

low pH

high hematocrit

dehydration
(diarrhea)

Crooping

~~Spells~~
dehydration

Spells breathing
rapid

low potassium (K^+)

One or two unusual
red blood cells

Dr. Friedman
giving her saline

Malaria

No evidence of

Regains Rehydration
therapy on Malaria

Maria has spike
cell trait

Erythrocyte was
conspicuously
as red blood cell.

seen in H&Es do
not appear to be ankyr

How does low pH affect the body?

How does pH get low in body?

How does body respond when pH is low?

What **Cole** is making her hematocrit high?

How does low O_2 in blood cells affect hematocrit?

Is her body producing additional RBC to adapt to altitude?

Not
Why is hematocrit increasing
respired when rate increases?

Does she have a high O_2 level with low pH?

If Maria is producing more RBCs, is she given saline?

Why do odd erythrocytes form? What causes hemoglobin to sickle?

Does muscle clamping have to do with low O_2 ?

What are the differences between sickle cell trait and disease?

Cole
Norton

Cole N

Formation of Old Erythrocytes / Sickle Cells

What are they?

Opposed to a normal red blood cell that is a very soft and malleable biconcave disk a sickle cell has a very stiff structure and appears to be a crescent like part of the moon.

Shape



Normal

Sickle

The hemoglobin in normal cells is all spread out opposed to sickled which forms long clumped chains.

hemoglobin



What gives it to sickle?

Sickled hemoglobin has a valine that replaces a glutamic acid. Valine is nonpolar whereas glutamic acid has a charge allowing it to be dissolved in blood.

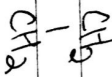
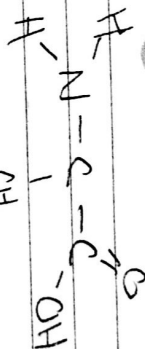
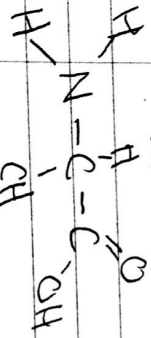
In a protein such as hemoglobin it is important that the order of amino acids in each of the 4 polypeptides is correct in order to carry oxygen as structure determines function. The side chains play a key role in the intermolecular forces that allow the protein to assume a proper tertiary form. With the non-polar valine vs the charged glutamic acid this would change the shape of the protein as certain aspects need to be oriented in a specific way as seen in class on the noodle and fork activity. The attractions and repulsion could lead to a change in shape and function.

Additionally, ~~as~~ the "corner" protein has a cofactor or heme group containing iron. It binds to hydrophobic side chains that shield from water and protect the 4 sites to bind oxygen. When the order of amino acids is changed at primary level the 3D molecular forces directly affect the shape the proteins fold into. This affects the function and makes it difficult for the proteins to complete their task effectively by carrying less oxygen and being unable to slip through capillaries.

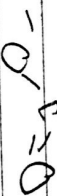
Amino Acids

Valine

Glutamic Acid



-Non-polar side chain



-hydrophobic

-charged side chain - normal

-hydrophilic

Different characteristics result in different effect in protein Hemoglobin.

As predicted a mutation is the cause of the different properties of sickle hemoglobin.

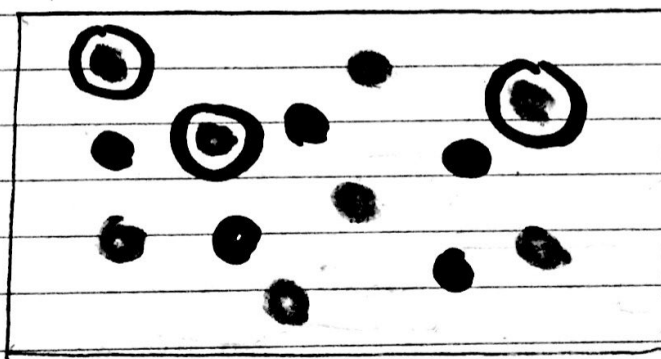
Body's Response to Low Blood pH

The human body's natural blood pH is in a range between 7.35-7.45. This means that it is slightly basic.

When the pH of the blood decreases that means that the concentration of H^+ ions in the blood increases. It is an inverse relationship.

Often, when the body's pH changes a buffer acts to reverse this change. This is an example of a negative feedback loop.

