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07 Intern Assignment Biological Adaptations

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Sara Edquist, Intern Assignments

Pre-class assignment

Based on what you know about heat, chemical properties, and physiology, what do you think are some of the consequences or effects of heat (or the lack thereof) for living organisms?

Post-class assignment

1. For the animal adaptation you investigated, does it aid in temperature regulation in cold or warm climate, or both? Could this adaptation serve as an alternative function?
2. Please describe two other animal adaptations (behavioral or physiological) to regulate body temperature. Explain how this adaptation works (include if heat transfer occurs by conduction, convection, radiation, and/or evaporative cooling).
3. Do you have any questions from Thursday's class (about mechanisms, other animals, etc.)? If so, please include and I will try to respond to them.

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Reflection - Thursday, April 9th

1) The animal that our group investigated was the fiddler crab. The specific adaptation that we looked at was the fiddler crab's ability to change the color of their carapace. The carapace is the exoskeleton, or the shell of the crab. What we studied was how the carapace color of the fiddler crab responds to changes in temperature. The color of the crab's shell changes in order to regulate its internal body temperature. These crabs inhibit sandy and muddy banks of estuary and coastal shorelines, so it can be assumed that this adaptation aids in temperature regulation in a warmer climate. Researchers have observed that in a warmer environment, the carapace color of the crab's shell will be a lighter color, and when the environment becomes cooler, the carapace color of the crab's shell will be darker. Based on this observation, one can infer that the heat transfer that is taking place is radiation. It makes sense that, when the temperature is cooler and the crab needs to heat itself, its shell will become darker. We know that darker colors absorb light energy better than lighter colors, and this light energy becomes heat energy, allowing it to heat the fiddler crab. This is similar to how a dark shirt will absorb more light energy than a light colored shirt, making a person warmer in a dark colored shirt.

   When the temperature of the environment around the fiddler crab is warmer, the carapace color of its shell will become lighter. A lighter colored shell will reflect more light energy than it absorbs, which means that the crab won't absorb as much heat energy, and it will have a cooler internal temperature. Because they live in a warmer environment, fiddler crabs will also burrow underground to keep themselves cool. Our group also discussed an alternate function that this adaptation might serve. One thing that color change is often associated with is camouflage. Changing colors as a form of camouflage is an adaptation that is present in several species of lizards. Fiddler crabs are smaller creatures, making them susceptible to larger predators, so our group speculated as to whether their ability to change shell color could offer them some sort of protection from predators.

2) Another animal adaptation that our group discussed as a way of regulating internal body temperature is the panting of dogs. Panting is related to the method of cooling used by many mammals, birds, and some reptiles. This method of cooling is accomplished by the evaporation of water from body surfaces, also known as evaporative cooling. The reason that dogs pant is because they have insulating fur, and this fur prevents them from sweating off of their bodies like a human would experience. When dogs pant, and stick their tongues out, the water evaporates off their tongue. When the saliva on the dog's tongue evaporates, so does the heat energy that was there. The level of heat energy will drop as the water evaporates (because water molecules have heat energy), and the internal temperature of the dog will decrease, which allows it to regulate its body temperature. Just like with the sweat of humans, dogs panting expends large amounts of water, and if the dog wants to continue to maintain effective heat regulation, it must replace the water lost. The heat transfer that is taking place when this happens is radiation. It is the heat coming from the sun that causes the saliva on the dogs tongue, or the sweat on a humans body, to evaporate and allows for evaporative cooling.

   One other animal adaptation that our group discussed was how lizards and other reptiles regulate their body temperatures by their behavior. Lizards and reptiles are cold-blooded creatures, or ectotherms. An ectotherm is an animal that is dependent on external

sources of heat. Animals that are cold-blooded do not have a constant internal temperature. The body temperature of an ectotherm changes as the temperature of the surrounding environment changes. Lizards have low metabolic rates and are poor insulators of heat, which means they can't generate enough heat to maintain a constant body temperature and they don't sustain heat well. To regulate their internal body temperature, lizards and reptiles will lay out on hot surfaces in the sun. There are two types of heat transfer that take place in this scenario. To warm the surface that the lizards lay on, the surface will absorb heat energy from the sun. This is an example of heat transfer by radiation. The lizard is warmed through heat conduction. The heat is being directly transferred from the warm surface into the lizard to warm it. If the lizard wants to cool down, it will lay down on a cooler surface and heat will transfer from the lizard to the cooler surface.

3) Questions**: How do fish regulate their temperatures?**
Why can some animals have a large range of internal body temperatures, but other animals get really sick when their internal body temperature fluctuates very little?
I am still a little confused as to what a fever is, what exactly is a fever?

Answer to Pre-Class Assignment Question

Heat, or lack thereof, in living organisms has many effects, and can have several consequences if not correctly regulated. Just the act of sustaining life itself relies on an organism's ability to maintain its core temperature within the range of tolerance of a body's enzymes. Heat in a living organism is generated by metabolic reactions. There are two different types of organisms, ectotherms and endotherms, which protect their core temperatures in different ways. The internal temperature of ectotherms reacts to the environment they are in, and they get their heat from external sources. Endotherms are mammals and birds that have high metabolic rates, and have a constant internal temperature that is self-regulating. Living organisms are always trying to strike a balance between gaining enough heat and losing enough heat to maintain the proper core temperature. Heat in a living organism can be regulated through conduction, convection, radiation, as well as evaporative cooling. These exchanges in heat all take place at body surfaces. There are several consequences that can result when a body gains or loses too much heat. When body temperature is elevated above what it is supposed to be at, the result can be a fever or hyperthermia. Hyperthermia is when the body produces or absorbs more heat than it lets out. The opposite of hyperthermia is hypothermia, and that is when the core body temperature drops below the level that it should be at. Our bodies have ways of counteracting heat stresses and cold stresses, and all living organisms have adaptations that allow them to maintain their proper core temperatures. Going to high or too low below these core temperatures can cause a living organism to get seriously sick and it can even result in death.

