What Does Chemistry Have to Do With Biology? H208

Chemistry students often wonder why they have to take chemistry to go into a medical field. I have a few tidbits to mention that shows how chemistry can relate to our bodies.

Gas Laws & Solutions:

Did you know that scuba divers have to deal with large water pressures the deeper they go? At a depth of only 33 feet the atmospheric pressure doubles to 2 atmospheres. This trend continues every 33 feet of depth so at around 100 feet the pressure is a whopping 4 atmospheres! This makes it much more difficult to breathe but scuba gear is designed to somewhat counteract this problem. At this pressure the gases divers breathe are compressed into solution in our bodies. The oxygen in the air is used up by the body but the nitrogen dissolves into the blood in greater and greater quantities. Divers need to be extremely careful to monitor their depth and the time elapsed. Ascent to the surface must be slow to allow the nitrogen to bubble out of solution slowly. Otherwise a rapid ascent can lead to the "bends" or decompression sickness. These nitrogen bubbles can manifest in any part of our bodies so multiple symptoms can occur such as joint pain, rashes, paralysis, and even death. The deeper they go, the longer it takes to adjust to the change in pressure. Divers sometimes have to spend time in recompression chambers to allow them to return to 1 atmosphere slowly.

Interaction Between Molecules:

Did you know that surface tension can play a big part in the digestion of fats? Digestive enzymes produced by our bodies can only work on the surface of the fat droplets in our intestines so our intestines contain a compound called bile salts designed to break up the fats into smaller and smaller droplets, on the order of 10^{-7}m, to increase the surface area accessible to these enzymes. This is known as emulsification. Think of shaking up an oil and vinegar salad dressing. The bile salts would keep the oil from coalescing on the surface of the vinegar/water part and keep them into small drops mixed in the vinegar/water. The decrease in droplet size correlates to a greater digestion speed.

Did you know that the alveoli of the lungs need to be stretched to take a breath? The inside of the air space of the alveolus is coated with a thin layer of water which performs as an elastic membrane. The work needed to overcome this membrane is considerable because the surface tension of water is very high. If this layer was pure water it is unlikely that no amount of muscle work would allow us to take a breath and in fact the lungs would tend to collapse but in healthy people the alveolar cells produce an agent that is called a lung surfactant that reduces the

surface tension and allows us to draw breath. Premature babies often have great difficulty breathing because the cells within the aveoli are not mature and breathing is strenuous. It can lead to exhaustion, lung collapse, and death but a synthetic surfactant can be aspirated directly into an infant's lungs which will allow it to breathe until its own cells are mature enough to produce the surfactant on their own.

Interaction Between Molecules & Heat Exchange:

Did you know that the topical anesthetic Ethyl Chloride (C_2H_5Cl) works because it has such a low boiling point (-135.4 degrees C, or -211.7 degrees F) and it evaporates at the rate at which heat is transferred into it. Let's say you whacked your knee on something hard and you are in great pain. If Ethyl Chloride were applied to the knee, which is somewhere between 30 to 35 degrees C, the heat transfer would result in quick evaporation of the ethyl chloride and rapid cooling of the area. This cooling affects the metabolic activity of the pain receptors in the skin which results in diminished pain.

Solutions & Diffusion:

Did you know that the size of our body's cells is limited by its ability to transport the oxygen to all parts of the cell? If the cells were too big all the oxygen would be used up by the various metabolic processes taking place and the more remote areas of the cell would not receive any resulting in the death of the cell. Therefore our cells never get so big that this would happen. Some organisms, such as kelp and flatworms, can allow their cells to grow larger because they are so flat that all of their cells are in contact with the oxygen-containing environment they live in. Our cardiovascular system developed to deal with this issue making sure that oxygen-rich blood is pumped to all parts of our bodies in just seconds so the oxygen has only short distances to travel to the cells that need it.

Chemical Reactions:

Did you know that the febrile response, the physiological changes that lead to increased body temperature in response to infection, occurs in virtually every animal phyla: fishes, amphibians, reptiles, as well as mammals? It seems to be a fundamental adaptive biological response to infection. The chills humans feel when they have a fever are the body's response to the hypothalamus' intent that the body temperature be raised. The shivers, which are violent

muscle contractions and are exothermic (heat as a product), cause they body's temperature to rise. Once the body has reached the temperature the hypothalamus dictated the shivers stop.

Once a fever breaks then the body feels too warm and physiological responses lower the body temperature. Some researchers question whether an anti-pyretic (such as Tylenol) should be used at the first sign of fever although too high of a fever for too long can be dangerous.

Quote from Beth Lerner Wilcox, R.N. who was asked "Do you use chemistry in your job?":

"Because chemistry describes the building blocks of the human body, its concepts are inseparable from the nursing assessment and care. For example, memory loss must never be assumed to be a "normal" part of the aging process, accepted without question; we may find that a treatable disease process or medication is responsible. The cause and treatment are based on principles of chemistry. In oncology, understanding the chemistry of treatment is essential to competent care and enables the nurse to help the patient understand his or her experience. One type of chemotherapy irritates the bladder wall during excretion, so another drug is added that binds with the irritating substance, enabling it to pass through the bladder without injury."

Quote from Terri E. Weaver, R.N., Ph.D. who was asked "Do you use chemistry in your job?"

"Chemistry is a big part of teaching about the physiology of the body: acid-base balance, renal, endocrine systems. In my research, it's important in a number of ways; for instance, the effect of hormones on the chemical process in cells and how that affects sleep disorders. You must know basic chemistry and apply it."