Student responses to selected items
Lesson Study, Fall 2007

Item 1: Pg 3, part b)
In your group, use at least one of the notecards you're given (or an idea of your own, if you can't do anything with the cards you have) to create a model explaining the fact above. A good model should have a diagram, explanation of the diagram, and how it helps explain the fact, and a discussion of your assumptions and limitations:

1. the tight skin restricts the vein from bulging out (due to the increase in pressure at the bottom of the vein). We assume that the skin is restrictive enough to affect the vein and that the force inward exerted by the skin and force outward exerted by the blood are equal. Limitations include that the blood isn't moving in our model and that we model 1 size of vein (in an actual leg they would vary quite a bit). (have picture)
2. The pressure is greatest at the bottom of the giraffe. This would push the skin outward. Assumption: Blood is not flowing. (have picture)
3. In creased pressure from tight skin forces blood to circulate back up to upper body. Doesn't allow blood to pool in legs. (have picture).
4. As you go towards the bottom of the giraffe's body, there is more pressure and therefore the skin is tighter. (have picture).
5. This explains tight skin at the legs of the giraffe because it (the giraffe) heads more force on the pressure at the legs because the pressure is so much greater down at the bottom than the top, so the tight skin acts as a counter force to the pressure. / Limitations are that the beaker is not universal for everything, including animals. / The arrows and their lengths represent pressure and their magnitudes. They increase further down the beaker.
6. Aua? Of blood vessels decreases in the legs / velocity must increase / blood needs to slow against gravity so the foece of the skin against the blood vessesl causes an increase in velocity of the blood (to flow against gravity). (have picture)
7. The pressure of blood increases as you get closer to the feet. Therefore, giraffes would be particularly prone to this problem since their feet are so far from the top of their circulatory system. An equalizing force (the skin in this case) is needed to stop the blood vessels in the feet from swelling with blood. (have picture)
8. Think of the giraffe as a container fillwed with water. As the depth increases the pressure increases. If pressure increases, the thickness of the containers walls need to increase so the walls do not burst. Limitation: giraffes arteries are not contiuously the same size, as the container is drawn. (have picure)
9. Think of the giraffe as a container filled with water. The bottom of the container has large pressure so the skin must be tighten in comparison to be higher end which has less pressure. (have picture)
10. As you get lower on the body, the pressure in the blood increases and wants to push out against the walls. The tight skin on the legs is there to keep the blood

from expanding it. Limitations: the giraffe is represented as a cylinder; only the skin and pressure due to gravity are taken into consideration

11. Because pressure increases as you go down (like bucket of water) the skin must be tighter to counteract the pressure pushing outward, to tighten the skin helps to hold it together (loose skin could allow to expand rom pressure inside) as arrows susggest. Limitations: assuming giraffe is cylinder and no chage of state. (have picture)
12. There is more pressure in the legs of the giraffes because pressure increases with depth. The skin is tighter because the pressure the skin exerts on the blood vessels needs to equal the pressure the blood vessel exerts on the skin. Limitations: ignore complexities of giraffe path of blood vessels ??????shape of blood vessel. (have picture)
13. P = rho g h; more blood pressure at the bottom of the giraffe makes the skin tight (have picture).
14. The fast circulation will make the tighter in their legs. I think the movement/moving ofleg is faster than other, so the frequency bigger and faster. Also the pressure will be also increased following the force in the joint.
15. More blood veins, need tighter skin gives more pressure to keep veins in place, not explained at the lower body.
16. Tight skin causes higher P, which decreases the area of blood vessels and therefore increases v of blood. Higher v helps pump the blood back up and prevents pooling of blood in the legs. Also, tight skin causes higher extra-cellular pressure, which counteracts the high p of the blood (due to the weight of fluid pumping down). This balance keeps the blood in the vessels, otherwise the blood would be forced out of the vessels. Simplifications: The giraffe leg is a tube and low resistance in the blood vessels.
17. Blood pressure increases with depth, which increases the volume of the tissue under the skin and makes the skin tighter.
18. The blood is under hydrostatic pressure. Therefore as we move down the giraffes body the pressure on the blood in the blood vessel will increase. Therefore the area of blood vessels will increase as we move down then increasing the area under the skin. This naturally will increase the tension on the skin.
19. Pressure = \rho g h. Pressure is greater in the legs due to gravity. The skin (blood vessels) has to be tighter to resist the pressure. Assumptions: composition of blood homogenous throughout body, radius of blood vessels don't change much.
20. Limitations: complexity of giraffe ignored, complexity of blood system ignored. Skin is tight because muscles contract to push blood up. Skin must be tighter so the force on the veins is greater to move blood up.
21. The blood pressure at a particular location is dependent on the weight of the liquid above it. The leg is low on the giraffe, thus it has the weight of the blood acting on the blood in the leg, causing a higher blood pressure pushing out on the skin. Assumptions: The giraffe is standing upright and lower than the rest of body. Limitation: model doesn't work of leg is horizontal. P_f = P_0 + \rho g d (assume blood has constant density, difference in blood pressure due to height).
22. 21: More blood needs to be pumped to the brain than to the legs. Consequently, to facilitate less blood flow to the giraffe's long legs, the skin is tighter and

