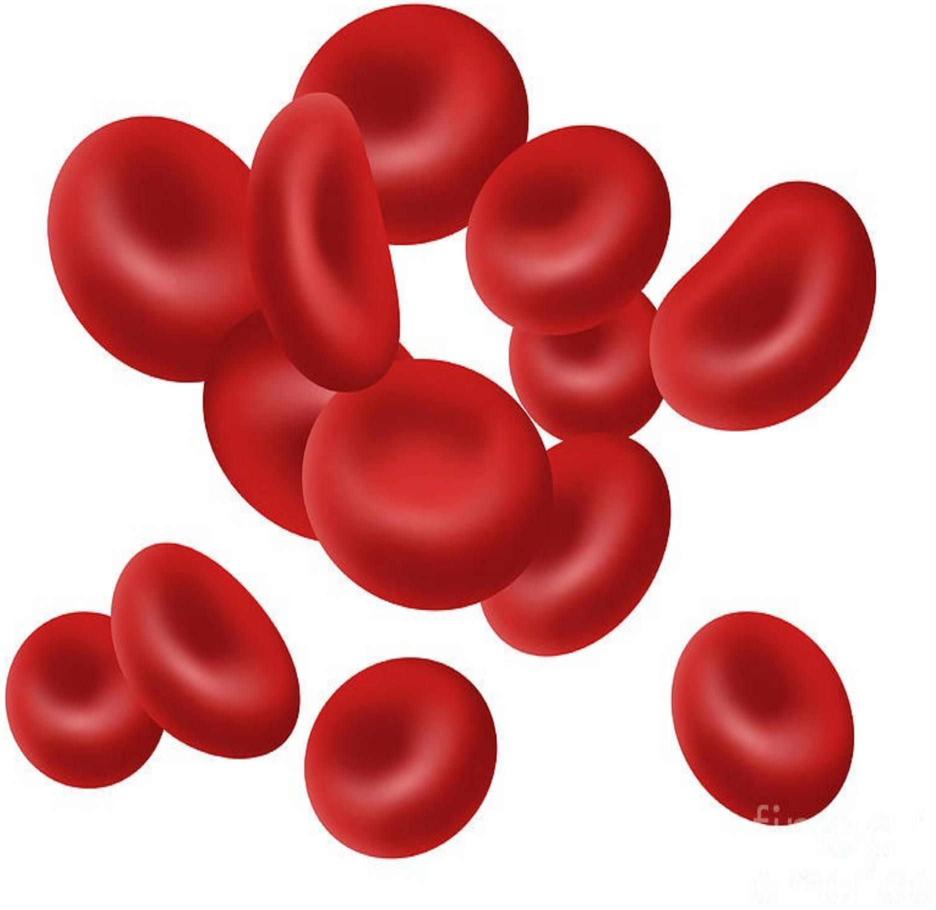
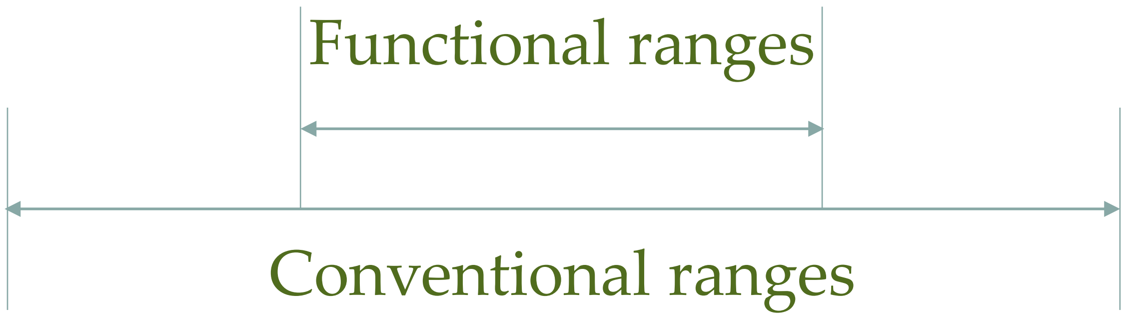


Red Blood Cells & Hemoconcentration

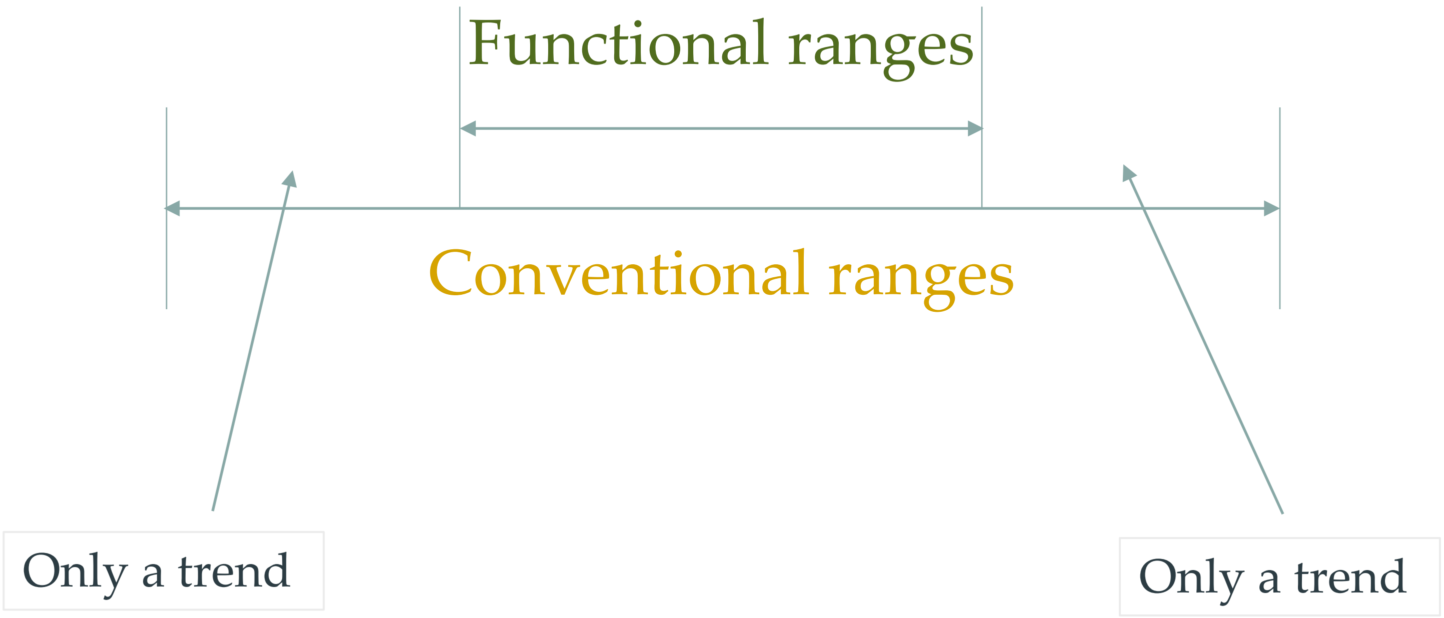
When speaking of reference ranges…

We are looking at early stages of imbalance, not disease



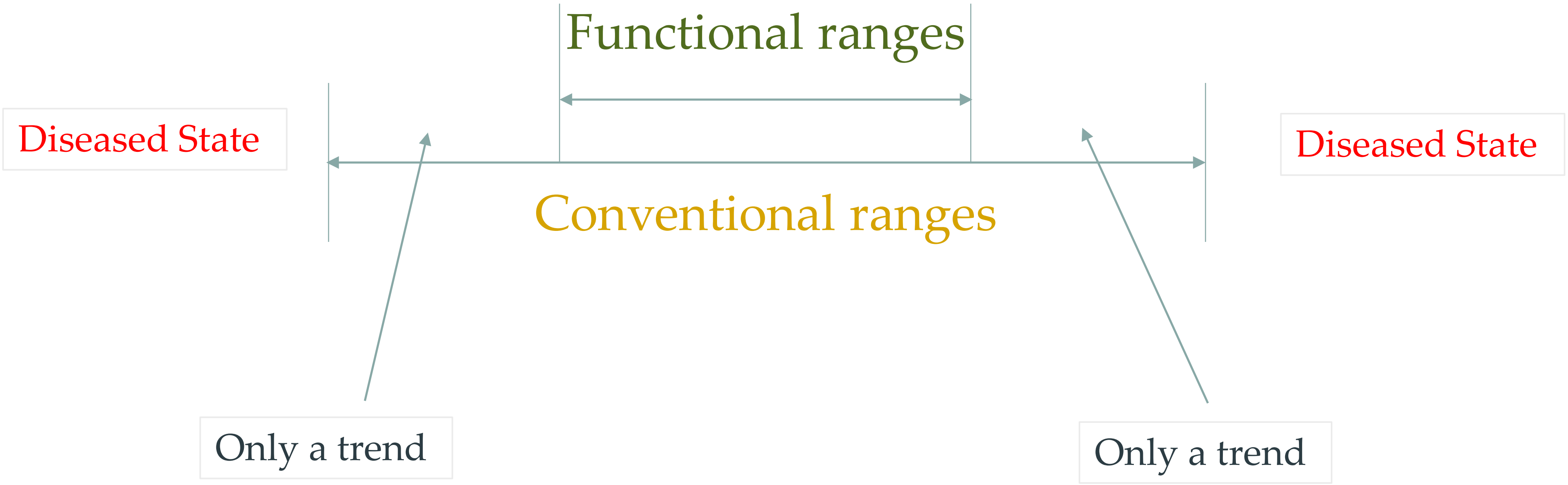
When speaking of reference ranges…

We are looking at early stages of imbalance, not disease



When speaking of reference ranges…

We are looking at early stages of imbalance, not disease



RBC	Red Blood Cell
HGB	Hemoglobin
HCT	Hematocrit
MCV	Mean Corpuscular Volume
MCH	Mean Corpuscular Hemoglobin
MCHC	Mean Corpuscular Hemoglobin Concentration
RDW	Red cell Distribution Width

