TIES
TEACHER INSTITUTE FOR EVOLUTIONARY SCIENCE

Message to Teachers,

Like most teachers, I often encourage students to research on their own using the Internet. Of course, we all warn our students about websites that may not have accurate information. But how wrong can a website on gravity or the laws of motion actually be??

Dora and I thought it would be a good idea to create this lesson with a research component. I was not prepared for what I found. A simple web search of "The Recurrent Laryngeal Nerve" or "The Blind Spot in our Optic Nerve" resulted in a plethora of misinformation. As a matter of fact, there were more inaccurate websites popping up than accurate ones. A web search of Dr. Nathan Lents' book, Human Errors, results in the same tsunami of misinformation.

Therefore, it is not advisable to allow students to research completely on their own for this lesson. They must guided, perhaps even warned about the purposeful misinformation out there. Students will be curious. Let them know that scientists will help them if they have questions about what they find on their own. (If they contact me, I can help with that). We should never discourage students from reading about a topic, but we can teach them to look for evidence and to seek the help of experts in the field of evolutionary biology.

If you would like to keep it simple, we strongly encourage you to use the following Research Guide to accompany this lesson. The Research Guide includes illustrations and one excerpt from Dr. Lents' book and some websites which will not deceive students about natural selection and the amazing "weirdness" of the human body.

Here's to good teaching!!

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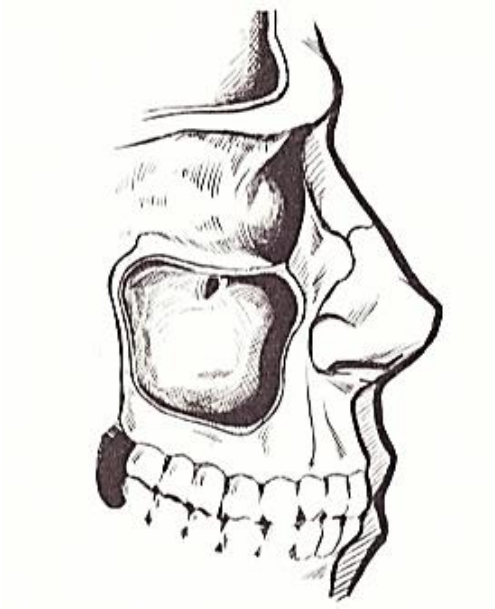
Research Guide for
the VERY Weird Human Body Convention

1. Introducing the…**Human Maxillary Sinus Cavity**

- Clues to Ape and Human Evolution can be seen in Sinuses. https://www.smithsonianmag.com/science-nature/clues-to-ape-and-human-evolution-can-be-seen-in-sinuses-73349254/



The human maxillary sinus cavity. Because the mucous collection duct is located at the top of the chamber, gravity cannot help with the drainage. This is part of the reason why colds and sinus infections are so common in humans but unheard of in other animals.

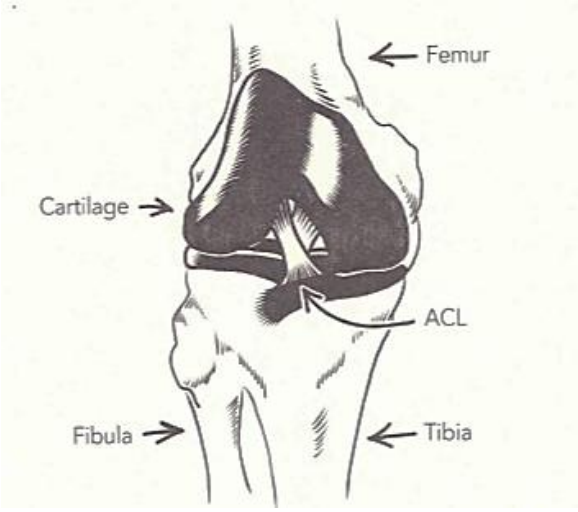
"There are a variety of reasons for why we are so susceptible to sinus infections, but one of them is that the mucus drainage system is not particularly well designed. Specifically, one of the important drainage-collection pipes is installed near the top of the largest pair of cavities, the maxillary sinuses, located underneath the upper cheeks. Putting the drainage-collection point high within these sinuses is not a good idea because of this pesky thing called gravity. While the sinuses behind the forehead and around the eyes can drain downward, the largest and lowest two cavities drain upward. Sure, there are cilia to help propel the mucus up, but wouldn't it be easier to have the drainage below the sinuses rather than above them? What kind of a plumber would put a drainpipe anywhere but at the bottom of a chamber? This plumbing is not without consequence. When the mucus become sticker, things get sticky, both figuratively and literally. Mucus thickens when it carries a heavy load of dust, pollen, or other particulates or antigens; when the air is cold or dry; or when a bacterial infection is fighting to take hold. During these times the cilia have much more work to do to get the sledging mucus to the collection point."