creates greater pressure on the veins and arteries within the legs. This extra pressure counteracts the influence of gravity that would naturally cause the blood to flow to lower parts of the body more readily – the blood is more able to target vital organs due to the pressure in the legs caused by the tight skin.

23. 22: The pressure increases as you move down in the leg/giraffe. This would result in tighter skin – more outward force – on the legs vs the body. Assume pressure increase correlates only with height, not volume or shape. Assume uniform body shape. Assume blood is static.
24. 23: At lowest point in the leg, pressure pushing out on skin is the greatest, making the skin the tightest here. Pressure increase due to distance (height) (not volume or shape). Assume uniform body shape. Assume pressure is only dependent on height. Assume blood standing still.
25. 24: More blood needs to be pumped to head than the legs. tight skin keeps the blood from pooling in the legs and keeps the blood moving so it can travel to the brain. A larger velocity keeps the blood from pooling in the legs. A_2 < A_1, v_1 A_1 = v_2 A_2, therefore v_2 > v_1.
26. 25: The skin of giraffes is tighter in their legs than the upper part of their body because blood pressure increases as depth increases, blood pressure in the legs is greater than in the rest of the body (especially for a giraffe). To counteract this greater pressure in the legs, the skin has to be tighter and the counteracting force will be greater. Limitations: do not provide information on other reasons perhaps it may act as a cooling system.
27. 26: By tighter skin, it limits vein area and prevents it from expanding. This causes blood to move from the feet to the head. Assumptions: the giraffe’s head is held upright. Limitations: giraffe’s head has to be up, so that pressure is increased in feet. Assuming giraffe is static full of blood.
28. 27: A higher pressure is needed to counteract the force of gravity and get the blood back to the heart. P = F/A More force is exerted on the skin in the bottom of the leg because force increases as you go down.
29. 28: The skin is tighter because the pressure is so much greater. In order to get blood all the way to the giraffe’s breain, there needs to be significant. If the skin weren’t tight on the giraffe’s legs, the blood in the arteries would escape/leave the arteries. The skin helps keep the blood in.
30. 29: The tighter skin keeps the blood vessels in shape and from ballooning out due to the pressure from above.

Item 2: pg 6, part c)
Based on the relevant physics principles that you identified, develop a model that explains the shape? In other words, explain why the glove is shaped this particular way. A good model should have a diagram, explanation of the diagram and how it helps explain the fact, and a discussion of your assumptions and possible limitations.

1. The liquid exerts a greater pressure at the bottom of its container; most of the liquid is pulled to the bottom due t gravity. The glove provides a restrictive container, but the pressure of water makes it stretch into the shape we see. We

assume the glove has the same elasticity at all parts. A limitation is that there is a limit to the amount of water in the glove; otherwise it will break. (has picture).