A vial of blood is a standardized amount drawn…this is how we can compare values and amounts…

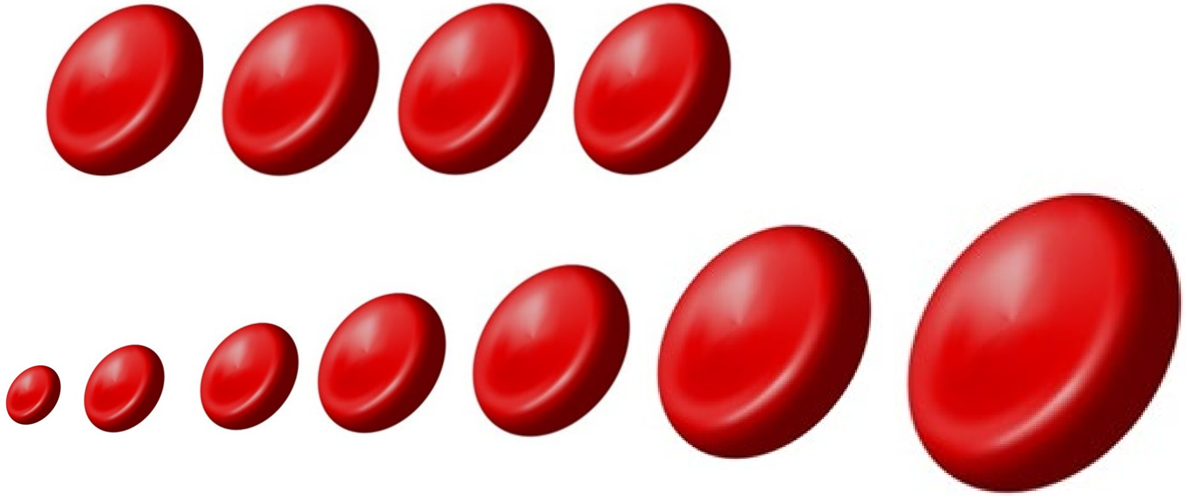
RBC	Measures how many red blood cells
HGB	Measure weight of molecules of hemoglobin in each RBC
HCT	Percentage of blood that contains RBCs
MCV	What is the volume (size) of the AVERAGE RBC
MCH	What is the AVERAGE amount of hemoglobin in the RBC
MCHC	What percentage of this RBC is made up of hemoglobin
RDW	Percentage of variation in size of all the RBCs

RDW

Red cell Distribution Width = Variance in size

RDW = 12

RDW = 13.5



RBC
HGB
HCT

Determines functional anemic tendency = can these cells carry/deliver oxygen

MCV
MCH
MCHC

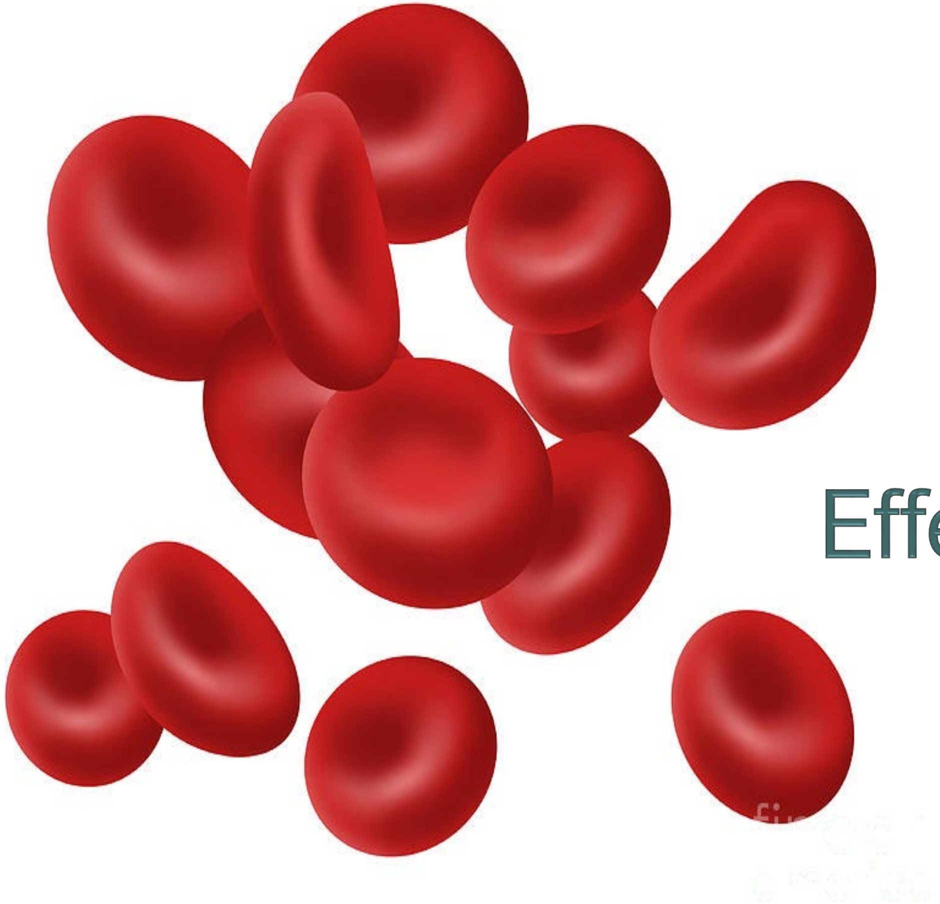
Possible reasons for functional anemia = production, destruction or loss

RDW

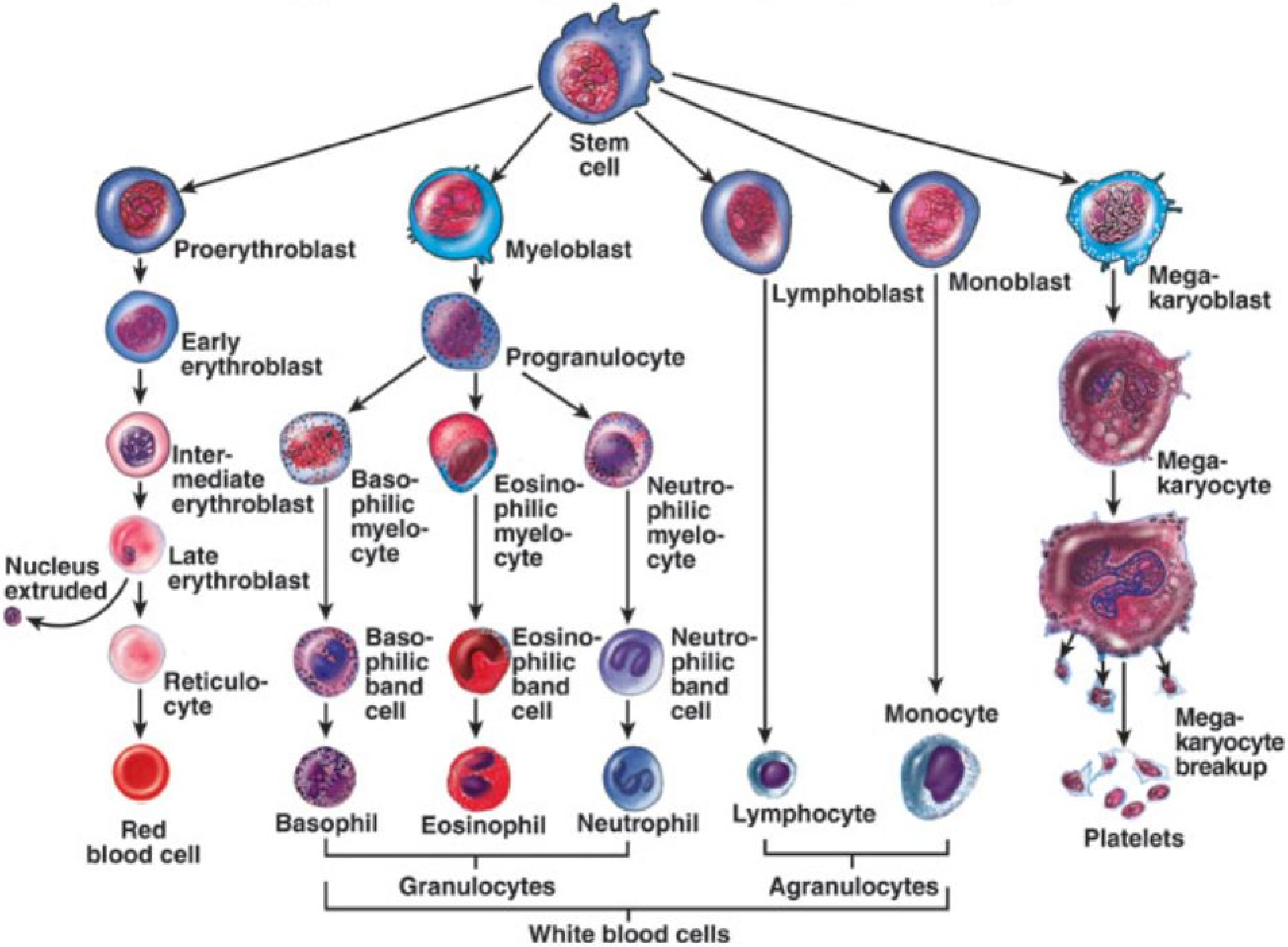
Who is ready for a prize question????