C37
April 11, 2015
CHEM444 Fire and Ice
Reflective Writing Assignment

1. The animal adaptation that my group investigated was how polar fishes avoid freezing. We determined that the fishes were able to avoid freezing because of the high concentration of protein in their blood, which reduced the freezing point of the blood. The additional protein in the blood adds more molecules and in turn makes it more difficult for a phase change to occur, preventing the liquid blood from freezing into a solid. This adaptation aids in temperature regulation for cold climates. Polar fishes live in the ocean where the water temperature is often close to freezing or even below. They are able to survive in these extremely cold conditions because of the adaptation of a higher concentration of protein in their blood. This adaptation decreases the freezing rate of the blood and allows for temperature regulation even in the freezing climate. An alternative function of this adaptation aside from depressing the freezing point of the fish's blood and body fluids is that it serves as antifreeze. The fish antifreeze proteins could alternatively be used for commercial applications such as to prevent freezing in foods. The proteins are effective in keeping the fish's blood from freezing and therefore keeping the fish warm as the blood continues flowing through their body. Heat is transferred in the fish through conduction from the blood into the surrounding tissues and also through convection as heat flows through the blood. If the proteins were to be isolated from the fish, I believe they would also be effective in serving an alternative function of preventing freezing in foods.

2.
    a. Another animal adaptation to regulate body temperature is sweating. Sweating is a physiological adaptation that humans and some other mammals posses as a response to heat stress. These animals have sweat glands that release water and solutes through their pores and onto the surface of their skin. Sweating works to regulate body temperature because there is a transfer of heat by evaporative cooling. Evaporative heat loss does not occur just from sweat dripping from the skin, but rather when the water in the sweat evaporates. If the water content in the air is high, such as on a very humid day, then the rate of evaporation will be slowed down and not as much heat will be lost through sweating. Sweating works to cool down an animal's body because energy must be absorbed in order for evaporation to occur. Heat energy is removed from the animal's body as the water in the sweat evaporates, therefore cooling the animal.
    b. Insulating fur is another physiological animal adaptation to regulate body temperature. This adaptation works to reduce heat transfer and conserve an animals' body heat in a cold climate. For example, arctic animals like the arctic fox have much thicker fur than tropical animals.

This thick fur works to insulate the fox's body so that it can comfortably withstand the cold climate without increasing its resting rate of metabolism. The insulating fur acts to reduce thermal conduction by providing the fox with a region of insulation. A layer of air can be trapped in this region and heated by the temperature of the fox's body. This adaptation also keeps the fox warm because it reflects thermal radiation. The adaptation of insulating fur reduces the rate of heat transfer through both conduction and radiation and therefore keeps the fox warm.

3. No questions from class on Thursday

Response to pre-class assignment:

Depending on the living organism, there are different consequences of heat that can occur. All organisms must adapt to heat, or the lack of heat, in their environment but they may do this in different ways. Animals can develop physiological adaptations like thick insulating fur in arctic animals, and also behavioral adaptations such as remaining in a burrow like the Mohave ground squirrel does to regulate their body temperature. The different behavioral and physiological adjustments to environmental temperature that organisms have developed allow them to protect their body's core temperature. We have learned that heat can be transferred in three ways; conduction, convection, and radiation. Conduction, convection, and radiation can cause both heat loss and heat gain to the organism's body, which is why organisms have adapted to control the transfer of heat in ways that best benefit them in their environment.

H22

CHEM 444A

Professor Bauer

14 April 2015

Reflection Assignment

1. My group investigated temperature regulation in aggregations of snails. For these animals the adaptation of aggregation helps to keep the snails warm in cold climates. The snails aggregate to help increase their overall body temperatures through radiation and convection. This aggregation adaptation could most definitely have alternative functions such as protection from predators and possibly reproduction. Aggregation of snails could aid in protection from predators not in the sense that they can help each other "fight off" predators, but for the reason that in a large group each snail's risk of being consumed by a predator is much lower than if they were alone or in a substantially smaller group. Also since snails have very limited mobility capabilities living within aggregations increases the chance of reproduction preventing population decline within the species. Aggregation allows the snails to easily find mates to ensure reproduction occurs preventing population decline or extinction. Therefore aggregation is beneficial in multiple ways other than providing warmth. Aggregation can also provide some protection from the elements, such as from wind.

2. Reptiles, such as snakes, acquire heat my bathing in the sun. Reptiles must attain heat from the sun or warm objects that are heated by the sun in order to attain heat and