2. The greatest force is in the middle, pushing downwards. It becomes less as you move away from the center. The bottom is sphere shaped to distribute weight evenly. The top is cone shaped because it has the least surface area.
3. Normal force of glove grasps water to shape it
4. The glove is fuller at the bottom because gravity forces the water at the bottom of the glove. There is more pressure at the bottom of the glove because gravity is pushing the fluid in that direction.
5. The reason it shapes itself like this is because gravity causes an increase in pressure further down the balloon, expanding the balloon further down due to the balloon's ability to stretch. Limitations include that we assume the elasticity of the balloon is the same as the glove and the amount of water in the glove is similar.
6. The glove has the force of weight and pressure acting on it. The downward force is weight (mg), the horizontal force is pressure and there is tension exerted by the latex material to all cause the tear-drop shape. Limitation: applicability.
7. Shape in zero gravity (has a picture). The water exerts an equal force at all points. // Shape on Earth (has a picture). The weight of the water on the top causes the water at the bottom to push outward.
8. A balloon is a good model for this. Net force on the balloon has to equal zero because there is no movement. Gravity pulls water in the balloon down, pressure increases as depth increases. P = P_0 + rho g h. This makes it stretch out at the bottom of the balloon in order to counteract the increases pressure at the bottom.
9. The force of pressure is larger at the bottom of the glove making it stretch out at the bottom of the glove.
10. It would have almost the same shape as the glass tower's springs from the previous problem. Pressure increases as depth increases. And the elasticity of the glove allows the pressure to change the shape. Limitations: we are neglecting the fingers and assuming the elasticity of the glove is consistent throughout.
11. As depth increases pressure increases. The elasticity of the ziplock bag allow the [increased?] pressure to further expand it. Limitations: we are neglecting the fingers that stick out a bit.
12. P = rho g h. As h increases P increases, causing the glove to take a tear drop shape. Limitations: density is uniform; omit elastic force of the glove.
13. Glove has more pressure at the bottom; stretches the glove to the max
14. The water pressure makes the shape of glove. Also it cause the expansion of elastic force of shape.
15. Elasticity of the glove cause shape deformation; air is less dense than water thus the air bubble moves to the top.
16. At the bottom the liquid exerts a greater amount of pressure than at the top. This causes the object to be wider at the bottom because it is moveable. This is due to the force of gravity pulling down on the liquid and the fact that the shape is not stationary. Simplifications: The glove was drawn as straight lines, not showing curves and the water is motionless

17. The downward force increases the force of water on the glove. The Area of the glove must expand in order to keep pressure relativly constant. Limitations: (1) Pressure does change a bit with this depth, which we don't account for. (2) We don't describe the glove's elasticity at all.
18. Gravity forces the water down while the normal force pushes back up to maintain the shape of the glove. We don't really have a means of accounting for the elasticity of the glove. This is a limitation of our model. Bernoullis principle also tells us that as depth increases the pressure on the ballon should increase. We are assuming in our model that the balloon doesn't break.
19. Most stable state->lowest E. Same spring constant. Homgeneous water.
20. $P = \rho g h$. As height changes pressure increases. This can be seen within the balloon itself and from the external change in height.
21. $P = P_0 + \rho g d$. The farther (downarrow) the balloon the greater the d of the liquid above. This results in a greater P. As this pressure (uparrow), the elastic of the baloon behaves like a Hooke's law spring in that it moves out, move with greater pressure. Assume: uniform density of H_2) and uniform elasticity, on earth with g. Limitation: can't describe the dipping at the bottom of the balloon.
22. As drawn, the pressure at the bottom of the container is greater than the pressure at the top – this is due to the force of gravity on the water and the increased depth.
23. Refer back to part b.) for explanation. Assumptions: glove is uniformly elastic, H_2O is uniform temp. [part b.) The force of gravity acting on the water in the glove "pulls" the water downwards. Since the pressure is greater towards the bottom of the glove, the water exerts more force on the glove. The force exerted causes the glove to expand more at the bottom than at the top due to the increased pressure (Fluids, pressure, gravity, elasticity).]
24. [refer to part b) for explanation] Assumptions: glove is uniformally elastic; uniform temperature. [part b): Force due to gravity acting on the water in the glove causes a greater presure as you go down the tear drop shape. Therefore the water pushes out on the glove most at the bottom and since the glove is elastic, it expands at the blottom, giving the tear drop shape. Gravity, fluids, pressure, elasticity -> principles.]
25. Assume: 1) glove has a constant stretching constant. $P = \rho g d$. As the depth increases, the pressure exerted on the glove by the water increases. If the glove was not made of uniform material, the shape would be different.
26. Gravity causes the water to go to the bottom of the glove and builds a big pressure on the bottom. The water pushes outward due to the large pressure but the glove's stretchiness counteracts it giving it the shape that it has. Limitations: the maximum volume and viscosity of the liquid. The stretchiness of the balloon...
27. Assumptions: The liquid is incompressible so density doesn't change. Assume blood flow is static. Limitations: elasticity of the glove. H_2O's pressure greatest near the bottom of glove so glove is most expanded there.
28. Water wants to occupy lowest position possible due to gravity. Assumptions: elasticity is constant throughout glove. Limitations: finger knots; represented as perfect teardrop.
29. The pressure (indicated by the length of the lines) increases w/depth stretching the sides of the glove. The exterior forces (air pressure) are generally the same.