Why are RBC figures higher for men?

Complete Blood Count (CBC)	Functional Range
WBC	5.0 - 7.5 $x10^3/\mu L$
RBC [Male]	4.2 - 4.9 $x10^6/\mu L$
RBC [Female]	3.9 - 4.5 $x10^6/\mu L$
Hemoglobin [Male]	14.0 - 15.0 g/dL
Hemoglobin [Female]	13.5 - 14.5 g/dL
Hematocrit [Male]	40 - 48%
Hematocrit [Female]	37 - 44%

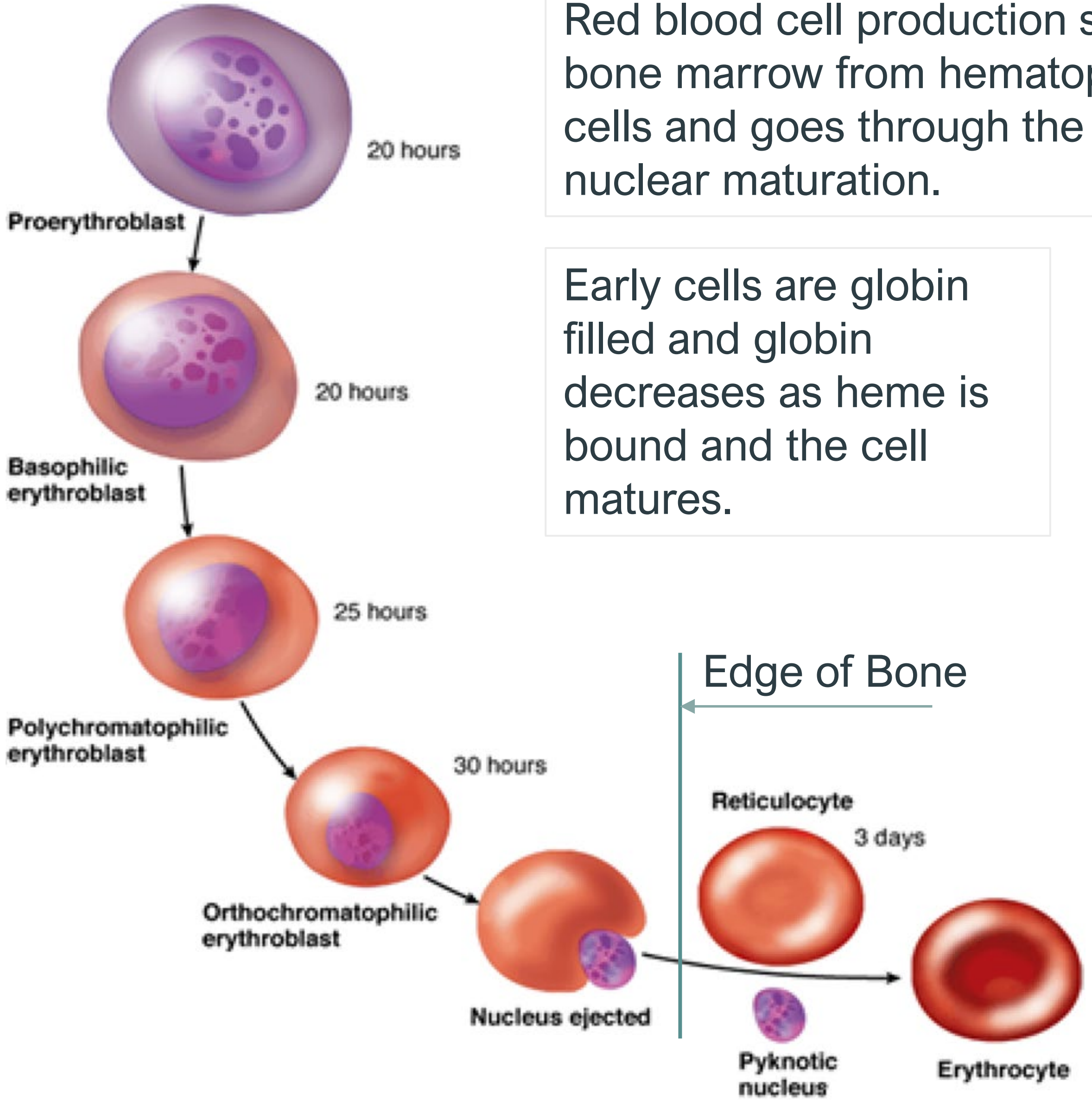


Erythropoiesis and the Effect of Nutritional Insufficiency on Nuclear Maturation


Stem cell
Proerythroblast
Myeloblast
Lymphoblast
Monoblast
Mega-karyoblast
Early erythroblast
Progranulocyte
Inter-mediate erythroblast
Baso-philic myelo-cyte
Eosino-philic myelo-cyte
Neutro-philic myelo-cyte
Mega-karyocyte
Late erythroblast
Nucleus extruded
Reticulo-cyte
Baso-philic band cell
Eosino-philic band cell
Neutro-philic band cell
Monocyte
Mega-karyocyte breakup
Red blood cell
Basophil
Eosinophil
Neutrophil
Lymphocyte
Platelets
Granulocytes
Agranulocytes
White blood cells

Red blood cell production starts in the bone marrow from hematopoietic stem cells and goes through the process of nuclear maturation.

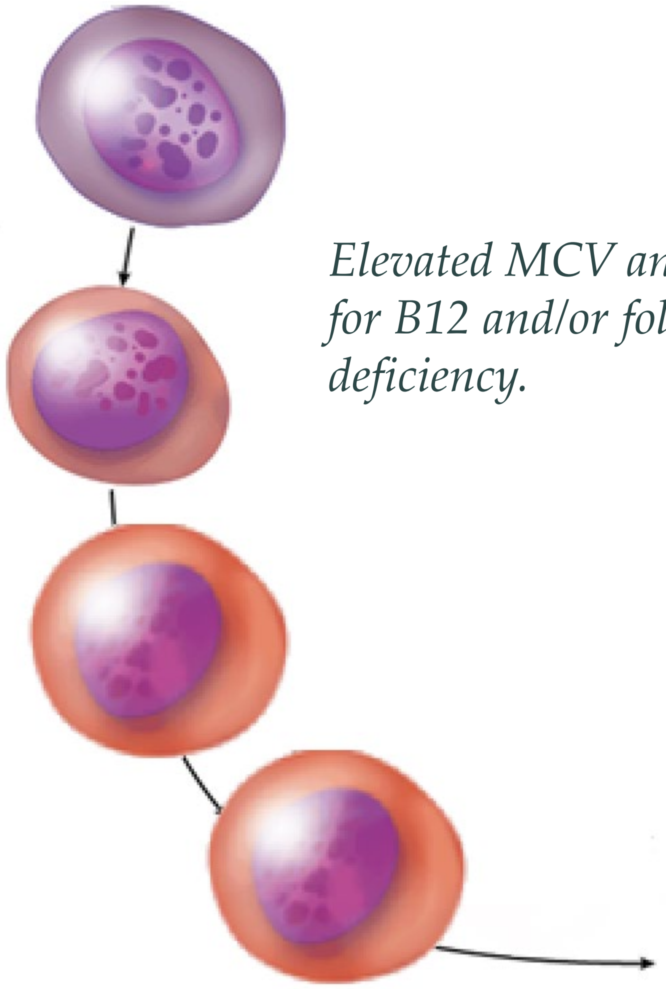
Early cells are globin filled and globin decreases as heme is bound and the cell matures.



See the nucleus getting smaller?

See the nucleus getting ejected from the reticulocyte?

Fully matured red blood cell and contains no nucleus.

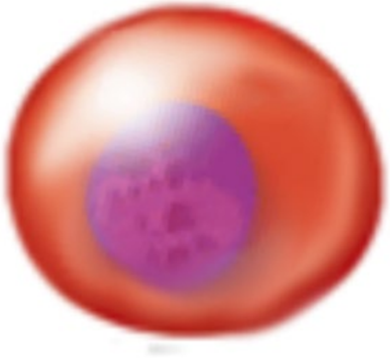


Elevated MCV and look for B12 and/or folate deficiency.

Red blood cell production starts in the bone marrow from hematopoietic stem cells and goes through the process of nuclear maturation.

B12 and folate are required for nuclear maturation. In B12 and/or folate deficiency, the nucleus doesn’t shrink, and the cell is larger than normal.

