Lab T-1
What Can Physics Tell Us About Physiology?

Fact: The skin of giraffes is tighter in their legs than the upper part of their body.

a) Now, we might ask, "Why is that?" What kind of *hypothesis* might *explain* this observation about this fact about giraffe's physiology? Come up with *as many hypotheses as possible. Hypotheses* are 'educated guesses' about the problem. There are no right answers, so be creative and brainstorm in your group for ideas. You must come up with **at least 3 hypotheses**.

1. tighter skin helps support the weight of their bodies/ tighter skin is more resistant to abrasion/ tighter skin helps bring deoxygenated blood back to the heart by increasing pressure/ prevent fluid pooling/ less flab, less drag/ doesn't need to be loose for expansion
2. the pressure of everything builds up in the legs making skin more taut/ the legs are primarily muscle so maybe the underlying tissue affects the skin's tightness/ the legs are under the most stress all day from standing so the skin needs to be tighter to prevent breakage from stress/ since the legs are mainly muscle the muscle is generally tighted to support the giraffe stretching the skin more constantly than other muscles in other parts of the body/ prevent fluid pooling/ less flab less drag
3. tighter skin may help support their body/ tighter skin is more likely not to be caught by other animals/ tighter skin helps with pumping blood up to the heart/ no need to be loose -> nothing to expand/ less air resistance
4. the legs have the most weight on top of them (more strain)/ legs are composed of primarily muscle due to running and walking/ pressure builds up in legs/ to prevent fluid building
5. pushing blood up/ skin is tougher to handle walking and scratching on things/ more muscles in leg
6. skin is tighter at the bottom because of the blood flow -> most is at the upper part/ it could be because it's primarily muscle/ they are also strained because of its weight
7. tighter skin may help their legs to support their bodies/ tighter skin may decrease the chances to be hurt by others/ tighter skins pushes the blood to the heads/ prevent fluid pooling/ less flab less drag/ doesn't loose, doesn't need to be
8. because legs grow last/ because blood pressure is greater…to counter act pooled blood/ legs do not have to expand as in to breathe
9. highest BP at the point closest to the ground/ because legs grow last/ they never expand (as in the chest area with breathing) so they never stretch and loosen
10. push blood up (not pool)/ skin get caught on stuff/ more muscles stretch out skin
11. push up blood/ defense against ground/ more muscles in legs stretches out skin
12. force of gravity or ???? as pressure / different types than elsewhere/ more strain/stress a those parts -> need more strength/ less function/ prog?
13. legs grow last---don't have to stretch/ highest pressure at bottom of body/ legs don't expand like abdoman does while breathing so the…/ prevent fluid pooling/ less drag for walking through brush

14. stronger defense against things nearer to the ground/ to keep fluid from collecting at the bottom of the legs/ there more muscles in the legs so the skin must be stronger
15. because to keep cells in the legs from filling up and help blood move up against gravity/ less fat on the legs/ adaptation external conditions

b) Among the hypotheses you came up with, are any of them based on physics principles? If yes, what physics principles (kinematics, force, momentum, rotation, gravity, etc…) or any combinations of them are relevant to your hypotheses. If none of them are based on physics principles, could you come up with some? Discuss among your groups.

1. gravity/pressure
2. the first one has to deal with gravity and the force of the entire giraffe on the skinny legs/ one deals with the elastic stretch of the skin so you can look at spring constants and young's modulus/ pressure
3. nothing written
4. gravity is relevant because the weight of the giraffe are acting on the legs/ young's modulus
5. gravity/ our first hypothesis involves gravity
6. our first hypothesis is related to physics due to the pressure (of blood flow). For the second one, gravity causes the strain on the legs by a downward force of g, with a normal force N by the ground.
7. gravity/ young's modulus
8. pressure/gravity ->greater blood pressure in legs/ elasticity skin stretches taut -> young's modulus
9. pressure and gravity/ elasticity – young's modulus
10. our pushing blood hypothesis is based on the idea that gravity would cause blood to pool in the legs
11. the first hypothesis involves blood pooling in the feet so tighter skin could help overcome the force of gravity
12. yes, force/pressure/gravity or fluids?/tissues, young's modulus/ (almost all of them had to do with these concepts directly or indirectly).
13. pressure difference due to gravity/elasticity -> young's modulus
14. the second hypothesis takes gravity into account as well as fluid pressure
15. yes gravitational force

Activity: You will fill up a latex glove with water and investigate its shape.

Procedure:
Tie off all the fingers on a latex glove. Use the faucet to fill up a latex glove with water until it's the size of 3~4 fists (you might think they would rupture, but latex are amazingly stretchy). **Before you fill it up,** make sure that there are no holes in the gloves (in order to avoid a wet mess). Avoid any air inside and close the glove by tying the tip (please do this over the sink to avoid getting wet). Now, transfer the filled balloon to your desk using the empty tub **and keep it in the tub at all times**. Observe the change in the shape when it is resting on a flat surface from when you hold it in the air by pulling on the end that you tied it.