30. The pressure is greater at the bottom, pressing out further than at the top.

Item 3: pg 12, part g)
Compare the adequacy and limitations of the model by comparing your measured difference in pressure to the difference in pressure predicted by your model. Are the differences completely explained by error?

1. Since we made assumptions and there are limitations to our model, we expect there to be difference between the predicted and actual differences. They aren't completely explained by our errors, but they are relatively close.
2. The measure and predicted values are close. Errors may explain the differences.
3. Error (experimental and systematic error occurs) doesn't explain everything. Limitations: assumed repeat of exact placement of cuff / tightness of cuff / ignorance of flux in BP (within body).
4. The differences are completely explained to error as there are huge differences.
5. The measured differences in pressure were off further from the region of error than our predicted delta-P. This is due to the limitations of our model which include the area difference in the measured spot as well as the density and elasticity differences in the areas being measured. Also, blood pressure is not consistent in any body's body, there are always differences throughout the body.
6. The measured difference is somewhat adequate in comparison to the predicted difference. These difference aren't completely explained by error due to internal changes/fluctuations in the body.
7. It did vary, but not as much as we thought it would.
8. The differences are somewhat close to the systolic pressure (between the predicted delta-P and the actual delta-P). However, 7 are more than 10mmHg off (systematically), so error cannot be the only factor.
9. The difference are close to the systolic pressure.
10. The model is fairly accurate, the predicted delta-P was pretty close to the measure delta-P but it still was not within the error.
11. Fairly accurate, however its not completely within error but we just got an avg. error (from Matt ☺).
12. No, theres's too big of a difference between numbers that can't be explained by error.
13. Yes, the difference for each trial is approx. the same showing error
14. Yes. 63/38 and height 1.2m; 9/2 and height 0.11m; because of the height differences, the applying g can be affect the pressure in the model.
15. (table of data included) The difference of measured and predicted ones are greater when standing since the distance of arm and leg is greater which results in greater value of experimental error.
16. The differences found are small between predictions and what was found. The differences cannot completely be explained by error because the prediction is off. Some limitations are that the exact \rho of blood is not known.
17. The differences are not explained by error and so our model is inadequate.
18. The differences are not explained by error. This states that our model is not adequate.