Edge of Bone



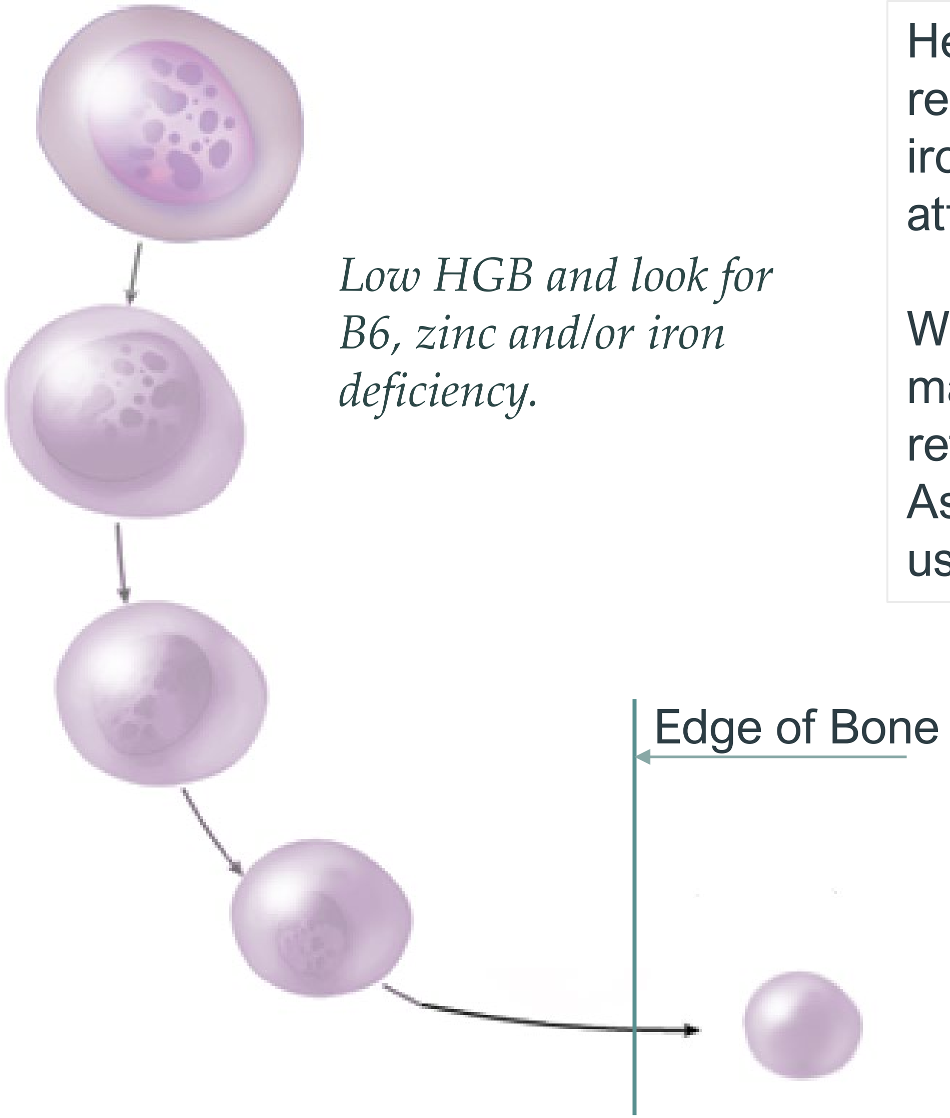
Macrocytic – very large in size

Hyperchromic – very red in color

Heme – For heme to be created, B6 and zinc are required. The polyporphyrin ring also needs to have iron attached to finish creating heme which can now attach to globin to make hemoglobin.

Without each of these 3 nutrients, heme cannot be made, and therefore no hemoglobin is made, so the reticulocyte ends up being too small, or microcytic. As it lacks any oxygen binding properties, it is usually very pale, or hypochromic.

Low HGB and look for B6, zinc and/or iron deficiency.

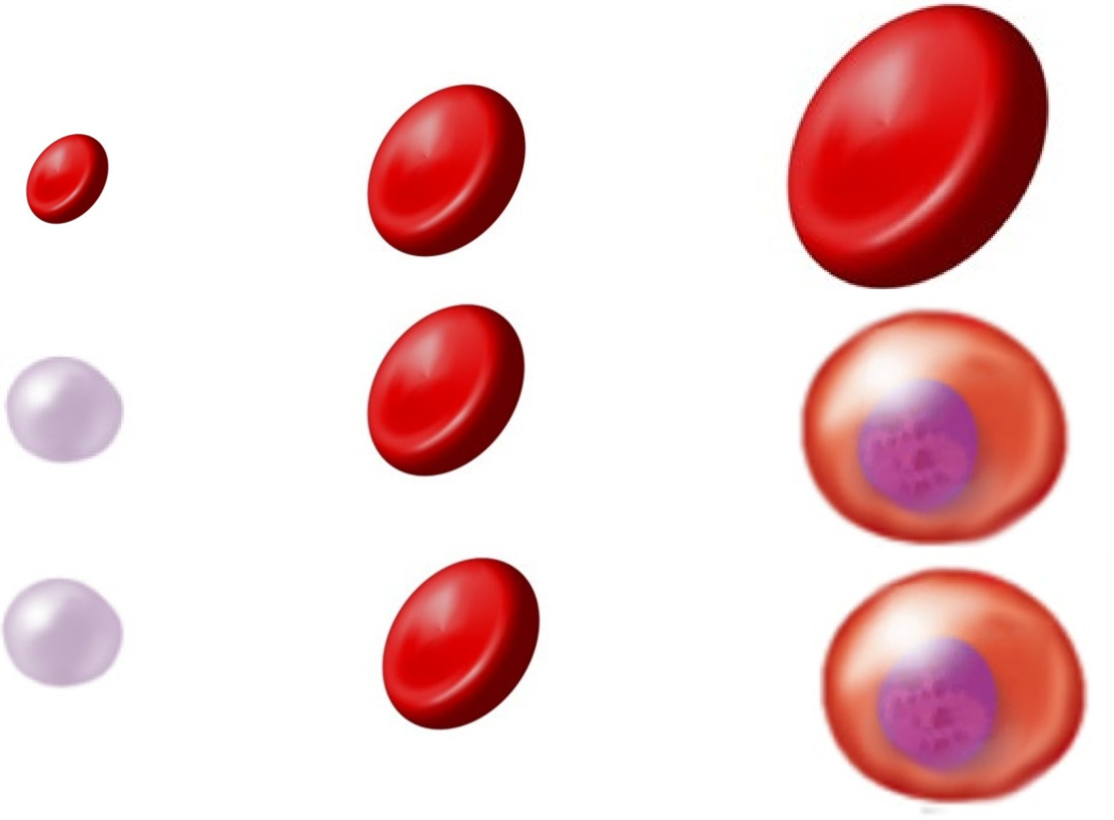


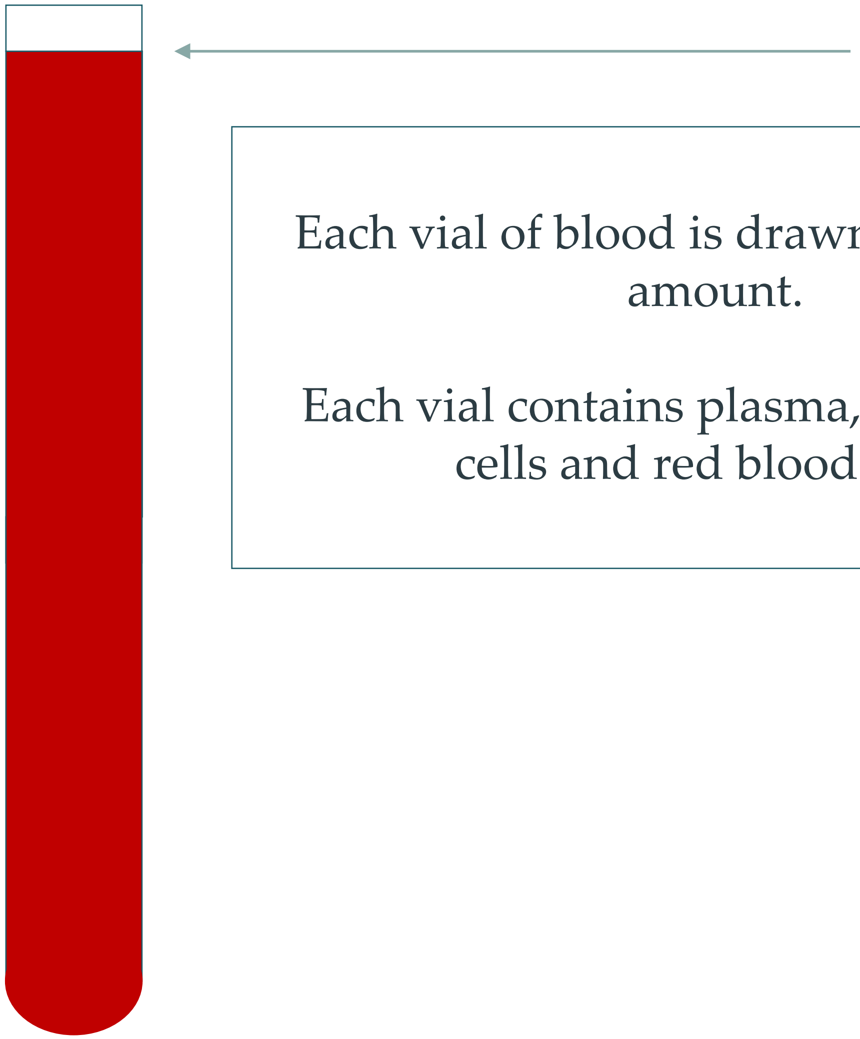
Microcytic – very small in size
Hypochromic – very pale in color

