Grade 7 Science Heat - Being Warm -Blooded

Date: _____

How do Humans, as Warm-Blooded Organisms, Generate Heat in Our Bodies?

The heat that we generate comes from all of the biochemical reactions carried out by cells. The liver is the main contributor of heat since it carries our hundreds of reactions. Every time that food (protein, sugar or fat), is broken down, heat is released as a by-product. The actual product of this food breakdown is Adenosine Tri Phosphate (ATP). This chemical is used by cells - energy to function properly. For example, each sugar molecule (Glucose) will produce 38 molecules of ATP plus carbon dioxide and water as waste products – and lots of heat energy. The heat is carried from our deep organs like our liver to all parts of our body through our blood.

Shivering is just very rapid muscle contraction and each time a muscle contracts, it needs ATP which is made by breaking down food that we eat – chemical energy. Since it uses up our chemical energy stores, we have to create more biologically, and this creates more heat.

So, basically, body heat is created in the deep organs such as the liver, brain, heart and through the contraction of muscles. This heat is spread through the body through our blood. That is why we are called 'warm-blooded'.

How do we Stay Cool in a Hot Environment?

We have no chemical way of staying cool, so we use our biggest human organ – our skin. There are two main ways that our skin helps regulate our temperature. The first is sweat glands and the second in surface blood flow.

We, like many mammals have sweat glands on our skin that produces water when we are hot. Water takes a huge amount of heat energy to evaporate and that cools us down. If you have ever climbed out

of water after swimming and found yourself shivering, that is because your body heat is quickly being used up to evaporate the water on your skin. If you are very hot, spraying water on your face or body, helps to cool you off – now you know why.

Your skin reacts to temperature like all living things. When it is cold, it contracts and, when it is warm, it expands. This includes the blood vessels in your skin. When you are hot, the vessels become bigger and pump more blood to the surface of your skin so that the heat can be released into the environment and be absorbed by your evaporating sweat. This is why your skin is sometimes more flushed or darker when you have been physically active or are very hot. In the case of being cold, your blood vessels in your skin will tighten and there is less blood flow to your skin surface – the blood is stored closer to your internal organs to keep you from losing too much body temperature. In this case, your skin will appear greyer and in some cases will be blueish.

Extreme Cases of Heat and Cold - Survival

Our bodies are designed to survive. They have evolved to do so for millions of years. We must have the same narrow range of body temperature to survive so we react to extremes in interesting ways.

If our cooling systems do not work properly, we will pass out in the heat – this results in us getting to the coolest temperature – the ground. It also stops us from generating more heat through activity. Passing out is our body's reaction to extreme heat. Further heating is not healthy.

Our reaction to extreme cold is also to start shivering and to pass out. At this point, our body stops blood flow to our outer body and keeps the blood around the internal organs (hypothermia). Parts of the body far from the organs like feet and hands, noses and ears (called extremities) can freeze solid (frostbite) and die but the body can still survive without some of the parts.

Our bodies are amazing things that are designed to survive.

Another Organ that Helps with Temperature Regulation

Humans are capable of thinking and not just reacting. We are observant and innovative which means that we do not just rely on our environment and our bodies to regulate our temperature. We change our houses and what we cover our bodies with in order to regulate our body temperature.

Humans live on every continent on Earth. We have even gone into the oceans - under water and into the cold vacuum of space. In every situation, we have to make sure that we are within our comfort zone of temperature so we are easily within our safe temperature range. We do this by designing buildings and structures that will heat up and cool down so that we are not shivering or sweating too much. Insulation and heating/cooling systems allow us to be comfortable. These systems have to be more complex and are more expensive in extreme climates and in some cases are absolutely essential to human survival.

Since we cannot stay inside all the time and cannot carry our homes with us at all times like a snail, we sometimes dress for 'outside' in a variety of ways to keep us warm or cool depending on the environment outside or 'outdoors'.

When it is hot, covering the skin will prevent sweat from evaporating and result in heat and sweat being trapped in clothing resulting in sweaty, wet clothing. Wearing less clothing such as shorts, swim suits, etc., is an option. Wearing clothing that breathes or allows ventilation (for convection of air) so that you get as cool as possible is also helpful. Light coloured clothing absorbs less radiant heat too.

When it is cold, keeping the heat we produce is important. Layers of clothing that are puffy and trap air and do not allow wind through are helpful (wind-breakers and quilted coats, scarves, hats, etc.). Our extremities are protected by special coverings such as mittens, socks, boots, ear muffs, etc.

Through our bodies, our houses and our clothing, we, as warm-blooded, thinking humans, do a lot to keep in our prime operating temperature.

Chemical Reactions of All Kinds

Our world runs on chemistry – it is part of all life processes but also processes that are not life – like the weather, the water cycle, ice ages and so on. Chemical reactions are dependent on temperature. Some only happen at certain temperatures and require heat and other reactions produce heat. Every single reaction is affected by heat and the general rule is – the greater the temperature, the faster the chemical reaction.

With biological reactions, the rate of reaction doubles for every 10 degrees Celsius increase. While this may not sound important, the effects of this are huge. For organisms to function properly, we need our temperature to be within an optimal operating temperature – a rather narrow range for warm-blooded animals. Not only biologically but behaviourally. Plants begin to grow in the spring in response to temperature. Certain plants only grow when it is warm enough in the spring and lose their greens in the fall like trees. If some plants start to grow and then it is very cold, they will be damaged – like some fruit crops or frost-sensitive plants.

With the global heat patterns changing, we have to understand the affects this is having on all of the plants and animals in order to react to it in a good manner and not make bad decisions that will damage the environment that we live in even more.

The next topic that we will tackle is saving energy since heat is energy and we, in Canada, use a lot of energy to keep our houses at a comfortable temperature.