19. They are somewhat similar (i.e. trends of decrease/increase in B.P.) but not accurate enough to fall in the range of error (This may be due to the fact that the fadisu of blood vessels not being consistent throughout the body (total radius of capillaries> total radius of arteries). The fact that body is not only composed of blood (not homogenous) would also alter the measurement.
20. Our measured and predicted values were very close so our limitations were minor. yes, the differences are explained by error.
21. Limitations: measurements not taken at the same time so not sure if activity (which affects bp) was different. Also, by in dominant arm has been show to be larger. The differences aren't completely explained by error -> they're a little to large for that.
22. The differences in systolic pressure were not always well predicted by our model equation, P = P_0 + \rho g d. Both times the left side was measured, the differences were fairly close to predicted, but when the right side was measure,d the differences were considerably larger than predicted. It is clear that there are other factors besides error that are affecting the results (the differences vary by mroe than +/- 2 mmHg).
23. The predicted and measured pressures vary greatly and aren't explained solely by error. The limitations explained below help explain the poor results.
24. The predicted and measured values vary and cannot completely be explained by error, but can maybe be explained by limitations listed in (h) – values standing up are predicted better than values lying down.
25. The differences are not completely explained by error. Our model did not predict the outcomes very accurately. The measurements on the left side were predicted accurately but the right side was not accurate and could not be explained by error.
26. The difference is mostly seen when blood pressure is measured when standing as opposed to lying down. This could be due to the fact that gravity, height and mas may affect blood pressure when standing in the arm and leg where lying down these factors do not affect it as much and thus the difference in lying down is lesser.
27. No our differences cannot be totally dependent on error: we did not take in account of blood flow in the body when standing up or lying down.
28. For kristin, differences are negligable. For nate, cuff application was difficult and the machine was having difficulties getting a reading.
29. Our model predicted the differences pretty accurately for standing but not for laying. The differences probably are as the equipment kept malfunctioning.
30. The differences when standing and laying are different by a number greater than the error (2), but when sitting (the normal way to take blood pressure) the difference found and predicted are within error (2). Sitting: measured 51, predicted 51.9.

Item 4: pg 13, Final Model

Write below the final model you have developed throughout the lab to explain this fact. Remember to include: a picture, a written description of how the picture helps explain the fact, identify the relevant physics principles, assumptions you have

made, and include any evidence you have collected that lead you to think your model is correct.

1. We still believe our original model is correct. We found the BP in the legs to be higher than BP in the arms (we used another model to predict the difference in BP in different areas of the body. We used the eq. P_leg – P_arm where P = P_0 + rho g h. Based on our predictions/ actual calculations, we know that there is a difference in BD.) This finding allows our model to work. The skin needs to be tight to equalize the increase of pressure. The same assumptions hold from before. (have picture)
2. The force of the skin inward must be greater at the lower part of the giraffe. Due to this the skin must be tighter. Relevant: gravity, pressure, spring constant. Assumptions: blood not flowing. Evidence: measured results from my blood pressure and the difference pressure + the caused by height. (have picture)
3. The lower you are relative to the heart, the higher the BP is to get the blood back to the heart. The tight skin adds this pressure. Relevant principles: pressure, force of gravity/ (have picture)
4. The skin of giraffe is tighter in their legs than their body because there is more pressure in the legs is greater than the pressure in their upper body. In measuring the delta_P in giraffes, we estimated a chance of 231.6mmHg probably due to gravity This change increases is proportional to height. Relevant physics principles: gravity, pressure. (have picture)
5. The blood pressure in the giraffe is related to the height in which the measurement is taken. When taken at h = 0, and h = y. At h = y the pressure will be much greater than at h = 0 because pressure is related to height. The lower on the animal, the higher the pressure should be. The change in the pressure (delta P) is equal to the density times the change in height times gravity. Knowing this the giraffes skin must be tighter at the bottom to prevent what happened to the water balloon earlier in lab, and not allow the veins walls of the legs to bulge. The area of the leg is also less meaning the stress on the leg will be higher, this is another reason the skin must be extra tight. (have picture)
6. V_1*A_1 = V_2*A_2 or V*A = constant / P = F / A / as pressure by the skin increases, the area of the blood vessel deceases (constricts) and then the velocity increases./ Assumptions: a giraffe's circulatory system can be modeled by a human. Evidence: when measured, an increase of pressure difference led to an increase of height difference. Explanation of the picture: In this picture, the arrows in the blood vessel represent the velocity of the blood, which increases with pressure (lowering area increases velocity) exerted by the skin. (have picture)
7. Pressure increases down the system. Therefore, the skin must be tight in order to keep the arteries from swelling. / Pressure varies directly with depth. / Tension is needed to keep the system from swelling. / Trials done on ourselves have shown that pressure actually is higher in the legs. (have picture)
8. Giraffe is a box—as depth of giraffe's body increase, the blood pressure in the giraffe's body increases. As pressure increases, a force is headed pushing back—thicker skin—to retain equilibrium. Assume that a box is like a giraffe: gravity is

constant; blood pressure is directly related to depth of body. / Balloon with water in it expands at bottom when give a chance to stretch in order to offset force of gravity. / Thicker skin would allow equilibrium—offset gravity and not cause swelling or poor circulation. / My blood pressure is higher in my leg than my arm, and the difference increase when stand up. (have picture).