MCV

MCH

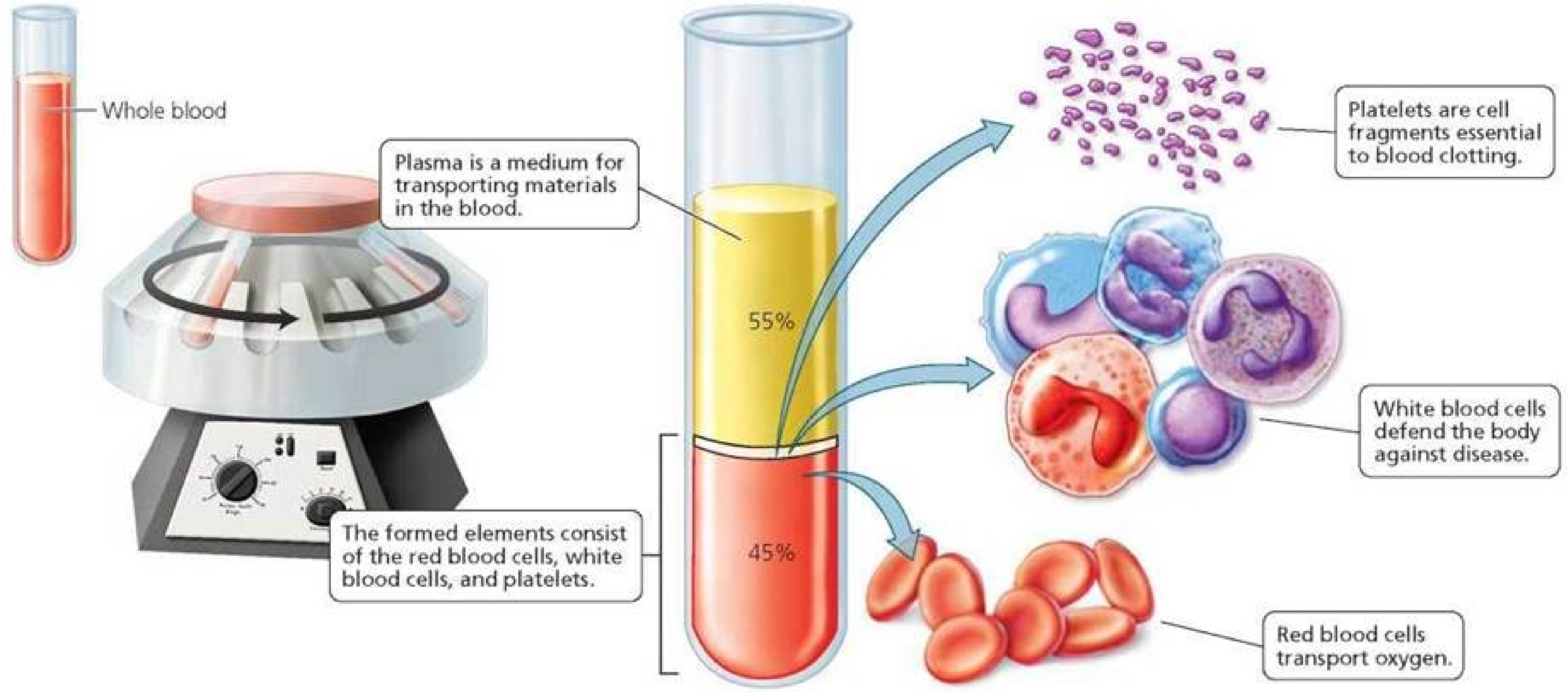
MCHC

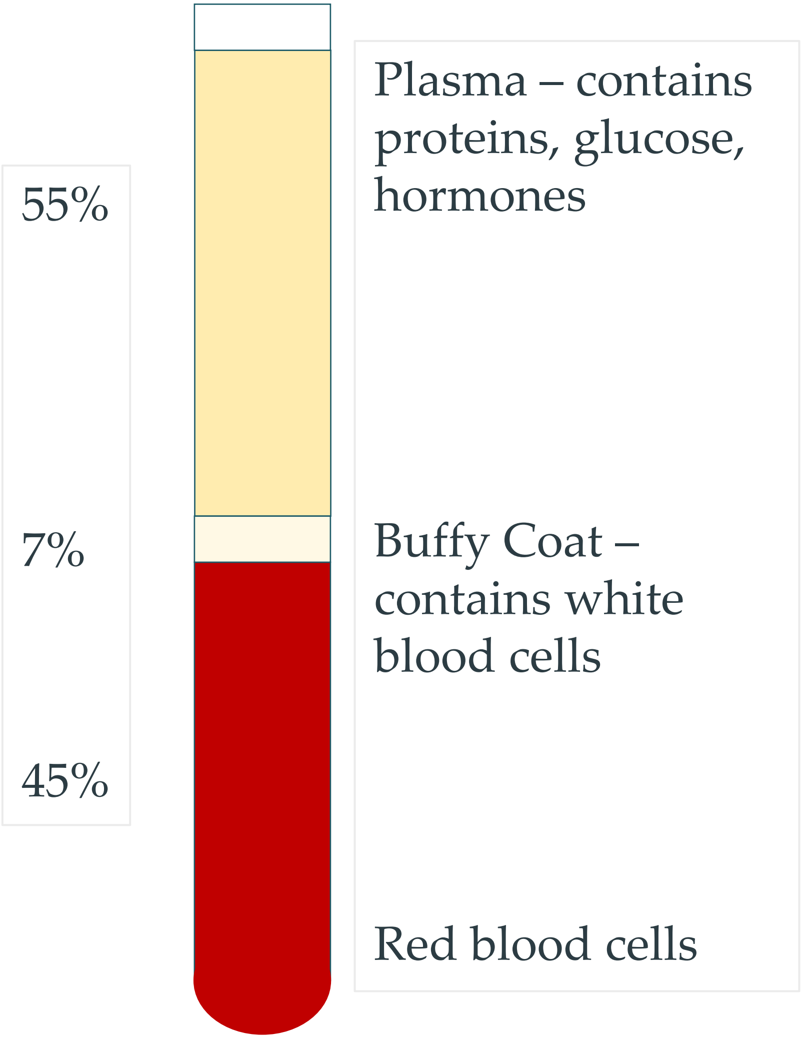




Each vial of blood is drawn to a specific amount.

Each vial contains plasma, white blood cells and red blood cells.


Whole blood
Plasma is a medium for transporting materials in the blood.
55%
45%
The formed elements consist of the red blood cells, white blood cells, and platelets.
Platelets are cell fragments essential to blood clotting.
White blood cells defend the body against disease.
Red blood cells transport oxygen.



Plasma is the largest part of your blood. It, makes up more than half (about 55%) of its overall content and plasma itself is just over 91% water. When separated from the rest of the blood, plasma is a light yellow liquid. Plasma carries water, salts, lipids and enzymes.
The main role of plasma is to take nutrients, hormones, and proteins to the parts of the body that need it. Plasma is the vehicle for everything.

Cells also put their waste products into the plasma. The plasma then helps remove this waste from the body. Blood plasma also carries all parts of the blood through your circulatory system.
Along with water, salt, and enzymes, plasma also contains important components. These include antibodies, clotting factors, and the proteins albumin and fibrinogen.

Plasma Proteins

Plasma proteins are the most abundant substances in the plasma and are present in three major types, namely, albumin, globulins, and fibrinogen. They play specialized roles as follows:

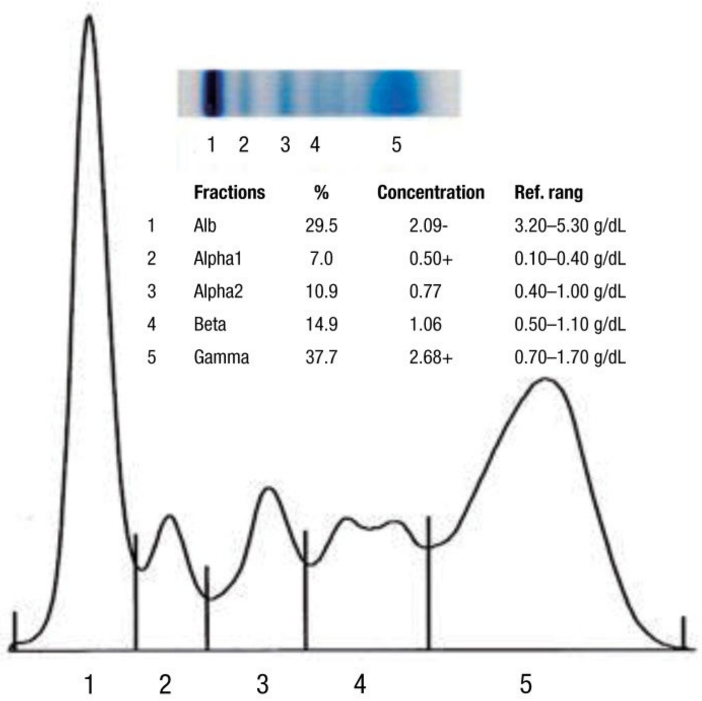
Albumin

Albumin helps maintain the colloid osmotic pressure of the blood. It is the smallest in size among the plasma proteins but makes up the largest percentage. The colloid osmotic pressure of the blood is important in maintaining a balance between the water inside the blood and that in the tissue fluid, around the cells. When the plasma proteins are deficient, the water in the plasma seeps out into the space around the blood vessels and may result in interstitial edema, a feature of liver disorders, kidney disease and malnutrition, for instance. Albumin also helps transport many substances such as drugs, hormones, and fatty acids.