regulate their body temperature. This type of behavioral adaption involves radiation since the reptiles are absorbing heat through UV rays from the sun and also through conduction since they can raise their body temperature by laying on warm objects such as rocks. This adaptation works since the reptiles, like all other living organisms need energy for many things. The absorption of heat from the sun allows the reptiles to attain and maintain an appropriate body temperature. Heat is transferred from the sun to the reptile by radiation and from a warm object to the reptile by conduction. Another behavioral adaptation to regulate body temperature is pigs rolling in the mud. Unlike humans, who regulate body temperature when it's hot through evaporative cooling (sweating), pigs don't sweat. Therefore when it is hot they must do something to prevent an "over-absorption" of heat. By rolling in the mud, heat can transfer from the pig to the cold mud by conduction. This allows heat to transfer away from the pig lowering their body temperature. The mud also prevents heat from transferring to the pig by radiation since it develops a "protective coating". This behavioral adaptation helps prevent pig's body temperatures from rising out of control, and also allows their physiological processes to function properly. Overall temperature regulation works in reptiles by transferring heat from the sun to the reptile to raise their body temperature through radiation. Reptile's body temperatures can also be raised by conduction when they are in contact with warm object. The heat goes from the object to the reptile. These processes help to warm the blood which is then circulated throughout the body raising the overall body temperature. Reptiles can lower their body temperatures by going beneath the surface of the ground or resting in the shade. They can then release heat by conduction. The heat transfers from their bodies to their cool environment by conduction. Therefore this adaptation helps reptiles both cool and warm

their bodies. Pigs can regulate body temperature by rolling in mud since the heat transfers from their hot bodies to the cool mud by conduction and also covers them preventing further heat transfer by radiation. Pigs can cool off by performing these activities since the mud will absorb the heat from the pig. As a result the pig's body temperature will decrease. The mud also contains water which will evaporate drawing heat away from the pig as well. Therefore the pig indirectly cools from evaporative cooling as well. As the water in the mud changes from a liquid to a gas it draws energy (heat) to complete the phase change. This also helps to lower the pig's body temperature.

3. Why do some of the snails not aggregate like the rest? When the snails move do they hold the aggregated shape constant or do they reposition once they've reached their destination? Are there any disadvantages or "down falls" to aggregating?

4. Pre-class assignment: 4/9/15

   Heat or the lack of heat has many consequences for animals in the wild. Some animals must retain heat to stay warm in cold climates while others must stay cool in hot climates. Animals have many different ways of controlling the transfer of heat so that they can survive in their environment. Some of the biggest consequences of heat would be either hypothermia or hyperthermia. Also, the ability for animals to retain heat in cold climates allows their bodies and cellular activities to function properly. The opposite holds true as well. Animals must be able to prevent an over-absorption of heat to prevent heat stroke or heat exhaustion. Heat or the lack of heat is crucial to animals in the environment. Heat can present several consequences if animals aren't able to control or regulate their body

temperatures. In order for any living thing to remain healthy with its systems functioning properly it must be able to maintain a normal body temperature. Another major effect of heat for every animal is energy, as most heat that animals attain comes directly from the sun. Therefore animals must attain energy while regulating their body temperature at a healthy level.

K29
Reflective Assignment
Animal Adaptation
April 14, 2015

I investigated snail aggregation during Thursday's class. My group and I concluded that snails aggregate in order to stay warm. The snails radiate heat to the surrounding air and the other snails can absorb the heat through convection. The snails in the inner center of the aggregation have the highest body temperature. The snails in each ring after the inner center decrease in body temperature. The snails in the inner center have a higher body temperature because they are positioned closer together and are protected by the other surrounding rings. The aggregation protects the snails from changes in the environment, like the wind. Heat is easily carried off by the wind, but the aggregation prevents wind from entering the inner circles of the aggregation. The snails in the inner center can radiate heat into the small air pockets between them and absorb the heat through convection before the wind carries the heat away from the snails. The snails in the outer edge have the lowest body temperatures in the aggregation because they are not protected from the natural environment.

Snail aggregation aids in temperature regulation in cold or warm climates. The snails use their own internal heat to radiate heat to each other and throughout the aggregation so a cold or warm climate is not specifically needed. The data from the worksheet shows that the inner center snails have higher body temperatures, which shows that the purpose of the aggregation is to increase temperature. Therefore, aggregation is probably more purposeful in a colder climate, but would still increase the internal body temperatures of aggregating snails in a warm climate. Aggregation could also serve as an alternate function. The aggregation could offer some protection from small predators. Small predators might not be able to reach the snails in the inner rings of the aggregation due to how tightly the snails are packed together.

By means of evaporative cooling elephants can stay cool. Evaporative cooling occurs when water on a surface evaporates, which releases excess heat into the air and therefore, decreases the overall temperature. Elephants spray water all over their bodies in order to make use of evaporative cooling. As the water evaporates it cools down the elephant. Another animal adaption that regulates body temperature is the huddling of penguins. Similar to a snail aggregation penguins huddle close together for warmth. However, penguins can transfer heat through conduction and convection. The penguins actually touch bodies; therefore the penguins can directly transfer heat from one and other. Heat that is not directly transferred is released into the air and can be absorbed by other penguins through convection. The penguin huddle also protects the innermost penguins from the environment, like the snail aggregation. Penguins in the innermost circle have higher body temperatures because they are protected from the wind. Penguins on the outside of the huddle will have colder body temperatures because they are exposed to the environment and have less opportunity to conduct heat between themselves and other penguins.

I never received a definitive answer of how temperature regulation works in a snail aggregation. I think it is plausible that the snails radiate heat and can take up heat through convection, but is that what is really happening?

Consequences of heat for animals: Animals and humans are susceptible to changes in body temperature, due to their environment. As temperatures rise or drop animal's body temperatures change through radiation, conduction, and convection. Through these three mechanisms an

animal can quickly gain or lose heat, which may put the animal in danger especially in extreme cases. Due to how easily changes in temperature in the environment can affect the normal functioning of an animal, animals must learn to adapt to their environments and develop mechanisms to protect their internal core temperature.

L18

Based on what you know about heat, chemical properties, and physiology, what do you think are some of the consequences or effects of heat (or the lack thereof) for living organisms? Use your knowledge from class discussions and the reading.

