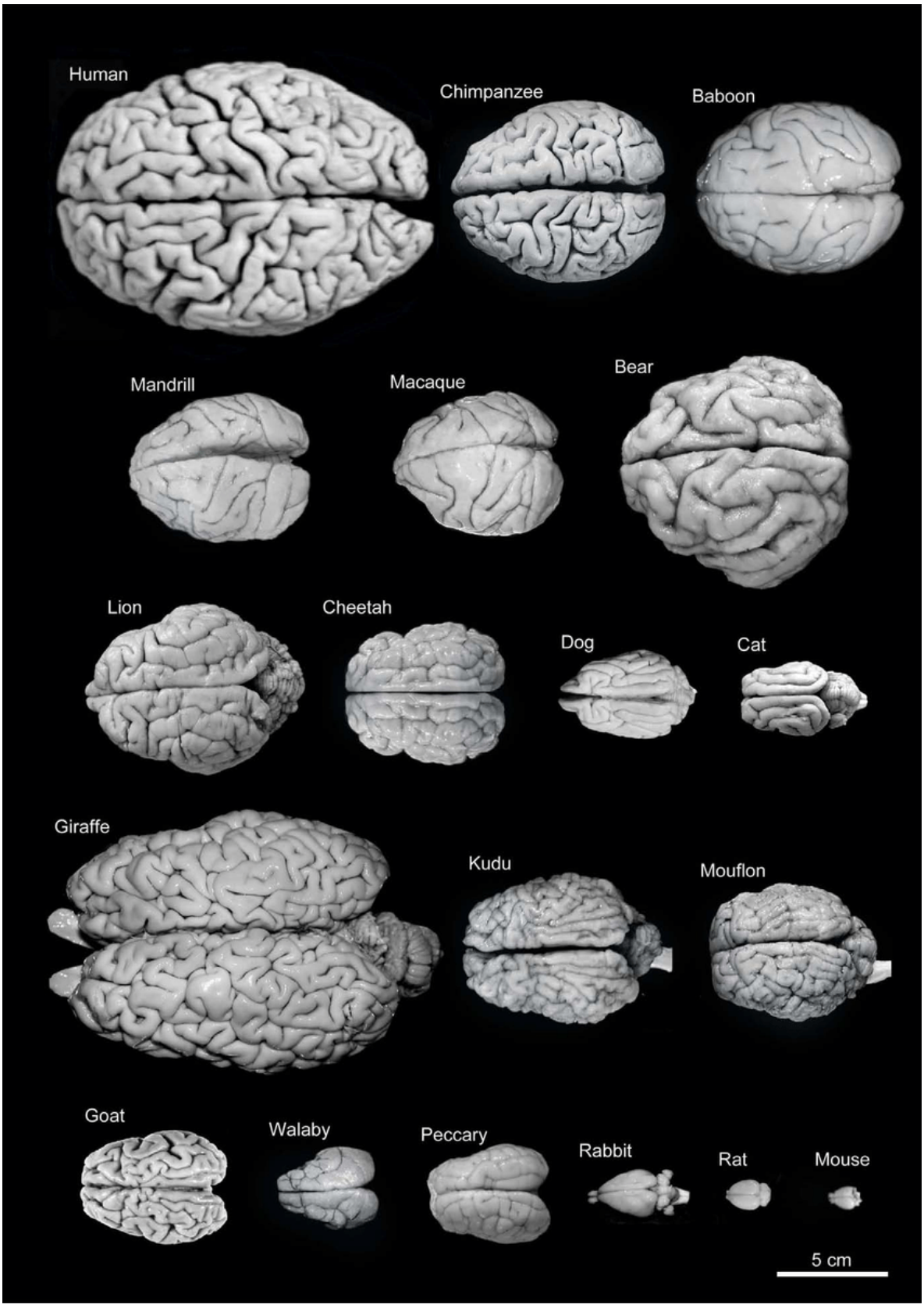

Human
Chimpanzee
Baboon
Mandrill
Macaque
Bear
Lion
Cheetah
Dog
Cat
Giraffe
Kudu
Mouflon
Goat
Walaby
Peccary
Rabbit
Rat
Mouse
5 cm