Globulins

Globulins are of three types, alpha, beta, and gamma, from smallest to largest. Gamma-globulins are called antibodies. The alpha globulins include the high-density lipoproteins (HDL) which are important in carrying fats to the cells for building various substances as well as for energy metabolism. HDL is best known for its role in preventing plaque formation by keeping cholesterol in transport within the blood. Low-density lipoproteins (LDL) are beta globulins which transport fat to the cells for steroid and cell membrane synthesis. It also promotes cholesterol plaque formation which is a risk factor for arterial and heart disease.

Antibodies or gamma globulins are also called immunoglobulins. They are produced by the B lymphocytes, a subset of the immune cells. Antibodies are responsible for the body's humoral immune function, recognizing pathogens via specific receptors and neutralizing them by various mechanisms.



Fibrinogen

Fibrinogen is an important soluble plasma clotting factor precursor, which is converted to a threadlike protein called fibrin on contact with a sticky surface. The fibrin threads formed in this way trap platelets to form the primary platelet clot on which a stable blood clot is formed by the process of coagulation.

High values

High values may be caused by many conditions. Some of the most common are shown here.

High albumin: Dehydration

High alpha-1 globulin: Infection; inflammation

High alpha-2 globulin: Inflammation; kidney disease

High beta globulin: Very high cholesterol; low iron (iron-deficiencyanemia)

High gamma globulin: Inflammation; infection; liver disease; some forms of cancer

Low values

Low values may be caused by many conditions. Some of the most common are shown here.

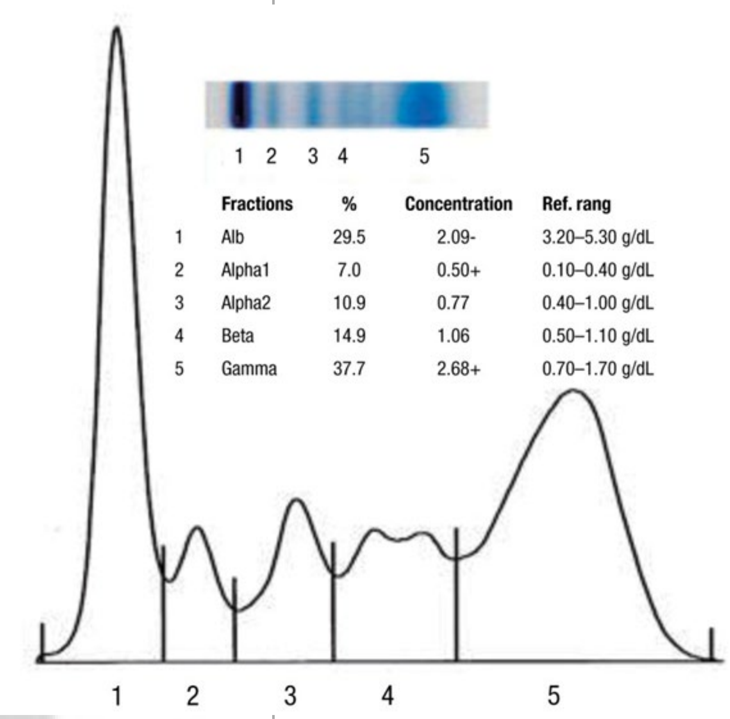
Low albumin: Poor nutrition; inflammation; liver disease; kidney disease

Low alpha-1 globulin: Severe inflammation; liver disease

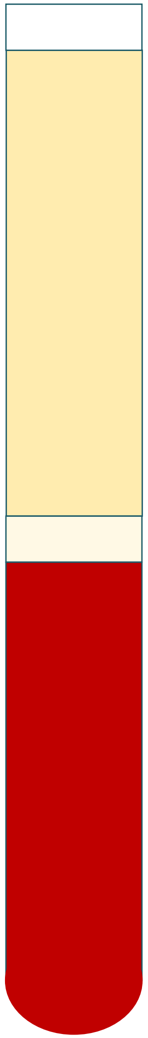
Low alpha-2 globulin: Thyroid problems; liver disease

Low beta globulin: Poor nutrition

Low gamma globulin: Problems with the immune system



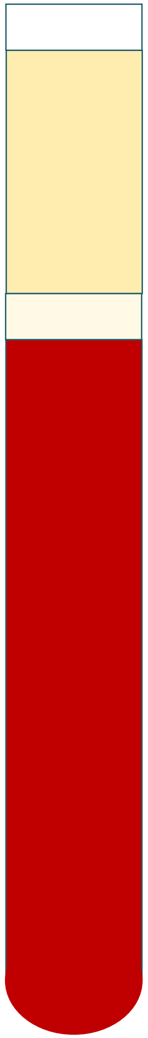
	Fractions	%	Concentration	Ref. rang
1	Alb	29.5	2.09-	3.20–5.30 g/dL
2	Alpha1	7.0	0.50+	0.10–0.40 g/dL
3	Alpha2	10.9	0.77	0.40–1.00 g/dL
4	Beta	14.9	1.06	0.50–1.10 g/dL
5	Gamma	37.7	2.68+	0.70–1.70 g/dL



Fully hydrated

Dehydrated

Plasma contains lipids, glucose, albumin, urea



More RBCs in sample due to less water in the blood will appear to be higher

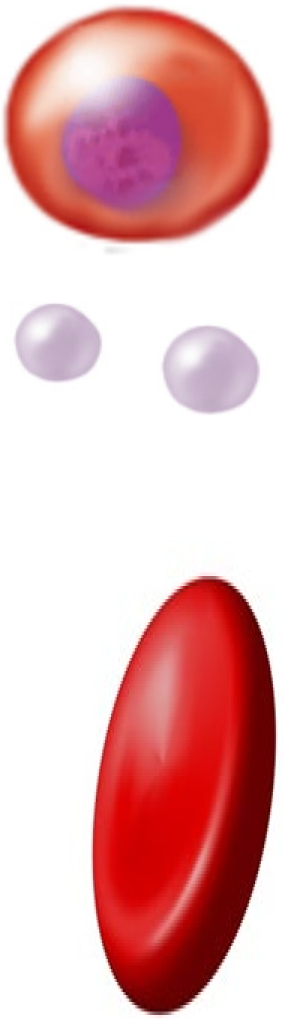
Cholesterol

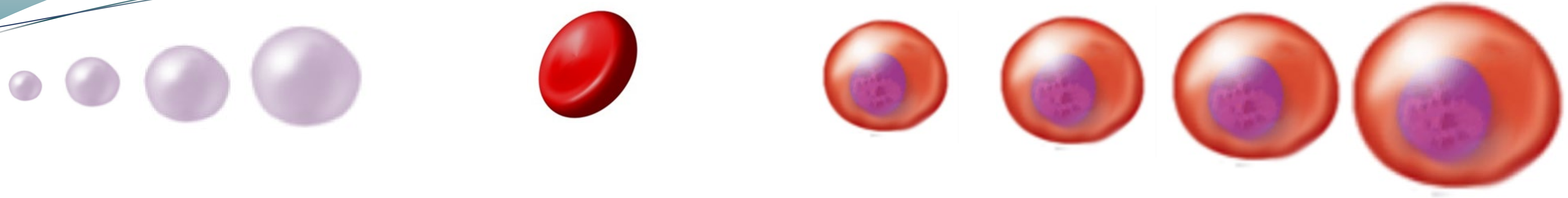
When the water intake is too low, several changes will also take place within the body to respond to the conditions. For example, your body will increase the production of cholesterol, so that it can keep the cell membranes pliable and moist.

When your body lacks fluids, a series of changes can take place. The increase of blood cholesterol levels can be considered as a perfect example for a change that can happen within your body. The body will then try to deposit the increased cholesterol levels within the cellular membranes of your body. This will be done as a natural protective mechanism, so that the body can make sure no more water is lost. This fact has been verified by scientific studies as well.

Lack of water, through the view of hemoconcentration, also make the amount of cholesterol in the blood higher than what it may be.