Question:

1. When you hold it up in the air, how does it change from when you just lay it sideways? Draw a picture and describe what you see. (The change in the shape may be subtle, so you have to look carefully.)

SUM: most students sketched the shapes correctly. See drawings.

2. What physics principle explains your observation? What is going on in terms of physics?
   1. gravity+pressure/ when the glove is held in the air, gravity is pulling down on all the water, and the glove is stretched in response to this to form a ball at the end which is constrained by the pressure from the glove. When the glove is on the table, gravity distributes the water evenly, causing equal pressure everywhere on the glove.
   2. pressure due to gravity/ p = rho*g*h/ water experiences more pressure at bottom due to gravity/ water wants to go to lowest point so tries to even out in glove
   3. the attraction of gravity on the water in the glove explains why the glove changes its shape. Also the tendency to have smallest surface which is due to the resistanc eof the glove not to expand anymore makes the shape to be kind of a sphere
   4. p= rho g h -> pressure due to gravity
   5. gravity is pulling the water towards the earth, and the elasticity of the glove allows the change in shape. The normal force keeps the shape more uniform and the tension force in the air is only applied at the top of the glove.
   6. pressure due to gravity: rho g h -> hwen held up, it's h is at the surface, but when layed down, the h goes down by the fingers creating more pressure, thus more expanding of the balloon
   7. p = p + rho g h/ when the height of the glove increases, the pressure at the bottom increases with all other things constant. When the height of the gloves decreases, the pressure at the bottom decreases with all other things constant.
   8. pressure due to gravity---the pressure is greater at the bottom when the glove is held up it is able to expand whearas the glove on the table exerts a force on the bucket the bucket exerts force on glove.
   9. pressure due to gravity/ the water is pushing down (and, when the glove is in the tub, the tub pushes back up on the wafer/gloves).
   10. gravity is moving H2O to the lowest point, in the air it is the fingers on the bottom. Latex also bends because of its elasticity. The tension force is the reason why it looks like a rain drop in the air.

11. in the upright position, the fource of tension acting on the top causes the stretch/ When the glove is on the bottom, the table is exerting a normal force/ the shape of the glove depends on where the force opposing gravity is being applied.
12. p= rho g h -> pressure due to gravity is [carrying the charge]???
13. pressure due to gravity/ the water on top is pushing down on the water at the bottom due to gravity. This makes the greatest pressure at the bottom, causing it to stretch the most.
14. gravity explain the downward pulling force. The elastic force explains the changing shape ??? gravity is opposed by either the pressure of the tub or the tension force of our ??? holding it.
15. force of gravity is pushing the water in the glove on to the table water on its sides and congregates its water to the bottom when in air [hard to read]/ normal force acting on the filled glove equal and opposite to g/ tension: acting on the air at the point where the glvoe is being held.

3. Based on the relevant physics principles that you identified, can you develop a model that describe what you see? That is, can you identify the essence of the phenomena? Can you think of the gloves in terms of something simpler? Can you draw a *simplified* picture of what you see?
   1. see picture
   2. p = rho g h/ our model is a tear shaped container filled with fluid so experiences pressure with height h and density 1g/cm^3/ see picture
   3. see picture
   4. see picture
   5. see picture
   6. see picture/ we can think of the gloves as fluid in a container with height h and density equal to water
   7. see picture
   8. see picture
   9. see picture
   10. see picture
   11. see picture
   12. fluid is a tead shaped container with height h and density of 1 g/cm^3
   13. see picture
   14. see picture
   15. see picture

4. Are there any parts of the model you are developing that can be used to understand the fact about giraffe's skin? Does the water-filled balloon represent any relevant part of the giraffe?
   1. This shows that the greatest pressure is at the bottom of the balloon-much like the greatest pressure from the blood, etc. ??? a giraffe would be at the bottom of their bodies. The tighter skin of the giraffe provides a bigger resistance force to counteract the greater pressure here from the fluids.