Obviously maintaining homeostasis is an important function of any organism, which requires a constant internal temperature. If heat was introduced to this organism, the body must respond accordingly to keep this temperature constant. Endotherms respond to lack of heat by increasing metabolic rates, which, in turn, produces heat to warm the body, and respond to too much heat by sweating to lose heat from evaporative cooling and lowering metabolic rates. Ectotherms do not regulate their temperature internally, instead they change their behavior to regulate temperature. If they are introduced to a lack of heat they try to find a warm spot, and if they are too hot, they try to find a cold spot. These concepts all relate to concepts we talked about in class with heat transfer like conduction, convection, and radiation. The organisms use these properties to exchange heat with their environment either to lower or raise their body temperature. There are both immediate consequences and evolutionary consequences to extreme heat/cold which allow animals to survive in these conditions. However all of this goes back to the fact that the body cannot perform the necessary functions outside a given temperature. Enzymes become denatured at temperatures too high, losing their ability to function, and temperatures too cold make reactions occur too slowly.

L18

1. The animal adaptation that we looked at (Fiddler Crab carapace color change) aids in both warm and cold climates, because when it is too cold it turns darker to absorb more light, and when it is too hot it turns lighter to reflect more light. The light being absorbed excites the molecules creating heat, so it helps both to cool down and heat up. It could also be used as camouflage although I don't believe the color change is voluntary, but this was not indicated. If it is voluntary, the crab could change color to blend in better.
2. One other animal adaptation that elephants use to regulate body temperature is to throw mud on themselves. In doing this, the mud cools them off through conduction because it is likely cooler than they are. Also, the water in the mud evaporates which in turn cools the mud, which then cools the elephant again through conduction and indirectly through evaporative cooling. Another animal adaptation that we still use although it does not help us much anymore is goose bumps. Back when we were really hairy beings, when we were cold, we would get goose bumps, which made our hairs stand up and essentially trap more air between our hairs and our skin. As we know air is a good insulator, so trapping the air would keep us from losing heat quickly, keeping us warm. This prevents convection directly with the skin and slows conduction.
3. I don't have any questions other than the ones that our group wrote down.

M27
April 9, 2015
CHEM 444A.H01

Heat and Living Organisms

Briefly (a few sentences or bullet notes) answer the following question and bring your response to class: Based on what you know about heat, chemical properties, and physiology, what do you think are some of the consequences or effects of heat (or the lack thereof) for living organisms? Use your knowledge from class discussions and the reading.

The increase or decrease in a few degrees in temperature can be the difference between life and death for many living organisms. In order to survive, living organisms need heat, which can be gained through various ways, including the sun, and physical activity. Temperature affects the performance of enzymes, which are protein molecules in cells that work to accelerate chemical reactions within the body. These protein molecules are necessary for living organisms to survive, as they participate in a range of crucial functions inside organisms, such as digestion and metabolism. If the temperature of the body increases, the bonds of the enzyme are destroyed and can no longer do their job in speeding up reactions within the body. These broken bonds will lead to the failure of vital processes, thus resulting in death of the organism. On the opposite side, if a body's temperature decreases, enzyme functions are slower, and do not function as they should, putting an organism's health at risk. Due to this sensitive relationship between temperature and enzyme function, organisms must take measures to prevent themselves from getting too hot or too cold, such as hiding in a burrow, or wearing layers of insulation. Through adaptation, organisms have changed and developed, allowing them to live in locations with extreme temperatures because they have a higher tolerance to heat, or they have the necessary body composition to withstand the temperatures.

M27
April 12, 2015
CHEM 444A.H01

Heat and Living Organisms

Reflection Assignment

1. *For the animal adaptation you investigated, does it aid in temperature regulation in cold or warm climate, or both? Could this adaptation serve as an alternative function?*

   Snails display aggregation behavior on their habitat between the land and the ocean, on rocky intertidal environments as a mechanism to regulate temperature because in their habitats, they experience daily fluctuations in exposure to water submergence and air. Data suggests that the temperature of the snail aggregation was higher than the temperature of a solitary snail. When examining different locations of the aggregation, data proved that the temperature in the center of the aggregation was higher than the outer edges. The reason the snail aggregation has a higher temperature reading than a solitary snail deals with two types of heat transfer. Initially, the air surrounding the aggregation gains heat from the sun through radiation. In the aggregation, snails are closely gathered in clusters, surrounded by small air pockets. These air pockets are heated quickly due to their size, which allows for the heat from the air to be transferred to the snails through their tissue, thus heating the organism, by the process of convection. The aggregation provides protection from the elements, such as wind, which is the primary mover of heat, allowing the majority of the heat to remain within the cluster. Some heat will inevitably be lost at the outer edge of the aggregation. Through this process, heat is gained, which warms the snails, which is an appropriate tactic in cold climates; however, in warm climates, snails would shy away from aggregation because they would be looking to cool down and lose heat, rather than gain it. In a cold climate, if the snail was maximizing its own individual heat preservation, the next step to increase its temperature would be to aggregate with other snails to increase their temperature.

2. *Please describe two other animal adaptations (behavioral or physiological) to regulate body temperature. Explain how this adaptation works (include if heat transfer occurs by conduction, convection, radiation, and/or evaporative cooling).*

   Just like aggregating snails, other animals develop strategies in order to help regulate their body temperature. Pigs, for example, are often found rolling about in mud on extremely hot days. The animals do this to cool themselves down and to add a layer to their skin in order to protect themselves from the sun. When seeking a cooler environment, pigs will roll in a puddle of mud that is at a cooler temperature than that of the pig's body. In doing so, the heat from the pig's body transfers to the cool mud, allowing heat to escape from the organism. This causes the pig to cool down and for the mud to gain heat through the process of conduction. Pigs are not the only animals who adopt this tactic; elephants splash water on themselves with their trunks, while tigers wade in bodies of water.