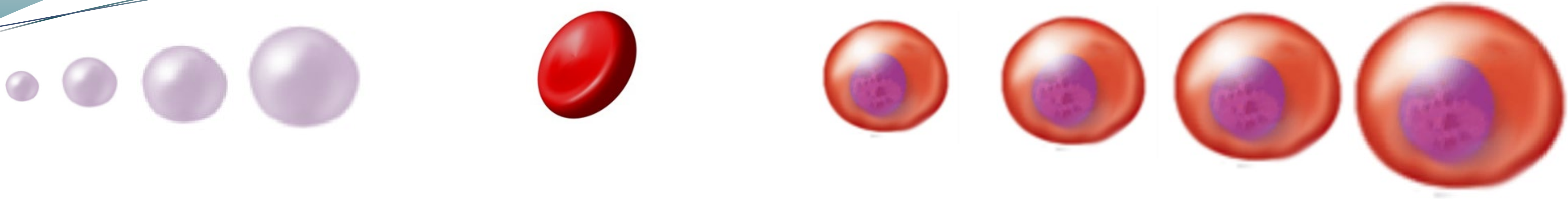
RBC [Female]	4.51	3.9 - 4.5 x10^6/µL
Hemoglobin [Male]		13.5 - 14.5 g/dL
Hemoglobin [Female]	14.1	13.0 - 14.0 g/dL
Hematocrit [Male]		38 - 46%
Hematocrit [Female]	41	37 - 44%
MCV	91	82.0 - 89.9 fL
MCH	31.3	28.0 - 31.9 pg
MCHC	34.4	32 - 35 g/dL
RDW	11.8	11 - 13%



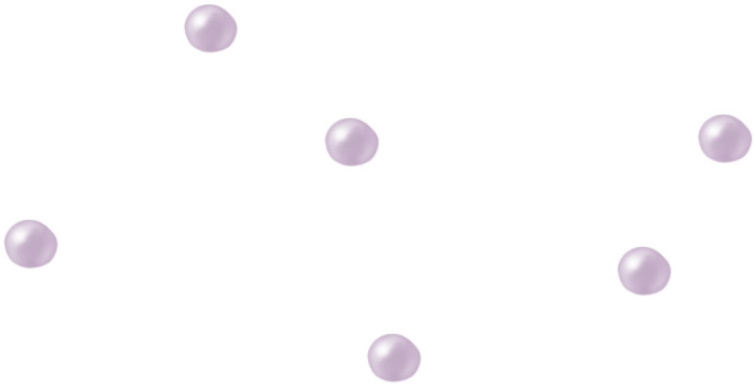


How many different sizes do you see here?

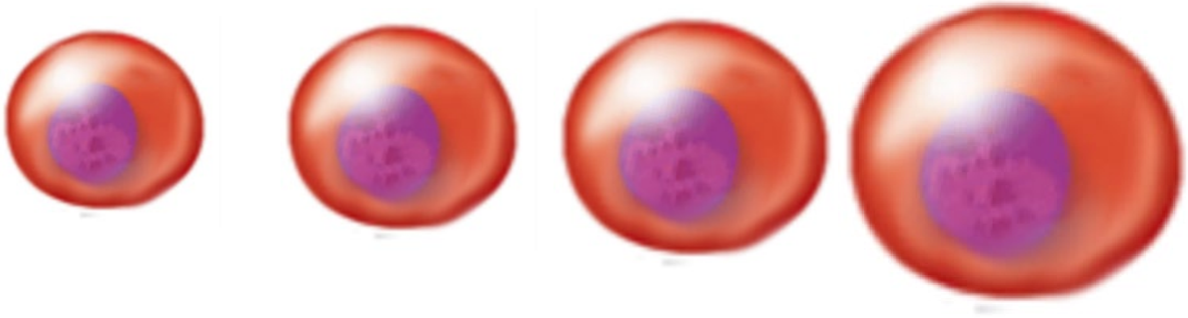
Nothing happens in a vacuum and nothing happens fast.



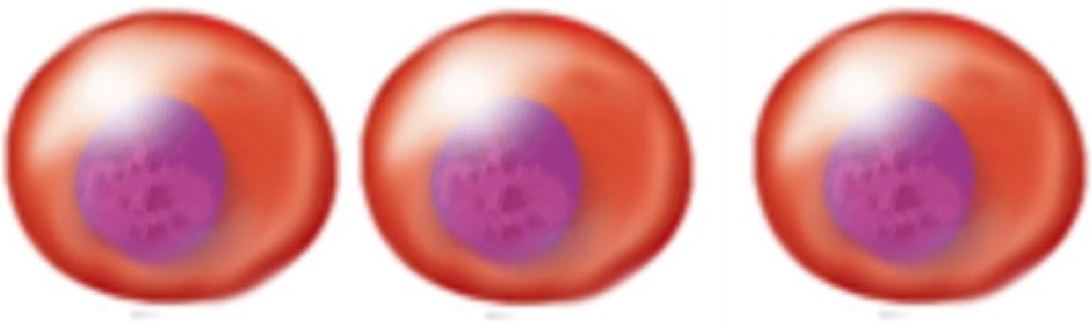
Describe what we know about these cells



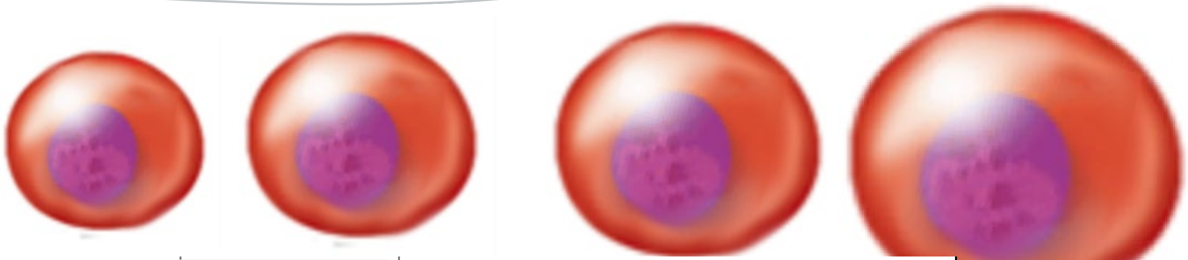
What would we expect the RDW to be and why?



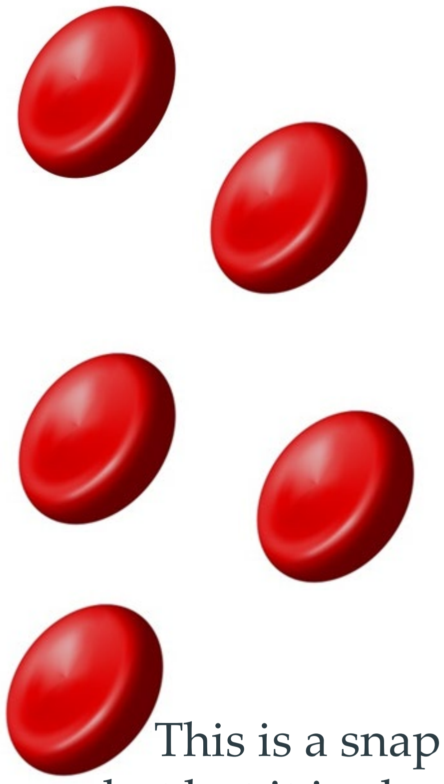
Describe what we know about these cells



What would we expect the RDW to be and why?



Month 1 – RDW 12

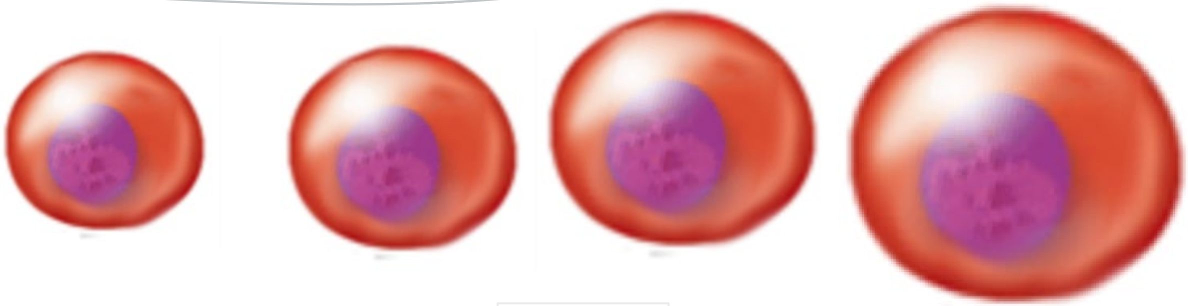


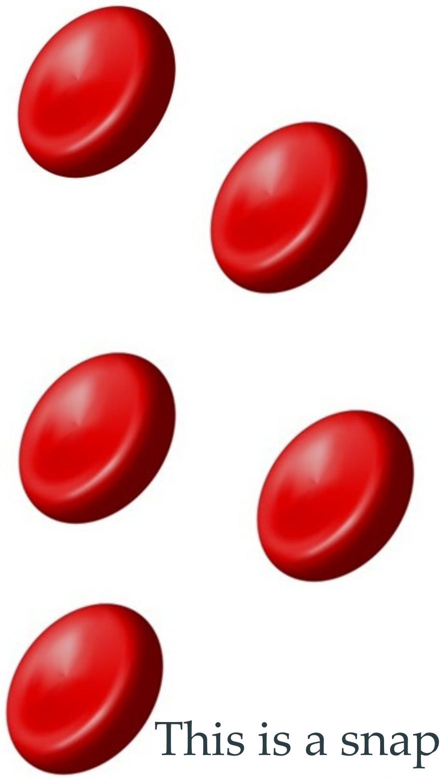
This is a snap shot but it is also a 4 month view.