2. the balloon can correspond to the legs of the giraffe the pressure of the fluid is greater at the bottom so the skin is tighter so that it can hold the fluid in. the skin must have enough tension then to compensate for the pressure of the fluid
3. if I think the glove as a cylinder when I holds up. In other words, when the glove is tightest, the glove exerts the greatest resistance force at the bottom similarly, tighter skin can exert greater resistance force to support the giraffe's weight well.
4. the balloon is tighter on the bottom when held in the air. This corresponds to the tightness in the giraffe's leg skin.
5. the glove represents the giraffe's skin, the water is the blood. There is more pressure at the bottom of the glove.
6. the pressure's greater in the legs, so the skin needs to be tighter in order not to break. The filled balloon represents the leg of the giraffe. It is tighter at the bottom because the pressure is greater.
7. giraffe's tighter skin can help to resist the large pressure on their feet, as the surface area of the water-filled balloon decreases with the same force, the pressure to resist bottom pressure increases. This applies to the legs and feet of giraffe.
8. the water filled ballon represents the whole system of the giraffe (water in is fluid, muscles, skin = skin). This is because of the higher pressure in the legs due to gravity. Either the skin needs to be tighter so that it doesn't stretch in response to the higher pressure or the skin is tighter in response to higher pressures.
9. both models show at the increased pressure occurring at the bottom of the object. The tear drop shape shows that the 'skin' of the balloon is tighter at the bottom. The skin of the giraffe's legs follows the same principles. The skin is tighter because it needs to handle more pressure.
10. the glove represents the giraffe's skin, the water is the blood. The amount of stretch in the latex is coordinated to the pressure exerted by the water. More stretched latex supports a higher force by the water.
11. The glove represents the giraffe's skin and the water is the blood. The latex at the bottom of the glove is more taught than the latex at the top because it has to incur the entire Fw of all the fluids in the giraffe so it stretches.
12. filled balloon -> leg of giraffe/ in order to conpensate for the ????? pressure @ the bottom, the skin must be tight or the skin will rupture or impede the animal??
13. Yes, the teardrop shape is showing that there is more pressure at the bottom of a closed fluid system than at the top. The tighter skin in the legs is due to the greater pressure at the bottom of the giraffe. The skin has either stretched because of the pressure, or has been made tighter evolutionally to withstand the greater pressure.
14. The water-filled balloon represents a fluid-filled giraffe body.
15. yes the water filled balloon can be viewed as a cell in giraffe's leg the skin will apply normal force on the cell/ all the forces that are present in the balloon are also present and acting on the giraffe's leg because that make up the balloon and the skin are not the same we do not expect to observe the same physical changes [hard to read]

Fact: Nurses measure blood pressure on your arm. Why not on your lower leg?

a) Is there a reason why nurses insist on taking your blood pressure on your arm other than that that's what doctors tell them to do? Should you expect there to be any difference in the measurements of blood pressure between your arms from your lower legs? Why or why not?

1. your blood pressure would be different at different points in your body (BP taken at your legs would be greater than BP taken at your arm). For the same reasons as discussed before. Because of this difference, in order to compare against a standard, BP would have to be taken at the same place.
2. They take the measurement in the arm because it is closer to your heart so the pressure will be higher than in the arms and closer to what the heart is actually doing.
3. The reason nurses take the blood pressure on my arm which is as high as the heart is because the blood pressure of any other parts of the body will be different, which can cause confusing among nurses and doctors. The blood pressure on my leg will be greater than the blood pressure on my arm because the gravity is pulling the blood down to the feet.
4. The arm is more accurate because it is closer to the heart, whereas the leg blood pressure would prob ably be lower because it is farther away from the heart.
5. Nurses take pressure on your arm because it is at the same level as your heart, so gravity would have the same affect on pressure. Pressure would be higher in the legs.
6. since your arm is closer to your heart, you will get a more accurate measurement of blood pressure vs. at the legs because it's much lower at the legs because of the distance from the heart.
7. The blood pressure on the arm is lower than pressure on the lower leg as the pressure towar the bottom is bigger than upper parts. So there are a lot of differences to measure blood pressure between my arms from my lower legs.
8. Yes, there would be higher pressure in the legs due to gravity. This higher pressure would cause both the systolic & diastolic values to be higher in the legs.
9. There would be a difference. Both systolic & diastolic pressures would be higher in the legs due to gravity.
10. It's level with your heart so gravity has the same effect on the heart as the arm. The pressure in the lower legs is higher than the arm.
11. The arm is approximately the same level as your hear so it is the most accurate. The blood pressure in your leg is higher because there is more fluid above.
12. The blood pressure in your arm is closer to that of your heart because of ????. your leg, by contrast, has a lower BP because the blood travels fortlae??
13. the pressure in your legs would be higher due to the pressure from gravity
14. because it is at the same height as your heart to the force of gravity will not factor into the measurment
15. because the vein in the arms is closer to the pumps. Pressure ??? have and the veins or arteries ~~ legs are stiffer these ??? will give exaggerated values for the systeloic and diastolic [hard to read].

b) What physics principles are relevant here? Can you develop a simplified model of the blood vessels to explain this fact? Can you represent human blood vessels (arteries in particular) as something simpler? Draw a picture of your model.