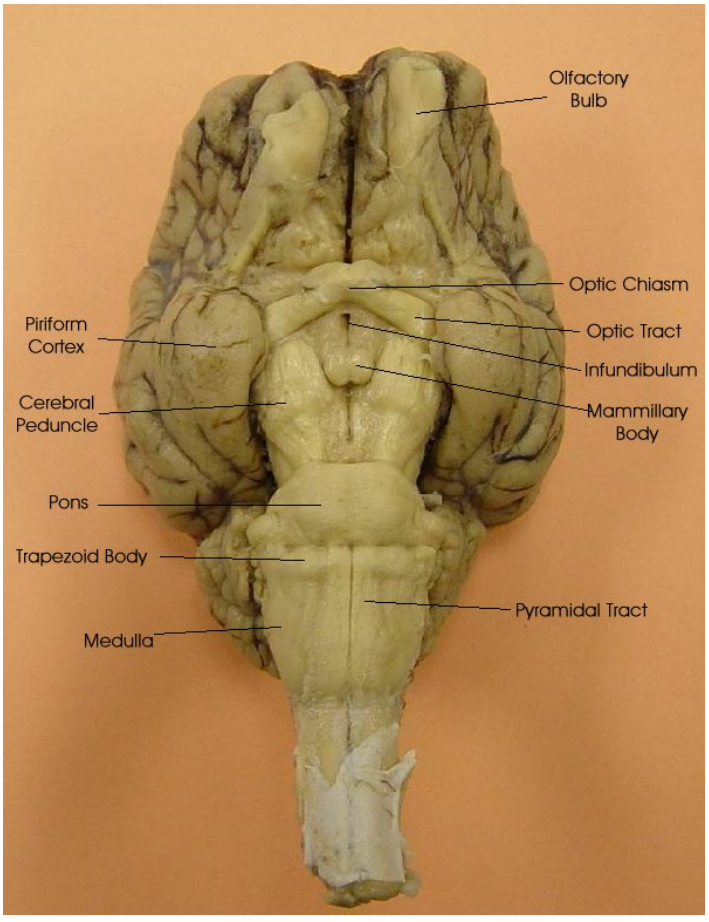
Figure 4

Brainstem (Ventral View)

Name Origin - A modern composite term. Includes the medulla oblongata (Latin: "elongated marrow"), the pons (Latin: "bridge"), and the midbrain. Ancient anatomists recognized this as the transition from brain to spinal cord.

Modern Function - Controls vital automatic functions: breathing, heart rate, blood pressure, swallowing, and sleep-wake cycles. Also serves as the major pathway connecting the brain to the spinal cord.

What to Look For - Turn the brain to view the ventral surface or posterior side. The brainstem extends downward from the base. Identify the medulla oblongata (the lowest portion, continuous with the spinal cord) and the pons (a bulging region above the medulla). The brainstem may be partially cut depending on specimen preparation.



Cranial Nerves and Optic Chiasma (Ventral View)

Name Origin - "Cranial" from the Greek kranion (skull). Galen classified cranial nerves into seven pairs; modern anatomy recognizes twelve. The optic chiasma is named for its resemblance to the Greek letter chi (X).

Modern Function - The twelve pairs of cranial nerves control sensation and movement in the head and face. The optic chiasma is where the optic nerves from each eye partially cross, allowing visual information from both eyes to reach both brain hemispheres.

What to Look For - On the ventral surface, look for the optic chiasma — an X-shaped structure near the front. This is fragile and may have been removed with the dura mater. Look also for the olfactory bulbs at the very front (elongated structures). Other cranial nerves may appear as *thin threads* along the brainstem.

Figure 5

Which structures were you able to find in your specimen?