Why? The evolutionary history of the human face holds the answer. As primate evolved from earlier mammals, the nasal features underwent a radical change in structure and function. In most mammals, smell is the most important sense. This is why most mammals have elongated snouts…As our primate ancestors evolved, there was less reliance on smell and more reliance

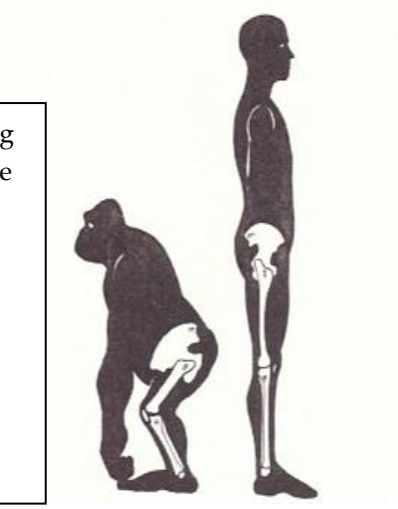
on vision, touch, and cognitive abilities. Accordingly, the snout regressed and the nasal cavities got smushed into a more compact face.

2. Introducing the…**Human Anterior Cruciate Ligament**

- Why ACL injuries are so common: https://thehumanevolutionblog.com/2015/02/23/why-are-acl-injuries-so-common-poor-design/



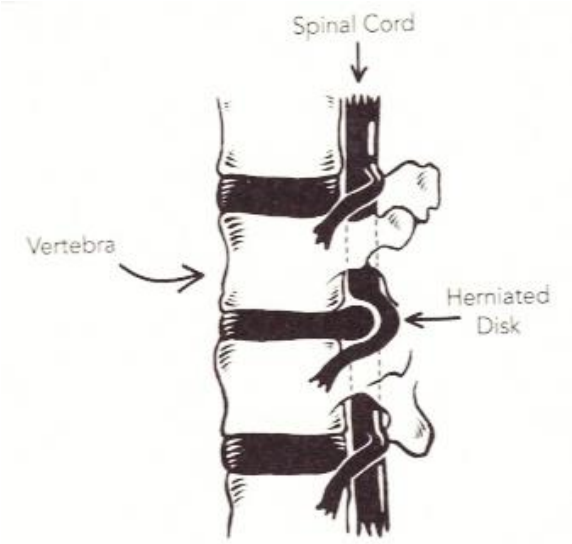
The bones and ligaments of the human knee, with kneecap (patella) removed to reveal the anterior cruciate ligament (ACL). Our incomplete adaptation to bipedalism has force this relatively skinny ligament to endure much more strain that it is designed for, which is why human-athletes especially suffer torn ACLs so often.



The natural postures of a standing ape and standing human. Because of our erect bipedal posture, humans rely on our leg bones to bear most of our weight when standing and walking. Apes, on the other hand, often employ a bent-leg posture, which recruits muscles to share the burden.

3. Introducing the…**Human Spinal Column**

- Many Human Ails are 'Scars' of Evolution https://www.sciencenewsforstudents.org/article/many-human-ails-are-%E2%80%98scars%E2%80%99-evolution



A herniated disk of cartilage in the human spinal column. As our ancestors adopted a more upright posture, the lumbar area of the vertebral column became sharply curved. The disks of cartilage between each vertebra are not optimally placed for this upright, curved posture; as a result, they sometimes "slip," leading to this painful condition.