1. see picture/ the principle of gravity + pressure are important here.
2. p = rho g h/ point of reference is the ground and the heart/ can use experimental data to find if pressure is higher in the arms or legs.
3. see picture/ the attraction of the gravity plays a role in this case
4. possible points of references—ground and heart
5. gravity affects blood pressure more in the legs than in the arms
6. see picture/ P = p + rho g h/ This model shows how the pressure would be greater in the arms due to an increase in height (h). This is making the h = 0 at ground level.
7. see picture
8. see picture/ pressure + gravity
9. see picture
10. see picture/ we will draw them as a circular column with a pump in the middle
11. Blood vessels are similar to a column of water. We can use pressure equation to determine the pressure required to pump blood from certain heights of your body. Circular columns would be most accurate.
12. model = rho g h where point of reference may be the ground or the heart, wearing the pressure may be greater e???? [hard to read]
13. see picture/ pressure due to gravity
14. gravity and fluid pressure and the key physics principles. You could simply represent blood vessels as a circular tube of fluid.
15. ???

c) Based on the model that you developed above, can you predict what the difference in blood pressure would be between your arm and legs? Make a **quantitative prediction based on the model you just developed.** Here are some useful conversion factors: 1atm = 1.013×10^5 Pa = 760mmHg; $\rho_{air} = 1.29$ kg/m^3; ρ_{blood} = 1050-60 kg/m^3; $\rho_{water} = 1000$ kg/m^3)

d) <u>Measurement:</u> In upright posture, measure your blood pressure using the automatic blood pressure cuff your arms and your calves. To measure the blood pressure, all you need to do is to wrap the cuff around your arm (or calve), and push the button labeled “Start”. The machine will pump the pressure automatically to about 160~180mmHg (a pressure at which, one may feel a little uncomfortable, but don’t worry; it won’t sever your arm) and then the pressure will start to drop slowly with a clicking sound. After it is done, it will give you a systolic and a diastolic pressure. All you have to do is wait. Measuring once in right and left arm and once in right and left calve is good enough. Compare these values you got for your arms and calves. How do they compare? Are there any differences in measurement between right and left limbs? Do the values you get agree with the values your models predict? If not, what can explain the discrepancies? Should you use systolic or diastolic pressure in your analysis? Why?

1. The blood pressure differences between the right and left limbs were not that big with the systolic being larger on the right side and diastolic being greater on the left side. The values we got do not agree with our predicted value, but did show the same trend of greater pressure in the legs. This difference with our predicted values

might be due to errors in our initial estimation of height. Systolic seems to be a better predictor in our analysis. (Diastolic has more to do with the elasticity of the artery).

2. the blood pressure in the legs is higher than in the arms and it is higher in the left limbs than the right. If we use systolic and average the legs and then average the arms we get a difference of about 108.5mmHg which is fairly close to what our model predicted. It could be different because the machine had to read the left calf twice so the second time the reading might not have been as accurate/ should use systolic pressure since it measures more directly the blood flow and blood pressure where as diastolic measures more the properties of the artery
3. there is a difference in pressures of right arm and left arm. Also, there's a difference in pressures of right legs and left leg/ the difference of the average arm pressure and the average leg pressure is 81.5mmHg. This is not exactly what I predicted, but I think this is close enough to what I expected since I roughly estimated the height difference of the arms and the legs/ I think I can use systolic and diastolic pressures in my analysis since the pressures on arms and on legs act like the systolic and diastolic pressures.
4. The blood pressure in the legs is much higher in the legs and also higher in the left than the right. Diastolic avg. difference between arms and legs 68.5mm/ Diastolic measures more of the properties of the artery itself.
5. left limbs have higher diastolic pressures than the right limbs. The values agree because the pressure is higher in the legs. For height, use systolic pressures, for left/right use diastolic.
6. The values are higher in the calves. The measurements also seem to be higher on the left side for systolic, and the same for systolic, but larger on the right for the legs. When we average the two differences we get about 68.5mHg, which is pretty close, but the slight error could be due to the machine having to measure twice on the left leg, and also body posture could have made a difference and the height at which we measured at.
7. systolic and diastolic pressures on the arm is much smaller than the ones on the leg. There is only a little bit difference between right and left limbs. The differences between the arm and the leg agree with my models predicted, which the blood pressure of 104.99mmhg is close to the measured value of the systolic pressure of my right arm. The systolic pressure is useful for the analysis, but diastolic pressure is not. It only depnds on the stiffness of arteries which the blood flows.
8. The difference was lower than estimated. We don not know the error. Right and Left arms were v. close, there was a diff between R+L legs. We may have oversimplified for our calculations. We modeled the body as a column of blood—we didn't account for pumping, therefore we should look at diastolic pressure because it ignores pumping.
9. left and right legs were about 20mmhg different/ our model predicted a 77mmHg difference. However, our model may have been too simple and our calculations show that/ diastolic the pumping will not interfere with measurements
10. legs higher pressure than arms. Left limbs have higher diastolic pressures than right limbs. Yes since lower areas have higher blood pressure. For height use systolic, for left/right use diastolic.