"Nature made the two nerves from the eyes meet together, so that each might share with the other the pneuma coming to it from the brain... For if each nerve went straight to the brain on its own side without any contact, and one eye were injured, then the pneuma from one eye could not pass to the other." "If you dissect the nerve skilfully, you will see the visible channel clearly." - Galen

Historical Reflection: *The optic chiasm is one of the few brain structures visible on the ventral surface without any cutting. If you were an ancient anatomist seeing this X-shaped crossing for the first time, what theories might you generate about what it does — based solely on its shape and position?*

Finger notes about Galen - "*He thought that odorants inhaled through the nose go straight to the olfactory bulbs under the front of the brain, and then on to the hollow ventricles. He reasoned that the brain expands to bring fresh air and odorants into the system and contracts to expel the stale air.*"

Historical Reflection: *The olfactory bulbs are proportionately much larger in the sheep brain than in the human brain. If Galen had used this difference to reason about human cognition, what conclusions might he have drawn? How does this illustrate the problem Vesalius identified — that reasoning from animal anatomy to human function is unreliable?*

Finger also notes that Galen "*showed that severing the spinal cord close to the skull leads to an immediate cessation of breathing. In contrast, the diaphragm continues to function if the cut is made lower."*

Historical Reflection: *If you were an ancient anatomist living in Galen's times, what function would you ascribe to the brainstem?*

Sheep Brain Dissection Worksheet

Lecture 2: Internal Anatomy — Seeing What They Saw

History of Neuroscience

Before the Sagittal cut

1. **Superior and Inferior Colliculi**



The gap between the **cerebrum** and the **cerebellum** at the transverse fissure can reveal some internal parts of the brain. Carefully bend the cerebellum down to show the **superior and inferior colliculi**. Just behind the colliculi, the pineal gland is barely visible.

Collis in Latin means “hill”. Colliculi appear as two small bumps, or hills, and hence the name. They are crucial for head/eye movement and sound localization. This structure is larger in sheep and other animals as compared to humans.

2. **Corpus Callosum**



Push the two hemispheres apart to reveal a white band. This is the Corpus Callosum. Corpus in Latin means a corpse or a body. Callosum means “tough”. Thus, Corpus Callosum means “tough body”. With one partner keeping the hemispheres apart, the other partner should touch the corpus callosum with their scalpels and see if they can feel a difference of rigidness between the corpus and the cerebral tissue. Swap the roles so that both partners have an opportunity to do so. You might have to remove some arachnoid membrane to see the corpus

Making the Midsagittal Cut

You will need: a sharp scalpel and your dissection tray. Sharp scalpels produce cleaner cuts that reveal internal structures more clearly.

Safety: Always leave the specimen in the dissecting tray when cutting. Do NOT hold the brain in your hand while using the scalpel.

Procedure: Using the longitudinal fissure as a guide, carefully separate the brain into left and right hemispheres with a single, smooth cut. If you are very careful, you will cleanly expose the internal structures on both halves. A clean cut will reveal the corpus callosum, ventricles, thalamus, and other features described below.

Note: The pineal gland is only visible if you make a very careful incision. It sits right at the midline and can easily be destroyed or displaced by the cut.

callosum. The corpus callosum is the bundle of nerve fibers that exchange information between the two hemispheres.

First Impressions After the Cut

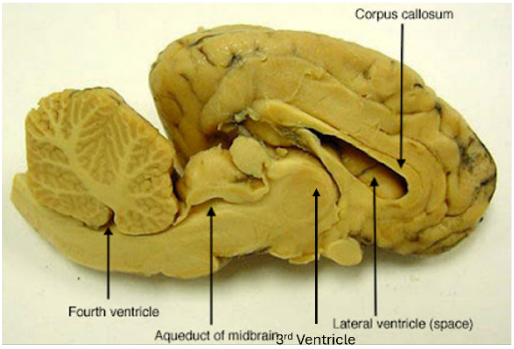
Before going forward in the worksheet, take a moment to look at the cut surface as a whole. How many visually distinct regions or textures are apparent TO YOU? Draw it out or try to describe it in as much detail as you can.