9. The blood pressure is higher at the lower end of the giraffe and so the skin is tightened more at the legs. The blood pressure is lower at the upper part of the giraffe's body. The relevant physics principles that explain this fact is pascal's principle or hydrostatic pressure of depth, which shows that pressure increases with depth. The data clearly shows that this principle is true by us taking our blood pressure. Our blood pressure in our legs were higher than the blood pressure in our arms. (have picture).
10. Delta-P = rho g h. The tight skin keeps the blood from expanding the veins near the legs so it wouldn't look like the glove. The principles involved are that pressure increases as depth increases and the elasticity of the veins and the density of blood and air. Assumptions: perfect shape, uniform skin / elasticity. Evidence: blood pressure is greater in human legs; the veins don't look like the glove; based on human comparison—mammals should be similar. (have picture)
11. Since skin is elastic it needs to be tight otherwise the blood would pool at the bottom like the bay? Principles: elasticity, pressure, density. Assumptions: perfect shape. Evidence: when measured BP on BP machine our leg BP was higher than our arms and higher than if we were sitting therefore if the skin wasn't tighter it would look like the balloon. (have picture)
12. Pressure increases as depth increases, therefore there is a greater pressure in the legs. Delta_P_heart = .2 (P_leg) = 152mmHg is the delta-P from heart to leg. A 10m increase in depth increases pressure by 760mmHg is a 2m difference should = deltaP = 152mmHg; about twice that of human. Limitations; assumes perfect cyrindrical vessels; neglects elasticity of blood vessels. (have picture)
13. As the height in the model increase, the pressure increases. Evidence is the blood pressure in a humans arm and leg, as well as a giraffe's skin tigher in its legs, and the water balloon
14. P_leg > P_arm / measure the pressure between leg and arm. The assumption is the Pleg will be grater than P arm. Because the pressure will be bigger in the bottom of the body.
15. Pleg > Pa / In order to pump blood from heart to throughout all the vins in body pressure is needed. Since leg is further away from heart than arm is. It acquires greater pressure. Thus, normally, skin at lower body is tighter due to higher pressure.
16. At the top of the model there is a smaller amount of liquid pressure than at the bottome. This is due to the greater depth at the bottom. To support this greater pressure the skin must be tighter. If it was not, the skin at the bottom would strecth allowing blood to collect in the feet/lower leg of the giraffe. P = P_0 + \rho g d. Also, (upper arrow) P => (down arrow) A => (upper arrow) v, v_1 A_1 = v_2 A_2 and this helps maintain the giraffe's blood flow. In this the assumptions are that there is no friction, the giraffe has no ciculartory problems

the giraffe is a tube the \rho_{blood} is constant. Our arm/leg blood pressures indicate that this model is correct because the leg had a higher blood pressure.