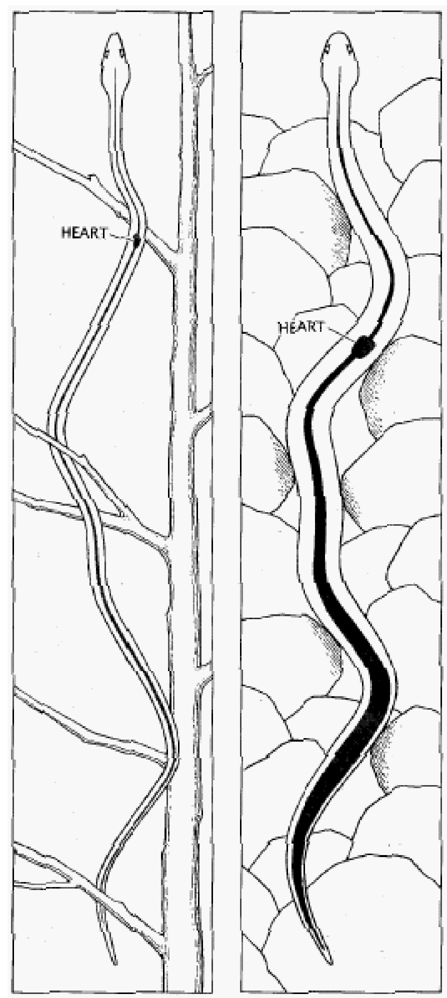
11. The pressures in the calves are significantly higher than in the arms. This is concurrent with our estimations. Additionally, we would assume the pressure in the left side of your body (closer to your heart). This is true in your arm and leg. Diastolic pressure in both are higher. Our quantitative prediction was ~203 and that agrees with our results.
12. We should use the systolic BP ??? because it….[hard to read]
13. The left + right arms were the same, the right leg was 20 higher than the left. Our model predicted 77, but we only got increases of systolic 36. The over simplification of the system led to the estimate being too high at 77. we're using diastolic to analyze, because the pumping isn't interfeing with the measurment.
14. Left limbs have higher diastolic pressures than right limbs. The results do agree with what we predicted.
15. the left arm and leg are higher than right arm an leg. Use diastolic because the relative charge from the arm and leg is low.

e) What does your understanding of the human blood pressure measurement add to your understanding of the fact about giraffe's skin? How might the blood pressure be relevant for giraffes' physiology, especially to the tightness of their skin?

1. Because the arteries have the same stiffness throughout the body, the tightness of the skin ????? with the increased pressure in the legs.
2. using the heart as the reference point the blood pressure is higher in the legs than the arms so since the pressure is higher in the legs the skin would be more taught to compensate.
3. In order to push the blood at the leg, which has the higher blood pressure than that of the blood at the arm, back up to the heart. The leg skin of the giraffe has to exert more force than the upper skin of the giraffe by being more tighter.
4. The higher blood pressure corresponds to the tightness in the giraffes skin. This makes sense because the pressure would be greater in the legs.
5. Skin is tighter at the legs because the blood pressure is higher. The diastolic pressure is higher in the legs, and the legs support more weight of blood, so the skin has to be tighter to change the pressure and push blood up.
6. Relating this bach to the filled latex glove, the pressure is greater near the bottom with a reference point chosen to be the heart. Just as in blood pressure for human, the skin must be tighter due to increased pressure in the lower extremities.
7. The tighter skin can resist the larger pressure on legs than the pressure on the upper body.
8. Higher blood pressure in legs would lead to tighter skin—we found that there is higher BP in the legs.
9. The blood pressure is definitely higher in the legs and this higher pressure can account for tighter skin.
10. Skin is tightest at the bottom because it has higher blood pressure.
11. The skin at the bottom of the giraffe is tighter because it supports more blood mass. Consequently, blood pressure is 150 higher.

12. Using the heard as our reference point, we can expect, by this model as well as experimental evidence that our BP is our lay in greater, requiring greater tension in the skin of the leg. [hard to read]
13. the higher blood pressure in the legs would mean that the leg skin need to be tighter to withstand the skin.
14. The higher the blood pressure, the tighter the ???. It ends ???? [hard to read].
15. blood is under pressure which aloow it to speed throughout pressure near the hear is higher (systolic). Tightness of the skin is important because pressure at the legs is higher due to the blood pressure + mass of the volume above it. Therefore, the skin is tight in the legs to counter these forces.

Fact: Tree climbing snakes have their hearts much closer to their heads than non-climbing snakes do.



a) What physics principles may be relevant here?