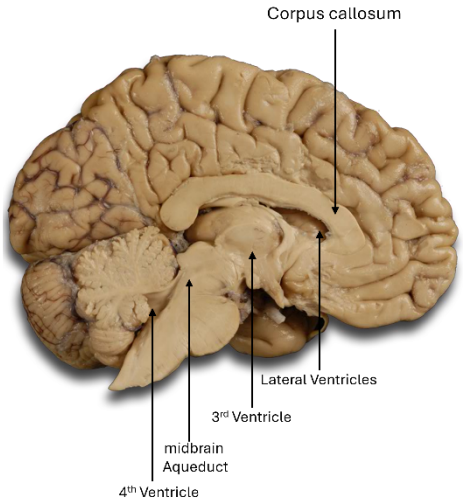
Lateral Ventricles

Name Origin - From the Latin ventriculus, meaning "little belly" or "small cavity." "Lateral" means "to the side" — these are the ventricles within each hemisphere.

Modern Function - Cavities filled with cerebrospinal fluid (CSF), which cushions the brain, removes waste, and maintains chemical stability. Part of a connected system of four ventricles.

What to Look For - In each half of the brain, look for an open cavity within the cerebral hemisphere. A probe can help you trace its shape. In a preserved specimen the ventricles may appear collapsed.





Historical Reflection: *For over a thousand years, the ventricles were considered the most important structures in the brain — the seat of the soul. Vesalius challenged this by noting that animal ventricles look the same as human ones, yet animals were not credited with rational souls. Now that you can see them: do the ventricles look like plausible seats of consciousness? What might have made them so compelling to earlier thinkers?*

Third Ventricle

Name Origin - Named by its position in the sequence of cavities. Medieval scholars assigned cognition and reasoning to this middle ventricle, following the front-to-back progression proposed by Nemesius and other Church Fathers.

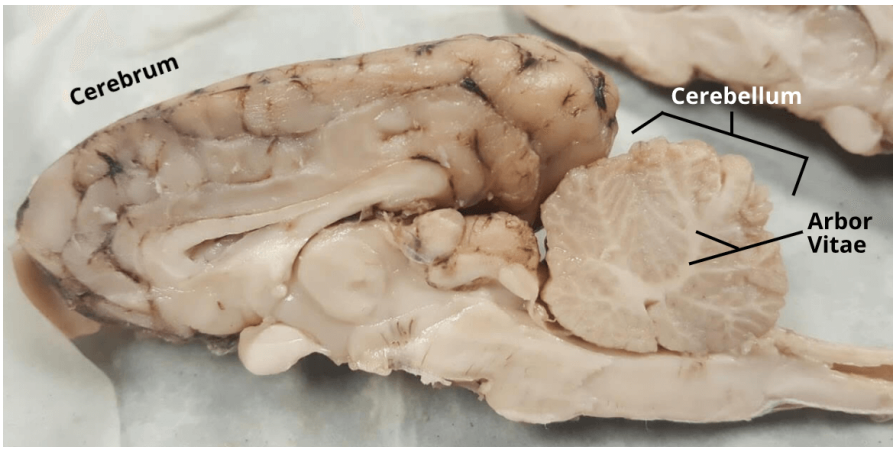
Modern Function - A narrow, slit-like cavity between the two halves of the thalamus. Connects the lateral ventricles above to the fourth ventricle below as part of the cerebrospinal fluid circulation system.

What to Look For - On the cut surface of the midsagittal section, look for a narrow space between the two thalamic masses. Much smaller than the lateral ventricles. You may also see the massa intermedia, a bridge of tissue crossing the ventricle between the two thalami.