17. As depth increases, pressure increases. The change in pressure between the upper body and legs of a giraffe is related to the distance between the two. F= P/A, (upper arrow) P = F (upper arrow) A -> P \propto Area. Pressure is proportional to area. Increases pressure due to increased depth results in increased area and thus tighter skin. Assumptions: Heart rate is irrelevant to pressure. The giraffe is treated like a latex glove. Limitations: Model can't account for body type differences. Evidence: The results of our experiment measuring arm vs leg blood pressure comparing standing and lying conditions shows the general trend that \Delta p \propto height difference.
18. Pooling of blood as we would expect with gravity forcing the blood down is counteracted by the giraffe's tighter skin around it's legs. The picture on the left shows what would happen if the skin didn't counteract the pooling of blood. Bernoulis law states that as we move down a cylinder the pressure of the liquid on the sides of the container increases. Therefore, the skin must increase it's tightness to counteract this fact and prevent blood from accumulating. The assumption that we have made is that the giraffe is standing. And are limited by the fact that the giraffes blood is not in a cylinder.
19. Systolic and diastolic B.P. will be measureable in the 2 areas (marked on figure, neck and ankle of giraffe). \Delta p will be calculated w error. By measuring the \Delta h we will also predict the \Delta p by given \rho values and the equation p = \rho g\Delta h. The \Delta p_{measured} and \Delta p_{predicted} will be compared to see the change in B.P. By doing this, we are assuming the radius of blood vessels are similar enough to ignore the difference and that the measurment is only measuring blood (not nother liquid like water, ISF...). The giraffe should be calm and not under any stress.
20. P = \rho gh (relevant physics principles). The pressure increases as you move down because it is reliant on height. The height difference is that between the heart and the legs the legs are much lower than the heart therefore the pressure is greater. It is the same as in humans, which we proved throught the measurements on previous pages.
21. In the lower leg, the vessels have a higher bp than those of the upper leg b/c the weight of the blood in the upper vessel of the leg causes the bp in the lower leg vessel to be higher (by archimedies princ). The vessel moves a certain dist due to this pressure, it moves farther when the pressure is higher b/c it exerts a greater force on the vessel. Applying Hooke's law, F= - k \Delta x. Assuming that the "spring constant" (not really a spring constant, but gives you a general idea of the concept...) is the same in both the upper and lower part of the vessel, the higher P in the lower leg causes a higher F on the lower part of the vessel. This higher F yields a greater \Delta x (x_f-x_e). This means that the skin in the lower leg will be more taught than that of the upper part of the body.
22. Model a vein as a balloon filled with water: without pressure being exerted on the outside of the balloon, all of the water pools at the bottom to form a teardrop shape. However, if pressure is exerted in increasing amounts to the outside of the balloon as you move down the balloon, the diagram will look more like this: In

terms of the giraffe, the tight skin of the giraffe exerts this extra pressure on the veins in the legs, preventing the natural pooling that would occur due to gravity and increasing hydrostatic pressure, as well as the elasticity of the venous material. That is, the pressure within the vein increases as you move down the vein, but the outside pressure also incrases discouraging the formation of the teardrop shape and facilitating blood flow. We have found that blood pressure is certainly higher in the legs, based upon the blood pressures measured from our human model. A tall giraffe would thus need quite tight skin to counteract the very high blood pressure in the bottom of the legs.

23. Description: The model diagram at left is of the giraffe (simplified as a column). As you move down the column (upper arrow d), the pressure increases. This is indicated by the larger arrows. The principles of fluids, pressure, and gravity are used to explain this change in pressure and stretch on leg skin. Assumptions/Limitations: Static blood; uniform body shape; no internal mechanisms/forces; p only dependent on diff. of height, not volume or shape.
24. Description: model giraffe as a column and longer arrows represent greater pressure. Largest pressure at greatest distance from heart. Larger pressure of blood pushing against surrounding tissue causes skin to feel tightest in the legs. Physics principles: fluid, gravity, pressure, used to explain change in pressure and stretch in skin. Assumptions/Limitations: blood not moving, uniform body shape, no external forces, pressure only dependent on distance from heart. [looks like same group as student 22]
25. The lower leg of a giraffe is located a distance “h” from its heart. Using hydrostatic pressure, $\Delta p = \rho_{blood} g h$, you can determine the pressure exerted on the vessel by the blood. If left alone, the higher pressure in the lower leg would cause the blood to pool. However, the tighter skin of the legs pushes back on the vessels keeping the blood from pooling. Assumptions: 1) heart pumps with constant pressure. 2) Vessel has equal elasticity throughout “h”.
26. This picture helps explain the fact that the skin of giraffes is tighter in their legs than the upper part of their body because blood pressure increases as depth increases (so as you go towards your feet and away from the heart). Therefore the pressure in the legs are greater than in the body and to account for this their is a counteracting force from the skin causing the tightening of the skin in the legs. Assumptions made is that all giraffes are in healthy conditions and exactly the same. Some evidence gathered is from blood pressure experiment of our arm and legs. The blood pressure in the leg was greater than in the arms.
27. The arrows show the pressure in the vein. The vein is limited in area, and therefore limited in pressure. The blood is able to move upwards, and does not collect at bottom. Assumptions: blood flow is static. Evidence: A liquid will conform to shape and pressure will cause the container of the liquid to expand (if it can expand), as shown in glove example.
28. $P = P_0 + \rho g y$. The pressure of the blood increases as depth increases, $P = F/A$, increased force causes an increase in pressure. The pressure of the skin on the blood must also interact to counteract this. Assumptions: body is a tube; skin effects blood (not other things – bones and such); veins are all vertical. Kristin’s pressures matched well with the predicted value.