   Most people wrote: pressure + gravity

b) Can you sketch a simplified version of the situation? Are there any useful objects or analogies, in terms of which we may be able to understand the physiology of snakes?

   See picture

c) Can you think of similar situations in which the distance between the head and the heart is important? (Think back to the giraffe example.)

   1. in the giraffe example the distance between the heart + the head is very important. The further the head is away from the heart, the more it is going to have to work to get blood to the brain and fight against gravity.
   2. The giraffes's long neck makes the heart closer to the feet than many other mammals. Also the brontesaurous had a long neck creating a long distance between the head and heart.
   3. Because giraffes are tall, the heart of the giraffe should be located at higher position to pump the blood up to the brain.
   4. giraffe (long necks)/ dinosaurs
   5. In a brontosaurus, the neck is very long, and the heart has to be close enough to pump blood to the brain.
   6. Giraffe's have a really long neck, so the distanc is really large; and also dinosaurs with really long necks.

7. The distance between the head and the heart is long for giraffes, so they need more pressures from the lower parts of their bodies to pump their blood to their heads.
8. with giraffes ← needs to pump blood up neck against gravity
9. giraffe: distance between head & heart is based on what is needed to get up the neck to reach the head/ elephant using its truck v. bending
10. it is very important for Brontasaurus to have a heart near its brain so it can eat vegetation from high limbs and not lose blood pressure in its brain.
11. Animals with long necks like ostriches or giraffes would like their hearts closer to their brains so it requires less effort to reach this essential organ. If the heart is so far away, the BP in the brain gets low.
12. giraffes' neck → long so need ??? higher/ ?????? → long neck, greater distance ????? [hard to read]
13. The giraffe has a huge neck, and the blood must be pumped up the neck against gravity/ an elephant heads don't change positions in relation to the heart.
14. the height of, say, a very tall dinosour. Or perhaps any animals with a long vertical neck
15. nothing written

Activity: You will fill submerge a latex glove filled with water in a tub of water and investigate its shape.

Procedure: There should be a few fish tanks in the room filled with water. Observe how the shape of the water-filled glove you used earlier in the lab changes when you submerge it in the fish tank. Compare its shape from when it is held in the air.

a) When you submerge it in the water, how does its shape change from when you hold it up in the air? Draw a **picture** and describe what you see in **words**. (The change in the shape may be subtle, so you have to look carefully.)

SUM: everyone observed that the shape of the glove becomes spherical from a tear drop shape when submerged under water.

b) What physics principle explains your observation? What is going on in terms of physics?

1. Pressure → The pressure outside the glove is the same as it is inside the glove. This means that (rho g h) inside = (rho g h) outside the glove. For all sides of the glove. In air the pressure differences cause more pressure at the bottom of the glove by the water.
2. buyoyancy can explain this—the glove is in a more dense fluid than air (water) so it can couteract the gravity and pushes on the glove at all sides equally so it makes it spherical,
3. the pressures of the water inside and the outside is exactly identical to each other and is constant anywhere. Therefore, the net pressure on the glove is zero. Since there's only the resistance force of the glove not to expand anymore at the constant volume exerted on the glove, the glove forms a sphere which has the smallest surface area among shapes of certain volume

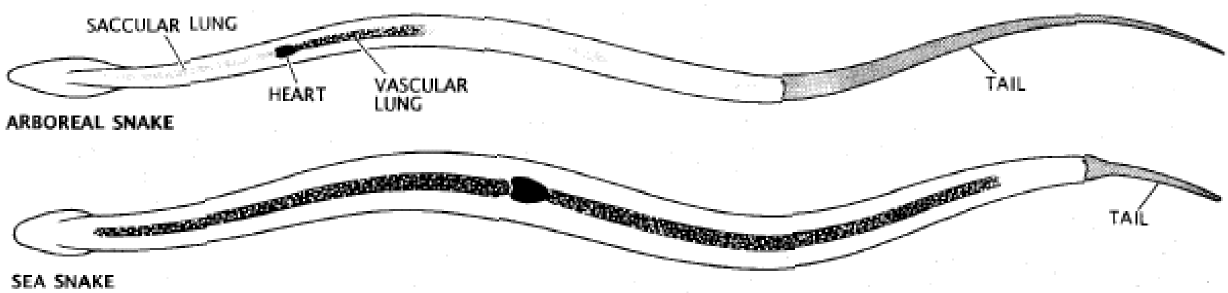
4. This can be explained due to buoyancy. The glove is pushed on all sides equal since there is the same fluids inside as outside.
5. Buoyancy negates the effects of gravity on the glove, so the displacement of shape doesn't take place.
6. As stated above, the force of buoyancy is against the force of gravity. The glove is in a more dense fluid which might cause a more uniform pressure distribution causing a more spherical shapes.
7. Buoyancy and gravity. Before putting the balloon in the sink, the gravity just pulls the bottom of the balloon down to an elongated circular shape. After sinking the balloon in the water, the buoyant force supports the water balloon in the water, the buoyant force supports the water balloon and its surface are a increases to form a compressed circular shape.
8. buoyancy—the higher pressure at the grater depths counteracts the greater pressure at the bottom of the glove/ Density—the glove contains water & then is submerged in water
9. buoyancy: the higher pressure at greater depthe counter acts the higher pressure at the bottom of the glove
10. buoyancy negates the effects of gravity causing a uniform dispersion of pressure making a nice sphere not a rain drop.
11. In this situation, the pressure on the outside of the latex is identical to those on the inside. This makes a perfect sphere buoyancy negates the effects of gravity. This makes a uniform dispersion of pressure
12. The buoyant force of the water counteracts the weight of the fluid in the glove (more dense fluid, changes the apparent weight)
13. Buoyancy—the higher pressure at greater depth conteracts the higher pressure at the bottom of the glove. The greater density of water provides the greater external pressure
14. buoyancy negates the force of gravity causing a uniform dispersion of pressure on the latex.
15. nothing written