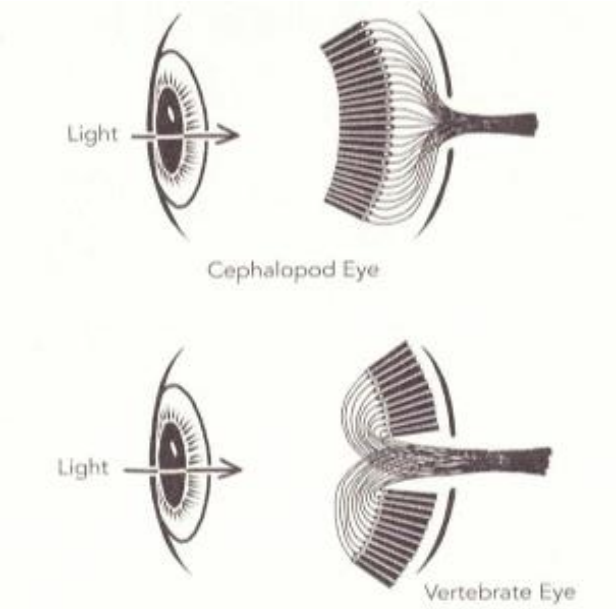
4. Introducing the…**Human Ankle**

- Many Human Ails are 'Scars' of Evolution https://www.sciencenewsforstudents.org/article/many-human-ails-are-%E2%80%98scars%E2%80%99-evolution

The seven bones of the human ankle (shown in white) are fixed in place relative to each other. No engineer would design a joint with so many separate parts, only to fix them together-yet incredibly, most humans manage just fine with this jumbled arrangement.

5. Introducing the…**Human Optic Nerve**

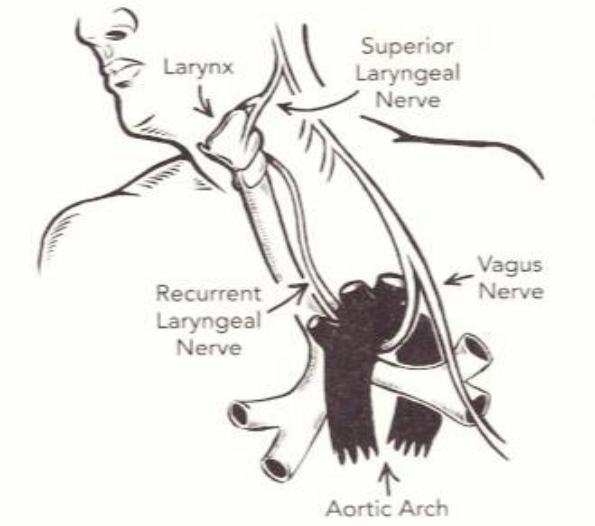
- The Poor Design of the Human Eye https://thehumanevolutionblog.com/2015/01/12/the-poor-design-of-the-human-eye/



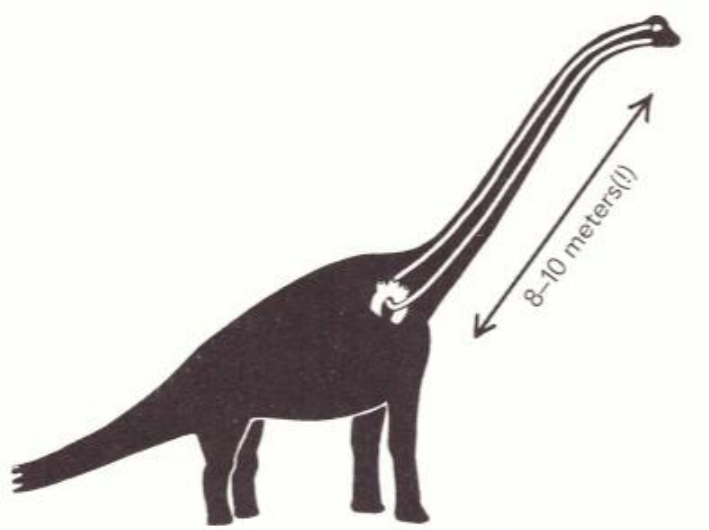
The photoreceptors of the cephalopod retina (top) are oriented toward the incoming light, while those of the vertebrate retina (bottom) are not. By the time this suboptimal design became disadvantageous to vertebrates, evolution was powerless to correct it.