These buffers resist changes in pH. If the blood pH decreases the buffer increases pH to maintain a steady point by isolating the change in pH.



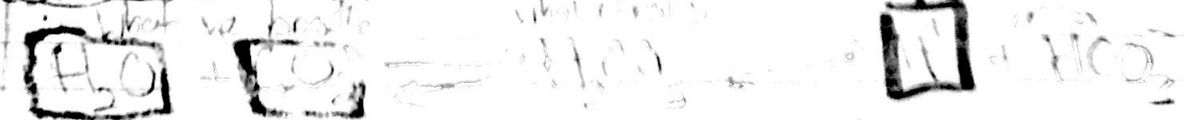
● = acid
○ = base
⊙ = buffer (base)

In this case, Maria's blood is acidic (low pH) so the buffer acts as a base by isolating or opposing some acidic particles to increase pH.

This can also be seen when Maria's breathing rate increases significantly. This is an example of a chemical buffer known as a Bicarbonate Buffer.

In response to my "hypothesis" the body reacts to stimuli the same for CO_2 in blood as heat (as seen on back) and the body uses a buffer system to increase blood pH.

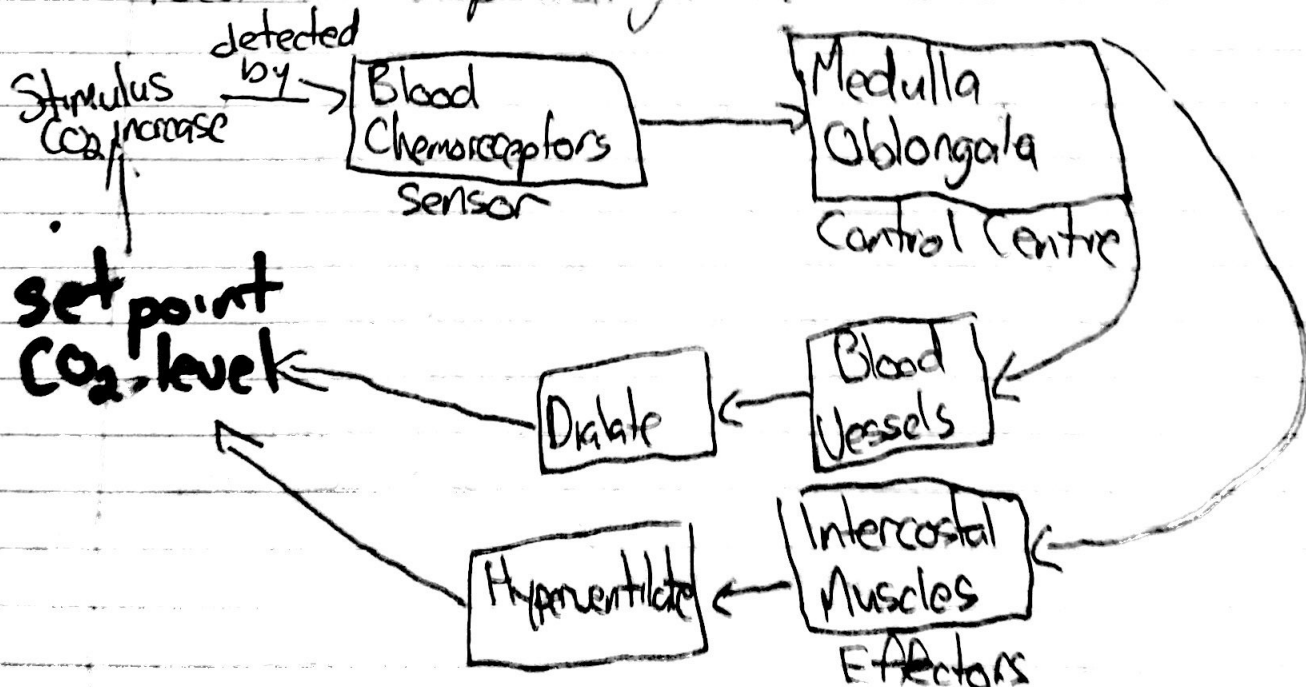
Bicarbonate Buffer



This follows Le Chatelier's Principle where when a molecule is in high concentration which in this case is H^+ which is causing acidification the body wants to make less of it. This means we will combine with bicarbonate and move it to the left ultimately resulting in more CO_2 and H_2O which are what we breathe.