   In addition to splashing water on their bodies to cool off, elephants stretch out their large ears in order to radiate heat from their bodies. Blood that flows into the ears carries heat out of the body, allowing cooler blood to reenter into the bloodstream in the process of convection. This procedure releases heat, resulting in a refreshed elephant, at a cooler temperature.

3. *Do you have any questions from Thursday's class (about mechanisms, other animals, etc.)? If so, please include and I will try to respond to them.*

   Why do we shiver and get goosebumps when we are cold?

Please reflect on the discussions from Thursday and answer the following questions:

Fennec and Arctic Foxes

1.) For the animal adaptation you investigated, does it aid in temperature regulation in cold or warm climate, or both? Could this adaptation serve an alternative function?

Ear size was an adaptation made by different types of foxes (specifically the Fennec and Arctic foxes) in order to regulate body heat. The Fennec has much larger ears than the arctic fox. The ear size adaptation works in both cold and warm climate for the respective types of foxes, but, for example, the arctic fox would have a hard time regulating heat in the Sahara desert due to its small ears. Additionally, the ear size could potentially serve as an audible function, or an 'identification to other foxes' function.

2.) Please describe two other animal adaptations (behavioral or physiological) to regulate body temperature. Explain how this adaptation works (include if heat transfer occurs by conduction, convection, radiation, and/or evaporative cooling).

- The Mohave Desert squirrel will rub its saliva on its face and head, which is for evaporative cooling. In the high temperatures, the saliva evaporates off the head and face of the squirrel, which takes heat away from the skin. This is just like sweating.

- Penguins can control the rate of blood flow to their feet, which brings less blood to the feet in the cold and more in the heat. This is a very sophisticated system. Additionally, penguins have "countercurrent heat exchangers" at the top of their legs, which causes heat to transfer from the veins to the arteries (conduction).

3.) Do you have any questions from Thursday's class (about mechanisms, other animals, etc.)? If so please include and I will try to respond to them.

What is happening biologically during frostbite?

Please respond in complete and concise sentences. Please submit your response electronically before Tuesday.

Please also submit your response to the pre-class assignment regarding the consequences of heat for animals (I don't need your notes from the readings, just your answer to the question).

Consequences from heat:

-Exhaustion, hypothermia, heat stroke, metabolic disorders, frost bite, shivering, etc.

CHEM 444AH Reflection Assignment

P14

April 14, 2015

Pre-Class Reading Question: Based on what you know about heat, chemical properties, and physiology, what do you think are some of the consequences or effects of heat (or lack there of) for living organisms?

All living organisms rely on maintaining a suitable core temperature. If this core temperature is not maintained, it can have deadly consequences for the organism. Enzymes of most animals typically function between the temperatures of 0º-40º C. If animals' enzymes cannot function, then metabolic processes necessary for life will not be able to be performed. Another consequence of not maintaining the core temperature is the risk of cells freezing and bursting at low temperatures, thus killing the animal.

Temperature also regulates where an organism can live. Different climates and different biomes house animals that have all adapted differently to living in their environment. The way in which the animal controls their internal temperature, whether they are ectotherms or endotherms, plays a large role in where an organism can survive.

1. For the animal adaptation you investigated, does it aid in temperature regulation in cold or warm climate, or both? Could this adaptation serve an alternative function?

The adaptations of the polar fish aid in temperature regulation in cold climates. The adaptation to the fishes' blood is necessary for the fishes' survival in the winter months when the body of water they live in freezes over. The adaptation's sole purpose is to prevent freezing.

2. Please describe two other animal adaptations (behavioral or physiological) to regulate body temperature. Explain how this adaptation works (include if heat transfer occurs by conduction, convection, radiation, and/or evaporative cooling).

One animal adaptation that is often seen is the behavioral adaptation of migration. In times of the year in which an animal's environment is colder than is suitable for survival, the animal will migrate to warmer conditions. This is seen most frequently in birds migrating south, but can also be found in whales and fishes migrating to warmer waters.

A physiological adaptation seen in animals to maintain body temperature is sweating. Many animals sweat form glands on their skin when the environment is too hot. Once released, the sweat evaporates, leaving the surface of the skin cooler through the process of evaporative cooling. Humans are one of may animals that take advantage of this adaptation.

3. Do you have any questions from Thursday's class (about mechanisms, other animals, etc.)? If so, please include and I will try to respond to them.

Is there a particular advantage to being an ectotherm versus being and endotherm? Is one more effective in regulating temperature than the other?

Q25

CHEM 444AH

Professor Bauer

Due: April 14, 2015

Reflection Assignment

1. I investigated how the blood flow to and from the petrel's feet can regulate its body temperature. The petrel lives in the cold climates of the Antarctic, but its feet can regulate its body temperature when the bird is too hot or too cold. When the petrel is sitting in cold water, the feet are very cold. To prevent the body from freezing, the warm blood flow from the body of the petrel transfers heat energy (through conduction) to the cold blood flowing from the foot. I don't see how this countercurrent system could have any alternative uses.
2. During cold weather, many animals curl up in a ball and decrease the surface area that is exposed to the cold. This behavioral adaptation warms up the animal by means of conduction. The heat from its body is transferred back to its body by touching. This behavior prevents heat from escaping the body. Another adaptation that many animals, particularly humans, have is sweating. When our bodies get too warm, our body releases heat through evaporative cooling. When the sweat on our skin evaporates, it uses up extra heat energy to change phases, thus removing heat from our skin and cooling us down.
3. Animals with fur tend to shed their fur during warmer months to cool down. How could you explain this in terms of conduction/convection/radiation/evaporative cooling? Or is it called something else entirely?