c) Based on the relevant physics principles that you identified, can you develop a model that describe what you see? That is, can you identify the essence of the phenomena? Can you think of the gloves in terms of something simpler? Can you draw a *simplified* picture of what you see?

1. see picture/ draw the gloves as spherical balls with elasticity
2. see picture
3. see picture
4. see picture
5. see picture
6. see picture
7. see picture/ I use a particle model to represent the balloon.
8. see picture

9. see picture/ the pressure at all points is equal to the inner pressure. These pressures are controlled by density.
10. see picture
11. see picture
12. see picture
13. see picture/ The greater pressure at the bottom of the glove equals the pressure of the tank
14. see picture
15. nothing written

Fact: Tree-climbing snakes have slender bodies with tight skin, while aquatic snakes have flabby bodies with looser skin.



a) What physics principles may be relevant here?

SUM: Pressure + buoyancy, gravity, density

3. because the tree snake needs to push its blood at the tail up to the heart, the tighter skin is helpful. However the tighter skin is unnecessary for sea snake because it is not hard for it to push the blood back to the heart.

b) Are any parts of the explanations you developed for the change in the shape of the latex glove relevant in explaining this fact about the physiology of snakes?

1. Yes. Since the sea snake spends its life in water and blood~water density, it doesn't need the tight skin that a tree snake would need to counteract the increased pressure of living on land. The increased flab in sea snakes would help with buoyancy.
2. less pressure difference exerted on the latex glove or skin through the system allows for the sea snake to have flabbier skin.
3. sea snake tends to have loose skin in order to obtain the smallest surface area in the water since its body exerts pressure against sea water to cancel the pressure sea water and therefore there's less force exerted on the skin.
4. less pressure exerted on the gloves or skin through the system lets the sea snake have flabbier skin
5. yes, the sea snake has equal pressure all around it, while the arboreal snake has different pressure on it, so it needs tighter skin to move blood

6. less pressure difference/ more uniform shape and blood flow for the sea snake
7. as aquatic snakes live in water, their flabby bodies with looser skins will let have more up ward force—buoyant force as compared to the ones of tighter skins. The tighter skin of arboreal snake helps them pump blood to their head than looser skins
8. The water provides the pressure to counteract internal pressure in the sea snake, so there is no need to have tight skin
9. The water pressure takes over for the need for tighter skin. The wafer is already providing the pressure to counteract the expansion o the skin from blood pressure.
10. yes, the pressure from the sea snake's blood is uniformly dispersed like the blood. There is no needed thin skin areas
11. yes, the pressure inside the snake is uniformly dispersed similar to the glove in water. This keeps its skin loose throughout. It is oriented horizontally rather than veritically.
12. less pressure difference, less need for tight skin
13. yes, the water provided the pressure needed to couteract the expansion of the skin that is normally provided by tight skin
14. yes the sea snakes has pressure exerted equally about is body, so it does not need tight parts to push blood up its body
15. Nothing written

c) Can you sketch a simplified version of the situation? Can you draw a picture of the situation? Are there any useful objects or analogies, in terms of which we may be able to better understand the physiology of snakes?

1. See picture
2. see picture/ the sea snake could be represented as the glove in the water. The tre snake can be related to the legs of the giraff or the glove out of water
3. see picture
4. the tree climbing snakes is like the leg of a giraffe/ the sea snake is like the glove
5. see picture
6. see picture/ the sea snake may be represented by the glove, and the land/tree snakes by something more right or tighter
7. see picture
8. see picture
9. see picture
10. see picture
11. see picture
12. legs of a giraffe→ tree snake/ glove → sea snake
13. see picture
14. see picture
15. Nothing written

d) Based on your answers above, how do you explain this fact about snakes?