The body then wants to get rid of the CO_2 which is done by hyperventilation, increased breathing rate. Hyperventilation causes alkalosis which causes the pH to rise back to the set point.

This process can be seen through a negative feedback loop diagram.



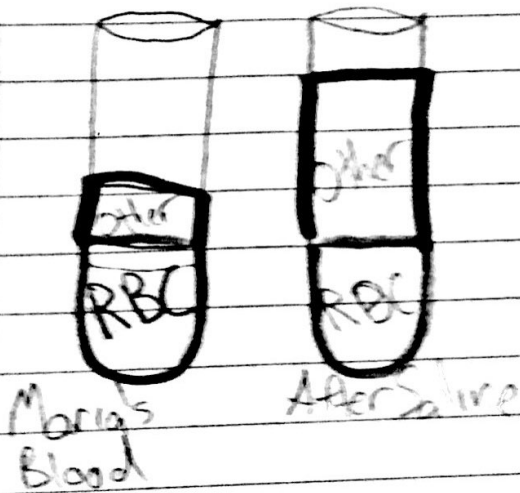
In a regular body these processes are effective in reaching a regular blood pH, however in Perla's case she has outlying factors that prevent this.

Blood pH hypothesis:

I predict that as body's blood pH decreases it will have a natural homeostatic response to bring pH back up similar to that when body temp increases.

Saline

Saline is a solution where salt is dissolved into water. Often people, including myself, believe that when Maria is given the saline it will further dehydrate her. This is not the case as we can infer the doctor is referring to normal saline (around 1% salt) which is often used as an intravenous liquid. Its job is to increase overall blood levels in the body as its salt concentration is isotonic to the blood.



Shown to be left is Maria's blood with a high hematocrit — as well as her blood after taking the saline. Originally, she had a very high volume of erythrocytes to total blood but the saline ultimately brings this percentage back to normal.

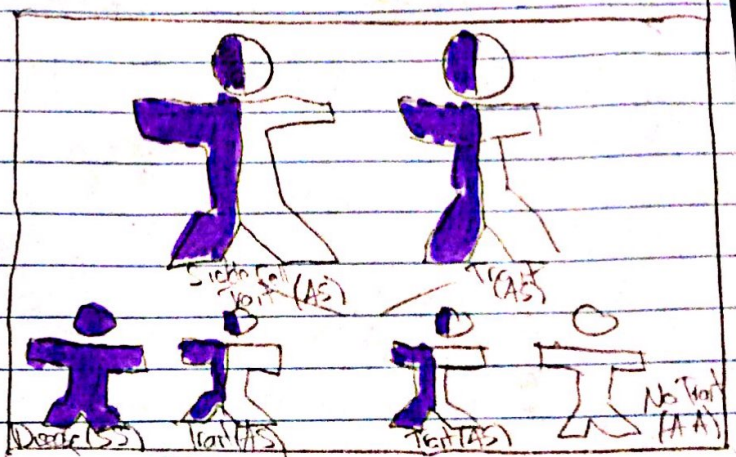
In contrary to my hypothesis, the saline will not further the symptoms of dehydration such as cramping and diarrhea as the saline is isotonic to cells in blood so water concentration will not change.

Saline Hypothesis: I predict that if Maria is given saline solution it will further her symptoms of dehydration.

Sickle Trait vs Disease

Sickle cell disease is a genetic disease that most commonly affects those of African or Caribbean descent however this is not always the case as Maria has the trait. It is an Autosomal Recessive Disease meaning you must have 2 copies of the gene.

Shown to the right is the pattern that the gene follows when two heterozygous parents are present.



Sickle Cell Trait

Often those with sickle cell trait experience no symptoms and are capable of living a perfectly healthy life as the doctor explains to Maria. As shown above those with the trait only have one copy of this disease gene. With regards to the hemoglobin the victim has 60% normal hemoglobin and 40% sickled hemoglobin and this percentage helps prevent symptoms from arising. In addition to this the red blood cells have the regular biconcave disc form. Maria believes that only African people may have this disease. This is because in Africa malaria is a large issue and those with this trait are resistant to contracting the additional disease thus promoting the trait as it can help one survive.

Sickle Trait vs. Disease Hypothesis

I predict that sickle trait will share all of the symptoms but be a more mild case of the disease