Pre-Class Assignment from April 9

For living organisms, heat (along with most other things) must be gained or lost in moderation to achieve a balanced temperature. When organisms get too cold, they can experience hypothermia; when they get too hot, they can experience hyperthermia. Both of these conditions are very serious and can be life-threatening. When we don't achieve the right level of heat, our bodies slow down and the system cannot work properly. Other consequences of

temperature imbalance include frostbite and burns, which can be extremely painful and have long-lasting negative effects.

To Professor Bauer,

Here are my reflection questions from Sara's classes.

1.) For the animal adaptation you investigated, does it aid in temperature regulation in cold or warm climate, or both? Could this adaptation serve an alternative function?

The webbed feet of the petrel aided in temperature regulation of both cold and warm climates. When the petrel heats up, the blood flow to the feet increases. When the blood reaches the feet a majority of its heat is released into the ground by conduction. Therefore the blood that returns back to the body is much cooler and it cools the petrel's body. When the petrel is in cold water the blood flow to the feet is decreased. This means that less blood is going to the feet so less heat can be released. The blood that does go to the feet ultimately loses some heat, but the blood is warmed back up by a process called the countercurrent system. This means that the blood in the venous system is being warmed by the blood in the arterial system. This way the blood is warm again when it gets back to the petrel's body and the petrel's body stays warm while it's in cold water. Besides temperature control the webbed feet can also be used to aid movement in water. Webbed feet that have more surface area allow for faster movement than non-webbed feet do.

2.) Please describe two other animal adaptations (behavioral or physiological) to regulate body temperature. Explain how this adaptation works (include if heat transfer occurs by conduction, convection, radiation, and/or evaporative cooling).

One animal adaption is sweating. This allows the body to regulate its temperature when it gets too hot. When the animal's body heats up, the sweat glands secrete a fluid, sweat, onto the skin. The sweat is warmed by the air and the skin. Then the warm water is evaporated and by doing so heat is being "carried" away from the animal's skin. This leaves the body cooler than before. This whole process is called evaporative cooling. Another adaptation is an animal increasing or decreasing their "surface area". For example a snake spreads out on a rock when it needs more heat. This would allow it to regulate its body temperature to keep it warm enough. This is done through radiation. The more surface area the snake has the more heat/energy the body can absorb from the sun, and therefore the warmer the snake can be.

3.) Based on what you know about heat, chemical properties, and physiology, what do you think are some of the consequences or effects of heat (or the lack thereof) for living organisms?

It is important that the body temperature of living organisms stays between certain temperatures. The body temperature is regulated depending on the different temperatures of the environment. Extreme changes in heat can be detrimental to the organism's enzymes and tissues, as well as overall health. The organism therefore regulates its temperature through conduction, convection, radiation, and evaporative cooling. There are also many behavioral and physical adaptations that occur due to the changes in heat:

sweating, increase in fur, and increase/decrease in surface area. Heat is necessary for all living organisms, however depending on the type of creature the amount of heat and the changes they can endure varies greatly.

Thanks,

R23

S21
April 12, 2015
CHEM 444

Reflection for April 9

* Answer to pre-class assignment

When the core temperature of living organisms is increased or decreased, the enzymes responsible for metabolic processes within the animal cannot function properly and denature. For example, the upper limit for humans is 104 degrees Fahrenheit, so a fever above 104 degrees must be treated or proteins will denature and the person will die.

Living organisms can tolerate hot and cold external temperatures thanks to physiological adaptations that allow for the retention or release of heat. Animals stay warm with fur, piloerection, fat layers, shivering, and low body surface area. Heat can be released through sweating, vasodilation, and contact with colder surfaces.

1) Does the animal adaptation I investigated aid in temperature regulation in cold or warm climates, or both? Could this adaptation serve an alternative function?

The petrel's adaptation can be used for cold or hot environments. When the bird is in cold water, the blood flow to the bird's feet is reduced. This reduces the amount of energy the bird must expend to maintain the body's core temperature. Because the venous blood returning to the core passes by warm arterial blood on its way to the feet, the venous blood can be warmed back up before it causes the core temperature to decrease. When the petrel is hot, as in the heat lamp experiment,

blood flow to the feet increases. This allows for more heat to be released by radiation, preventing the core temperature from getting too hot.

In people, vasodilation and vasoconstriction in the extremities also helps maintain blood pressure. For example, if the bird was bleeding, I imagine the blood flow to the feet would be reduced in order to keep vital organs functioning.

2) Describe two other animal adaptations (behavioral or physiological) to regulate body temperature. Explain how it works (heat transfer by conduction, convection, radiation, evaporation).

Dogs pant when it is hot in order to release heat. This is an example of evaporative cooling. As the saliva on the dog's tongue evaporates, it takes heat with it.

Another example is how animals in colder climates have evolved to have less surface area but more mass. Smaller ears and shorter limbs reduce the amount of heat lost by radiation. Increased mass insulates the animal from heat loss by radiation and conduction and increases the amount of heat generated by metabolic processes.

3) Any questions from Thursday's class?

I was a little confused about the crab. Does it change color rapidly depending on the ambient temperature, or does it change color seasonally?