6. Introducing the…**Human Recurrent Laryngeal Nerve**

- Video of a Giraffe Dissection (it's graphic, viewer discretion is advised) https://www.youtube.com/watch?time_continue=1&v=cO1a1Ek-HD0



The left vagus nerve and some of the nerves that branch off from it- including the recurrent laryngeal nerve (RLN). Its circuitous route through the chest and neck is an evolutionary throwback to our early vertebrate ancestors, in which a straight path from the brain to gills went very near the heart.



Brachiosaurus

The left recurrent laryngeal nerve (RLN) loops under the aorta in all vertebrates. Therefore, the RLN of sauropod dinosaurs would have been incredibly long.

Teacher's Guide

Welcome to the VERY Weird Human Convention!

Objectives: Vestigial structures are one of the many lines of evidence for evolution. Students will learn about vestigial structures and communicate how this information supports the idea of common ancestry and the non-linear nature of evolution.

Bell-ringer Activity:

Option A: The teacher should have a ball of yarn or string in his/her hands.

1. Ask 10-15 students to form a circle.
2. Hand a ball of yarn or string to one of the students (Student A).
3. Make sure student A keeps the loose end of the yarn in his/her hand at all times.
4. Ask another student to take the ball of yarn and hand it to any other student (Student B). As a result, students A and B will be connected with the yarn.
5. Pose the question, Do you think this is the most efficient way to connect two students in the circle with the yarn?
6. Take the yarn from the student B and go to 4-5 students, making sure each one holds the yarn before returning the ball of yarn to student B.
7. Repeat the question, Do you think this is the most efficient way to connect two students in the circle with the yarn?

Option B: The teacher should have a ball of yarn or string in his/her hands.

1. Tape index cards labeled A and B to two objects in the classroom.
2. Ask the students, Is this the most efficient way to connect Object A with Object B?
3. Choose a student to attach the two objects together using the yarn.
4. Untie the second object and connect the yarn to several objects before finally tying it to Object B once more.
5. Repeat the question, Is this the most efficient way to connect Object A with Object B?

Pre-assessment (Can be done on paper or orally):

Pose the following open-ended questions to the students:

1. Does everything in the human body serve a beneficial purpose?
2. Do cars have redundant or superfluous parts? For example, have you ever seen a car with two steering wheels or two gas pedals for the driver?

Activity: Divide the class into groups of four. Each group will be assigned to investigate one of the 6 Weird Human Body Parts (WHBPs) described above.

Each group will:

1. Create a poster-

- Draw and label the Weird Human Body Part.
- Complete the Weird Human Body Part Chart.

2. Present their poster and findings to the rest of the students, or "scientists at the convention."

3. Each Student must complete the entire chart with the help of the other presentations.

4. Show the entire class the two following videos:

- Proof of evolution that you can find on your body

https://www.youtube.com/watch?time_continue=4&v=rFxu7NEoKC8

- Richard Dawkins demonstrates laryngeal nerve of the giraffe

  https://www.youtube.com/watch?v=cO1a1Ek-HD0&t=40s

Post Discussion Questions:

1. The activity with the yarn at the beginning of the lesson was analogous to which Weird Human Body Part? (The recurrent laryngeal nerve)

2. The weirdness of the maxillary sinus cavity is unique to humans. The weirdness of the recurrent laryngeal nerve occurs in all tetrapods (animals with limbs). What does this tell you about when this weirdness appeared in the history of life? (Answer: The problem with the maxillary sinus cavity probably evolved in the line of hominins leading to our species. The recurrent laryngeal nerve evolved in the common ancestor of all tetrapods).

3. Remember when I asked, "Does everything in the human body serve a beneficial purpose?" Have you changed your answer?

4. Humans, unlike cars, have some useless or superfluous parts. Why? (Answer: Evolution is not a ladder of progression. It is not linear. Once evolved, some parts may linger beyond their original function or may even be harmful to the organism).