Historical Reflection: *Nemesius assigned intellect to the middle ventricle around 400 AD, claiming that injuries to this area deranged the mind while leaving sensation and memory intact. Examine the size of the third ventricle. Does it seem plausible that a cavity this small could be the seat of reasoning? What does this tell you about how theoretical commitments can shape anatomical interpretation?*

Cerebellum: Arbor Vitae (Internal View)

Name Origin - "Arbor vitae" is Latin for "tree of life" — named for the striking tree-like branching pattern of white matter visible when the cerebellum is cut. "Cerebellum" is Latin for "little brain."



Modern Function - The branching white matter carries signals between the cerebellar cortex and the rest of the brain. The surrounding thin gray matter (cerebellar cortex) is where neural computation occurs. The cerebellum coordinates movement, balance, and motor learning.

What to Look For - Examine the cerebellum in your midsagittal section. You should see a very distinct tree-like pattern of white matter (the arbor vitae) surrounded by a thin layer of gray matter. This is one of the most visually striking features of the cut brain. Note how tightly folded the cerebellar surface is compared to the cerebrum.

Historical Reflection: *Nemesius assigned memory to the posterior ventricle near the cerebellum. Galen considered the cerebellum harder than the cerebrum and therefore better suited for motor functions. Examine the arbor vitae — its beauty led Renaissance anatomists to name it the "tree of life." Can you feel a difference in firmness between the cerebellum and the cerebrum? What do you make of Galen's reasoning that tissue hardness determines function?*

Thalamus

Name Origin From the Greek *thalamos*, meaning "inner chamber" or "bridal chamber." Galen used the term to describe its deep, central position in the brain.

Modern Function - A major relay station for sensory information. Nearly all sensory input (except smell) passes through the thalamus on its way to the cerebral cortex. Also plays roles in consciousness, sleep, and alertness.

What to Look For - Look for the large, egg-shaped mass of gray matter on either side of the third ventricle. It forms the walls of the third ventricle and is one of the most prominent internal structures.

Reflection – *Galen recognized the thalamus as a structure but did not assign it any function. Were you able to identify the structure in the second page of the worksheet ?*

Hypothalamus

Name Origin - From the Greek hypo ("under") and thalamos ("inner chamber") — literally "under the thalamus." Despite its small size, it is one of the most functionally important brain regions.

Modern Function - Regulates homeostasis: body temperature, hunger, thirst, sleep, circadian rhythms, and emotional responses. Controls the pituitary gland, linking the nervous system to the endocrine (hormonal) system.

What to Look For - Located below the thalamus on the midsagittal surface, It is small and may be difficult to distinguish as a separate structure, but its position relative to the thalamus and pituitary region can help you orient.

Historical Reflection: *Just from the shape, location and size, what function would you have attributed to this structure, if any at all?*