29. \Delta p = 0.91 \Delta h. As \Delta height from the reference pt increases the \Delta pressure also increases. As height itself increases pressure decreases. We are assuming that the relationship is linear and the relationship we found for humans is about the same as that for giraffes. We've based all this on the data we collected from ourselves.
30. The pressure decreases as the height (from the ground) increases. The higher parts of the giraffe have lower pressure. The skin is tighter at lower points because it has to counteract the pressure of the blood. This is bernoulli's equation put into use. Assumptions: our human bodies and blood vessels/pressure relate directly to that of a giraffe. Evidence: human measurements of sitting persons [data table].

The left overs from page 7 f)

1. We believe our model from page 3 is correct. The skin equalizes the pressure and restricts the bulging of the vein that would cause the blood to pool. It is comparable to our model of the water-filled glove. See pg. 3 the same assumptions/limitations apply.
2. Strong, tight legs hold in the blood and internal parts of the leg. Assuming no blood is moving. (have picture)
3. Tight skin prevents pooling that can cause pain and clotting; doesn't allow veins to stretch and hold excess blood pools. (have minor picture).
4. The giraffe skin is tighter in their legs because the increase in pressure in the legs help prevent all the blood from settling at the bottom of the giraffe especially since it is tall. (have picture)
5. This diagram shows that the further you go down the more pressure you are going to need pushing in on the object. The tight skin is a giraffe is similar to the large pressure arrows on fig. 1. The further you move down the giraffe, the tighter the skin needs to be to counter the pressure exerted outward. Limitations: a giraffe does not have uniform internal composition like these water balloons do. The giraffe's skin is also not as elastic as the rubber water balloons. (have picture)
6. Once again the skin exerts a force on the blood vessels, constricting them so that surface area decreases and velocity increases allowing the blood to flow in the leg (opposing gravity). Limitations: this is only the leg of the giraffe with 1) blood vessels and we assume that the arrow represent pressure generated by the skin and other surrounding tissues/????? (have picture)
7. With pressure exerted by the skin the system maintains pressure throughout; If fluid is allowed to build up in the leg, pressure is lost at the top of the system. (have picture).
8. The giraffe's leg can be seen as a box. Pressure increases as depth increases. Pascal's principle P = P_0 + rho g h helps calculate this. A giraffe's leg has depth increases as the pressure increase, just as the box. Assumption: gravity is present (giraff is not floating in space) Limitations: giraffe's leg is not a box. (have picture)
9. The giraffe experiences more pressure at the bottom of its body than the top of its body. The blood pressure in the legs is higher which is causing the skin in its legs

to be tighter, while the up part of the body has a lower blood pressure. (have picture)

10. The skin is tigher in the lower legs because the high pressure due to depth wants to make the veins expand because of their elasticity. The tight skin kkeeps the veins from expanding and the blood from pooling in the legs. If the blood doesn't pool than the velocity doesn't decrease and then the blood pressure doesn't get really hight. Limitations: the giraffe is represented as a box/ we are assuming the skin is uniform/ assuming veins have same elasticity (have picture)
11. Because skin is elastic it must be tighter in the legs to presevent pooling of theblood (as seen in te balloon). Explanations as depth increase pressure increases but using an unelastic tube prevents bottom from expanding. Limitations: assuming giraffe is tube and elasticity is same at all areas.
12. Exactly the same as (b) on page 3 (have picture)
13. Skin is stretched to its max because of the pressure in the veins (have picture)
14. blank
15. more blood veins in lower leg need more pressure. Should measure blood pressure when lay down so the blood pressure is consistence over the body.