5. Evolution does not invent new parts from scratch, it re-tools existing parts. For example, the ventral fins on a lungfish can become a bat's wing or a human arm. Can you think of any other examples of homologous structures? (answers may vary)

Rubric: 100 points total

WHBP	Problems associated with this WHBP	Evolutionary reason for this weirdness?
Human Maxillary Sinus Cavity	Drainage hole on top. Gravity cannot help with drainage. Points 7 points	Demonstrates the accelerated evolution of human skull. The reduction of typical mammalian snout in primates and the movement of eyes forward for stereoscopic, 3-D vision. This emphasizes the switch that primates made from being driven mostly by smell to mostly by vision. Humans have the flattest face of all. 7 points
Human Anterior Cruciate Ligament	Prone to injury 7 points	Human upright position puts too much weight on a relatively thin ligament. Plus, our bodies have steadily gotten bigger, both in deep time (last couple million years) and recently (last couple hundred years. The ACL has not responded and exercise does not strengthen it. 7 points
Human Spinal Column	Intervertebral cartilage slips out of lace 7 points	The human spinal column evolved before humans walked upright. Its original J-shape, instead of straightening, went to an S-shape with sharp curve in the lower back, creating points of weakness 7 points
Human Ankle	Prone to injury, too many bones 7 points	Redundancy, as humans evolved, we never lost the extra bones. 7 points
Human Optic Nerve	Area of retina where optic nerve leaves the eyeball has no receptor cells, leading to a blind spot and more common retinal detachments. 7 points	This design was in place in early vertebrate eye evolution, before the problem presented itself. The backwards retina is the reason that the optic disk is an inevitable structure in vertebrates. Octopi don't have the optic disk because their retinas are "verted." 7 points

Human Recurrent Laryngeal Nerve	Nerve takes a crazy path all the way down to the heart 7 points	The nerve originally innervated the gills of fish, which are much lower. The introduction of the mammalian neck caused this weirdness. 7 points
Poster Drawing	8 points	4 points drawing 4 points labels for drawing
Oral Presentation	8 points	

Student Activity

Welcome to the VERY Weird Human Convention!

Scenario:
You have been invited to be a speaker at this year's Weird Human Convention. With your fellow scientists, you will learn about a Weird Human Body Part (WHBP) using the Research Guide your teacher will give you. You will present your findings to other scientists and complete the WHBP Chart for all of the WHBPs.

Presenting Six (out of many others) Weird Human Body Parts, aka WHBP

1. Colleen has a recurrent head cold. She has terrible pain and pressure in her sinuses. Her mother takes her to the doctor where she finds out that she has a sinus infection. She has to take antibiotics for a week. She misses school for five days.
Introducing the…Human Maxillary Sinus Cavity

2. Billy is the star football player on his high school team. He dreams of playing college football for the University of Alabama. During the fifth game of the season, Billy tries to make a hard turn. While running at full speed, he hears a snap in his knee.
Introducing the…Human Anterior Cruciate Ligament

3. Your favorite teacher, Mrs. Johnson, misses school for two weeks. After years of bending over to help students at their desks, she developed an excruciating pain in her lower back. She needed surgery.
Introducing the…Human Spinal Column

4. During a thunderstorm, Josh ran to his car in the school parking lot. He stepped into a large puddle of water. He fell to the ground in agony as his ankle buckled beneath him, tearing his Achilles tendon. The surgery he required used two screws to make the joint functional again.
Introducing the…Human Ankle

5. In Anatomy class, Lisa's teacher uses a simple exercise where Lisa sees one of her fingers completely vanish before her eyes. She learns that her eyes have a blind spot.
Introducing the…Human Optic Nerve

6. George is in Lisa's Anatomy class. They must have a wonderful teacher because she shows the class a video of an anatomist dissecting a giraffe, revealing the strangely circuitous path of a very important nerve.
Introducing the…Human Recurrent Laryngeal Nerve

Name: _____ Period: _____ Date: _____

Weird Human Body Part: _____

WHBP	Problems associated with this WHBP	Evolutionary reason for this weirdness?
Human Maxillary Sinus Cavity		
Human Anterior Cruciate Ligament		
Human Spinal Column		
Human Ankle		

Human Optic Nerve		
Human Recurrent Laryngeal Nerve		