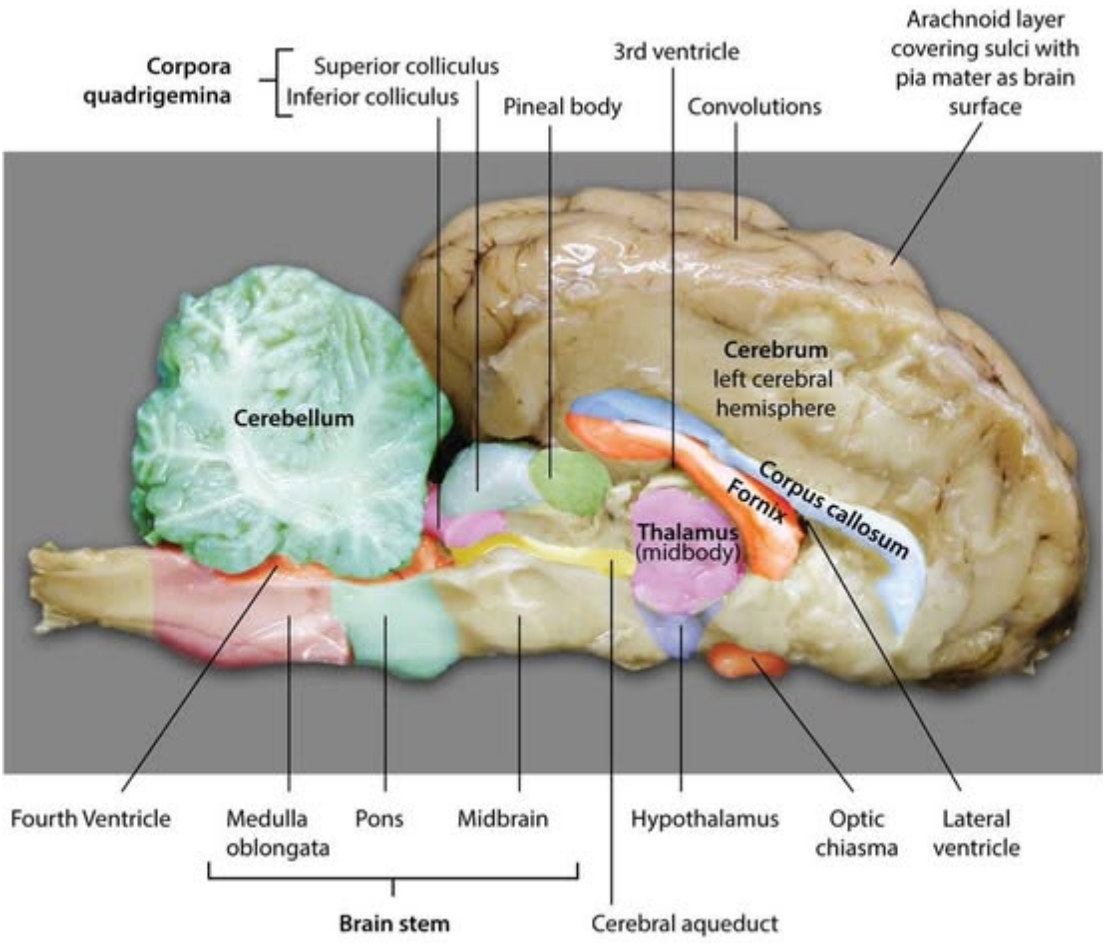
Pineal Gland*

Name Origin - From the Latin pinea, meaning "pine nut" — Galen named it for its resemblance to a small pine cone. Descartes later called it the "seat of the soul."

Modern Function - Produces melatonin, a hormone regulating sleep-wake cycles (circadian rhythm). Responds to light information relayed from the eyes. Not involved in consciousness or reasoning.

What to Look For - Look for a small, rounded structure just above and behind the third ventricle, near the colliculi. It is quite small and may have been destroyed or displaced by the midsagittal cut. The pineal gland is only reliably visible with a very careful incision. If you cannot find it, note its expected location.

Historical Reflection: *Galen mentioned the pineal gland in his ox brain dissection instructions. Descartes later argued it was the point where the immaterial soul interacts with the physical body, partly because it appeared to be a singular (unpaired) structure in a symmetrical brain. If you can see it, look at its actual size and position. Does it seem like a plausible candidate for such a role? What does this history reveal about projecting philosophical commitments onto physical structures?*



Sheep brain, sagittal section, medial view

Final Reflection

You have now performed a dissection like the ones Galen instructed his students to carry out nearly two thousand years ago, using a comparable specimen. Vesalius later argued that Galen's reliance on animal brains led him astray — yet here you are, learning from a sheep brain yourself.

1. What was the single most surprising thing you observed during the dissection, and why?

2. Having held and cut open a brain, has your understanding of why the ventricular theory persisted for over a thousand years changed? Explain.

3. Vesalius said he could not understand how the brain performs its "office of imagining, meditating, thinking, and remembering." After seeing the brain’s internal structures, do you sympathize with his confusion? What about the brain makes function so hard to infer from structure alone?