T19

CHEM 444A

4/11/2015

Reflection Assignment for 4/14

Pre-Class Assignment:

Heat, when in excess, can make it difficult for the body to function. It changes how different substances in the body function because it causes changes to their structures (one example is enzymes). Heat also increases the metabolic demands of the body. A lack of heat is also detrimental to body function because heat is required as a form of energy. When there is a lack of heat, blood is shunted to vital organs and this can cause damage to the peripheral limbs/tissues. Both severe heat and cold can cause damage to cells/tissues (burns and frostbite).

Reflection Assignment:

1.) My group looked at the adaptation of ear size. Larger ears aid in temperature regulation in warmer climates because there is a larger surface area to lose heat (primarily through radiation). Smaller ears are an adaptation of animals in colder climates because there is less surface area over which heat can be lost. This helps these animals to retain body heat in order to maintain body temperature. I do not believe that this adaptation could serve an alternative function. The only possibility is that those animals with larger ears have a greater area to funnel sound into the ear. This may increase hearing ability, but I do not know if this is true or if the increase is significant.
2.) One behavioral adaptation to regulate body temperature is that hippos spend a large portion of the day in water. This is because water temperature is lower than body

temperature and results in cooling by conduction. Additionally, when the hippos get out of the water, evaporation takes place and their temperature is lowered through evaporative cooling.

A physiological adaptation is the size and mobility of the elephant's ears. While a part of this is similar to what I described in question one, elephants are also able to fan their ears to cool themselves through convection.

3.) I understand that living beings can give off heat through radiation, but I am unsure of the mechanism of how this works.

1. We investigated the aggregation behavior of snails. Aggregations in the snail community do not aid in temperature regulation for warm climates, only cold climates. This is proven in the data our article presented. The graph shows that the temperature of the snails is highest among the inner center and gradually decreases the closer the snails are to the edge of the aggregation. Snails aggregate to generate heat, not to stay cool, therefore this behavior is only useful in colder climates. This adaptation of aggregation also serves as a barrier for protection from the natural elements of the rocky intertidal in which they live. The snails in the aggregation are less likely to be affected by the elements than a solitary individual.

2. Because dogs have different physiology than humans, their adaptational behavior is also different. Humans can cool down through evaporative cooling by sweating, but dogs have fur coats that disable them from doing so. Instead of sweating, dogs cool down using the same mechanism as humans (evaporative cooling), but do so through panting. Panting increases the airflow over the wet surfaces inside the dog's respiratory system which increases the evaporative cooling. The evaporative cooling allows the heat to leave the dog's body and, in turn, cools the dog.

Snakes, being cold-blooded, must stay comfortably warm on colder days through thermoregulation. Snakes partake in basking and obtaining heat through infrared energy from the solar rays. This is called radiation. They have also learned that the more surface area they cover, the more heat they will gain through solar energy. Some snakes have the ability to make their skin darker to gain more heat from radiation through black body radiation.

3. When animals change color to absorb more energy, is it a conscious decision or is it a reaction?

4. Pre-class assignment:

Heat, or lack of heat, is only good for living organisms in moderation so that the body can maintain its internal, or "core" temperature. Lack of heat slows your blood flow. Too much heat can cause dehydration (through sweat) and decreased muscle action. Not enough heat can cause a rhythmic tremor. Luckily, most animals have adaptations that allow them to live comfortably in certain temperatures.

Fennec vs. Arctic Fox

Please reflect on the discussions from Thursday and answer the following questions:

1.) For the animal adaptation you investigated, does it aid in temperature regulation in cold or warm climate, or both? Could this adaptation serve an alternative function?

The Fennec fox's adaptation works in warmer climates, while the Arctic fox's works in the cooler climates. Their adaptation is based upon the size of their ears. The bigger ears of the Fennec are able to radiate more heat out of it's body, while the smaller ears of the Arctic radiate less heat, therefore keeping it's internal body temperature higher. The size of the ears could also play a role in how well they hear. That could be pivotal to their survival.

2.) Please describe two other animal adaptations (behavioral or physiological) to regulate body temperature. Explain how this adaptation works (include if heat transfer occurs by conduction, convection, radiation, and/or evaporative cooling).

The desert squirrel has a broad thermal neutral zone and can absorb more heat than many other mammals without causing harm to itself. This adaptation allows the desert squirrel to run around for a while without the risk or dangers of heat. It will then go underground or lie down to cool off. The squirrel loses heat through evaporative cooling and radiation. The fiddler crab has the ability to change the color of its shell in order to regulate its core temperature. When the crab is hot, the shell would get lighter so that it wouldn't absorb as much heat. However, when it was cold, the shell would get darker and absorb more heat. This adaptation works by conduction, because the internal temperature pushed out against the shell and causes it to change color according to the needs.

3.) Do you have any questions from Thursday's class (about mechanisms, other animals, etc.)? If so please include and I will try to respond to them.

No, I do not.

Please also submit your response to the pre-class assignment regarding the consequences of heat for animals (I don't need your notes from the readings, just your answer to the question).

The consequences of heat can be exhaustion, hypothermia, hyperthermia, dehydration, heat stroke, frostbite, and many other conditions. Also, cells will die if they are dehydrated, the body will get tired and fatigued, and could pass out. When it is too cold, the body could freeze. The water in the cells freeze and the internal temperature drops. This can lead to organ failures.