1. This fact is explained as I said in (b). The flabbiness of the sea snake helps with buoyancy + the difference in skin tightness is explained in (b).
2. the tree snakes are similar to the giraffe's legs so they….
3. Nothing written
4. the flabby skin helps the snake remain buoyant in the water
5. snakes whose blood pressure is uniform does not need tighter skin to counteract the force of gravity
6. Nothing written
7. the buoyant force by loose skins helps sea snakes live in water and pressure of tighter. Skins help tree snakes live in trees. The physiology of their characteristics helps them live in specific habitats.
8. tighter skin provides resistance to internal pressures caused by gravity. Since water pressure aids skin in resisting internal pressure, water snakes do no need tight skin.
9. terrestial snakes need a higher skin pressure than aquatic snakes because they don't have added water pressure
10. snakes whose blood pressure is uniformly dispersed don't need thin skin to hold that pressure, so it's flabby all over.
11. there is no need for snakes to have tighter skin because their blood pressure is uniform. This makes the skin looser throughout. The snakes horizontal orientation means the pressure in its body is always the same.
12. Nothing written
13. Terrestial snakes need the greater pressure of the skin because they don't have the help of the water to resist expansion
14. because the pressure are equal throughout, the snake doesn't need tight skin to push blood up its body
15. Nothing written

e) If your model predicts some new facts (some facts that are beyond the context in which the model was formulated), the credibility of the model increases. Does your model for the snake's skin predict anything? That is, assuming that your model is roughly correct, come up with something that we expect to observe in nature. Does the model imply anything about how **you** might feel being upside down in the air as opposed to in the water?

1. Nothing written
2. Nothing written
3. Nothing written
4. Nothing written
5. water snakes would not be able to tell if they are upside down in water because they have uniform pressure and the water aoround them exerts equal pressure on them.
6. Nothing written
7. Nothing written
8. Yes, the model predicts that in water, regardless of your orientation , water pressure ins greatest at greatest depth—as is the greaterst internal pressure—under water + upside down you do not feel any difference regardless of orientation. In the air you

do feel a great pressure will inverted. The model predicts that the skin resists this pressure—the head does not explode!

9. When you are upside down, there is more pressure on your head. In air, you will feel discomfort because of this added pressure. In water this higher pressure will be counteracted due to the depth of the water that you are in. This is why divers carry buoyancy devices, to know which way is up.
10. in water you'd feel no difference in blood pressure upside down as rightside up. In air the blood would make a higher pressure when you're upside down in your head.
11. If you had uniform pressure in you body, being upside down in water would feel more like being right side up than it would be if a snake were upside down in air. Sea snakes blood is closer to water density than tree snakes.
12. Nothing written
13. when you are upside down, the pressure in your head increases. However, when you are under water, this is counteracted by the equal increase in pressure at greater depths. When in the air, the pressure change from 2m → 0m outside doesn not counteract the change of pressure in your head.
14. the model would imply that being upside down in water would feel more like being right side up in water than being upside down in air would feel like being rightside up in air
15. Nothing written

f) It is also necessary to be humble in your claims by acknowledging any limitation of the model that you developed. Are there any limitations of the model? Does the model oversimplify what actually is going on? To what extent, can you say the model that you developed is a good one? (No right answer here. Start by brainstorming in your group.)

1. Nothing written
2. Nothing written
3. Nothing written
4. Nothing written
5. the snake is not completely filled with water, so our model did not take that in to account. Also if the snake is very long, the pressure would start to change because of the weight of water.
6. Nothing written
7. Nothing written
8. skin is not the only material responding to/resisting pressure changes/ our circulatory system is largely responsible for regularting pressure differences in the body—not the skin/ it explains the increase in bood pressure due to different heights.
9. Our model only deals with skin filled with water. The skull, brain, blood vessels all need to be accounted for. The circulation system is trying to control our BP. Our model does explain the increasing pressure due to heights.
10. you would feel some difference because of buoyancy caused by air in the lungs.
11. This model assumes that a snake is completely filled with a liquid the same density as water (blood, muscle). This model oversimplifies the situation because the above assumption isn't true.

12. Nothing written
13. our model assumes we are skin filled with water. When we actually have blood pressure and organs etc. The circulatory system actively work to keep the pressure up in the system so it can pump blood to your head. Our model does explain the increasing pressure due to different heights
14. a snake's body is not filled only with water. Other things, like ??? and ???? have different densities which would affect how the pressure is dispersed about the body. Our model is sufficient for our purposes in observing the skin of the snakes.
15. Nothing written

Student ran out of time at this point, so we don't have any data after this point in the worksheet.