X15

Professor Bauer

Chem 444

14 April 2015

Reflective Writing Assignment

1. The countercurrent system present in the petrel aids in temperature regulation in both warm and cold environments, even though the petrel lives in an area that is primarily cold. It helps them to retain body heat when they are in cold areas, but if they become warm (as in the experiment with the heat lamp or as a result of heat generated by high activity and expending lots of energy), the countercurrent system can help to release excess heat from the body. Since the countercurrent system provides double functions, it should ostensibly allow the petrel to survive and be relatively comfortable in a warmer climate as an alternative to its natural cold one.
2. One behavioral adaptation would be the example of a lizard basking in the sun. Because reptiles have low metabolic rates and low insulation, they need to gain heat from their environment. In this example, heat transfer occurs via radiation when the lizard's body gains heat from its exposure to the radiant energy of the sun. Another behavioral adaptation can be seen when a dog pants to cool off, letting water evaporate from the mouth and tongue in an instance of evaporative cooling.
3. I was originally wondering whether it was voluntary or involuntary when the blood vessels in an animal depress or dilate, but my group concluded that it must be involuntary because humans do it too, and we're not conscious of it.
4. Consequences of heat for animals: they have to be able to adapt in one way or another, whether that means that they have physical attributes that help them to survive in their climate (i.e. fur or fat for insulation, being able to retain water in arid climes), or whether they engage in activities that allow them to adapt (i.e. small desert animals that burrow into the ground during the day and come out at night when it's cooler). They have to be able to receive heat via different processes to get warm (i.e. conduction, radiation), and they have to be able to release heat to stay cool (i.e. evaporative cooling).

Y13

Based on what you know about heat, chemical properties, and physiology, what do you think are some of the consequences or effects of heat (or the lack thereof) for living organisms?

Animals in cold climates need to maintain an internal temperature while animals in hot climates need to release heat in order to remain a reasonable temperature. There are two extremes where the animal can either overheat or get hypothermia, both are which are serious conditions and want to be avoided at all cost. Overtime animals have adapted to their environments and found what is necessary to survive and be best suited for their living conditions. With either the lack of heat or having excess heat animals or any living organism can die. Organs start to shut down with situations are not within the correct range and your body will begin to mainly focus on retaining thermal equilibrium within the body to a safe temperature range.

Notes:

- The temperatures around you affect your body temperature so in cold conditions your body has to work to maintain its body temperature in in hot conditions your body sweats to cool itself down
- Two extremes are hypothermia and heat stroke
- 32- 104 degrees Fahrenheit are when enzymes within a living organism can function
- Metabolism and life itself rely on being able to maintain a core temperature within the range of tolerance for the body's enzymes
- The core temperature holds steady when the rate of heat loss balances the rate of metabolic heat production
- Radiation, convection and conduction are all possible ways to alter body temperature
- When heated air becomes less dense it moves away from the body, and even without a breeze the body loses heat because its movements create convection
- Ectothermic = heat from outside; Endothermic = heat from inside
- Responses to cold stress: peripheral vasoconstriction, pilomotor response, shivering response, nonshivering heat response
- Responses to heat stress: peripheral vasodilation, evaporative heat loss occurs, fever
- For some animals the difference of a couple degrees can mean life or death, and for plants it is necessary for them to grow and remain nourished to stay within a certain range
- You have to take in effect the body insulation of animals. For example the thickness of the fur of animals in the artic is a lot thicker than those in California
- The range of the body temperatures in which it can function effectively and the rate at which it can produce body heat

Reflection

1. I investigated the arctic and fennec fox so the adaptation aided for both cold and warm climate animals. For the Fennec fox it was the feature of bigger ears and for the arctic fox it was the smaller ears. Our main focus was to discuss how heat was released through their ears and why size mattered. We concluded that both conduction and radiation were part of the process and that the bigger the ear the more surface area and therefore more heat that is able to escape from the animal's body. I cannot think of an alternative reason for the size difference in ears, and to be completely honest I didn't even know that was a purpose of ears for any living organism. But, it now makes sense as to why humans wear a hat in the winter to keep their ears warm and keep the warmth of the body from being released. When we presented we focused on the fact that animals in the desert need to give off more heat so they do not overheat and animals in the arctic must maintain heat in order to not freeze.

2. One other group discussed how crabs change color slightly to absorb or reflect the rays from the sun, which would be heating through radiation. They turn a lighter color to reflect the rays and a dark color to absorb. When we had to read the pre class articles, one of them had to do with the desert squirrel. I found it kind of funny that one of his ways to cool, through evaporative cooling that is, was to spit into his hands and slick it back on his face.

3. I don't have any specific questions from class on Thursday. I thought it was very interesting to relate what we were doing to living organisms and have each group discuss a different adaptation for a different animal. Although I knew most of the animals presented I didn't know they had such adaptations and it was cool to see how they adapted based on their environment and body.

1. My group investigated the protein levels in polar fish's blood. This adaptation is to aid in temperature regulation in cold climates. High levels of protein make it more difficult for its blood to freeze.
2. Another animal's adaptation is the size of fox's ears depending on its environment. Foxes that live in a hot climate generally have bigger ears, with more surface area. This allows for convection and evaporative cooling. Foxes that live in a colder environment tend to have smaller ears to conserve heat and keep it closer to the body. Another adaptation to the environment is the thickening of fur in colder environments. This can be seen in wolves. In colder climates, fur is thicker to insulate the wolf's body. In warmer environments, fur is thinner and allows body heat to be released through convection and evaporative cooling.

Consequences of heat for animals:

- Helps to maintain core body temperature
- It is necessary to maintain core temperature because of certain temperatures needed for all components of bodily processes; for example, when proteins or enzymes are heated above body temperature, they become denatured and do not complete their function
- A drop or rise in body temperature of few degrees can cause serious harm to organs, tissues, like the brain, which can cause death