RBC [Female]	4.20	3.9 - 4.5 x10^6/µL
Hemoglobin [Male]		13.5 - 14.5 g/dL
Hemoglobin [Female]	13.5	13.0 - 14.0 g/dL
Hematocrit [Male]		38 - 46%
Hematocrit [Female]	41	37 - 44%
MCV	85	82.0 - 89.9 fL
MCH	30	28.0 - 31.9 pg
MCHC	34	32 - 35 g/dL
RDW	12	11 - 13%

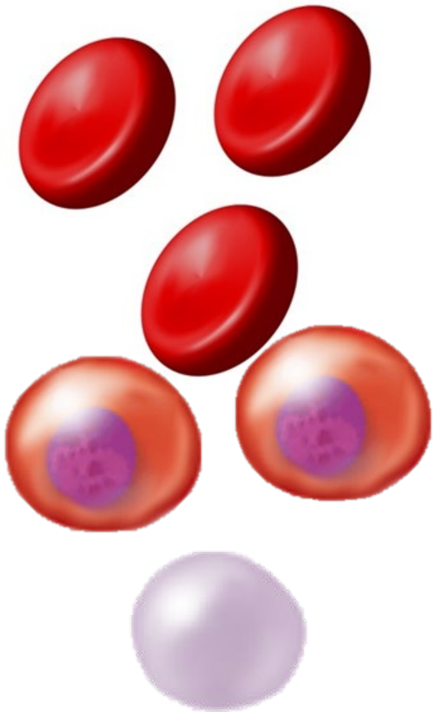
Month 1 – RDW 12

Month 2 – RDW 12.9



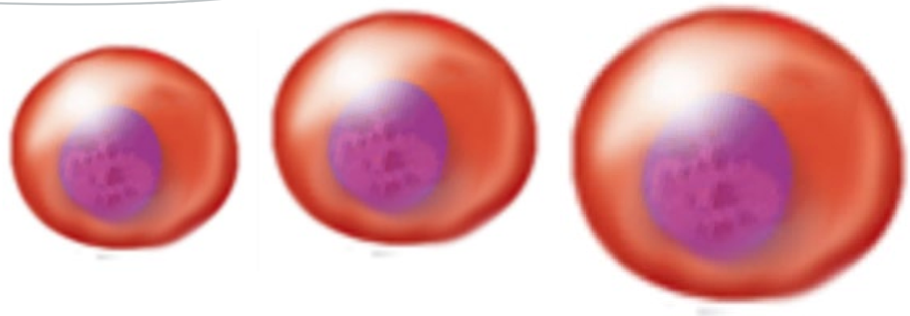


This is a snap shot but it is also a 4 month view.



B12 and iron deficiency starting to show up and variability is rising.

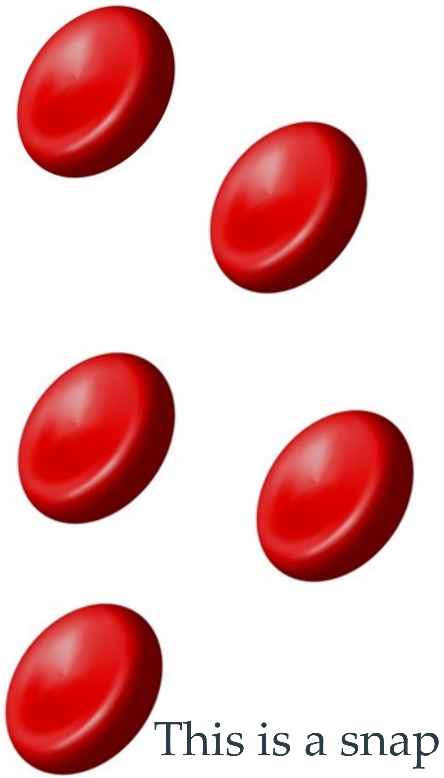
RBC [Female]	4.20	3.9 - 4.5 x10^6/μL
Hemoglobin [Male]		13.5 - 14.5 g/dL
Hemoglobin [Female]	12.9	13.0 - 14.0 g/dL
Hematocrit [Male]		38 - 46%
Hematocrit [Female]	41	37 - 44%
MCV	90	82.0 - 89.9 fL
MCH	30	28.0 - 31.9 pg
MCHC	33	32 - 35 g/dL
RDW	12.9	11 - 13%



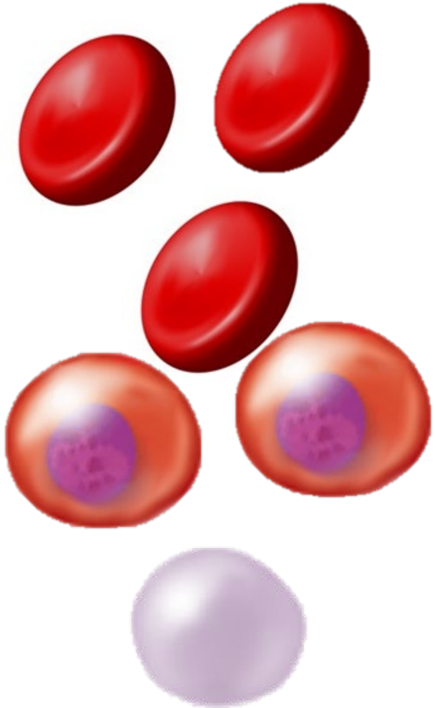
Month 1 – RDW 12

Month 2 – RDW 12.9

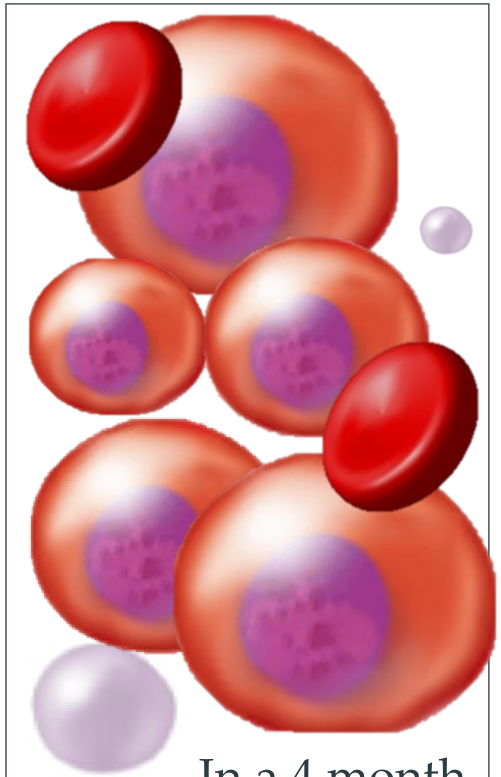
Month 3 – RDW 14.5



This is a snap shot but it is also a 4 month view.



B12 and iron deficiency starting to show up and variability is rising.



In a 4 month window, anemia can have many cell sizes.

Several bigs, a few optimal and a few small

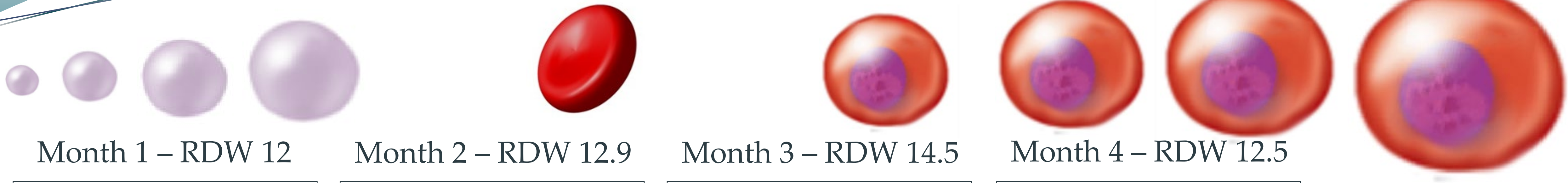
RBC [Female]	4.20	3.9 - 4.5 x10^{6}/µL
Hemoglobin [Male]		13.5 - 14.5 g/dL
Hemoglobin [Female]	12.5	13.0 - 14.0 g/dL
Hematocrit [Male]		38 - 46%
Hematocrit [Female]	40	37 - 44%
MCV	94	82.0 - 89.9 fL
MCH	30.9	28.0 - 31.9 pg
MCHC	35	32 - 35 g/dL
RDW	14.5	11 - 13%

How would it change if there were several smalls and only a few bigs?

RBC [Female]	4.20	3.9 - 4.5 x10^{6}/µL
Hemoglobin [Male]		13.5 - 14.5 g/dL
Hemoglobin [Female]	?	13.0 - 14.0 g/dL
Hematocrit [Male]		38 - 46%
Hematocrit [Female]	?	37 - 44%
MCV	?	82.0 - 89.9 fL
MCH	?	28.0 - 31.9 pg
MCHC	?	32 - 35 g/dL
RDW	14.5	11 - 13%

What would dehydration look like in each example?

RBC [Female]	4.20	3.9 - 4.5 x10^6/µL	RBC [Female]	4.20	3.9 - 4.5 x10^6/µL
Hemoglobin [Male]		13.5 - 14.5 g/dL	Hemoglobin [Male]		13.5 - 14.5 g/dL
Hemoglobin [Female]	12.5	13.0 - 14.0 g/dL	Hemoglobin [Female]	11.9	13.0 - 14.0 g/dL
Hematocrit [Male]		38 - 46%	Hematocrit [Male]		38 - 46%
Hematocrit [Female]	40	37 - 44%	Hematocrit [Female]	37	37 - 44%
MCV	94	82.0 - 89.9 fL	MCV	92	82.0 - 89.9 fL
MCH	30.9	28.0 - 31.9 pg	MCH	28	28.0 - 31.9 pg
MCHC	35	32 - 35 g/dL	MCHC	33	32 - 35 g/dL
RDW	14.5	11 - 13%	RDW	14.5	11 - 13%

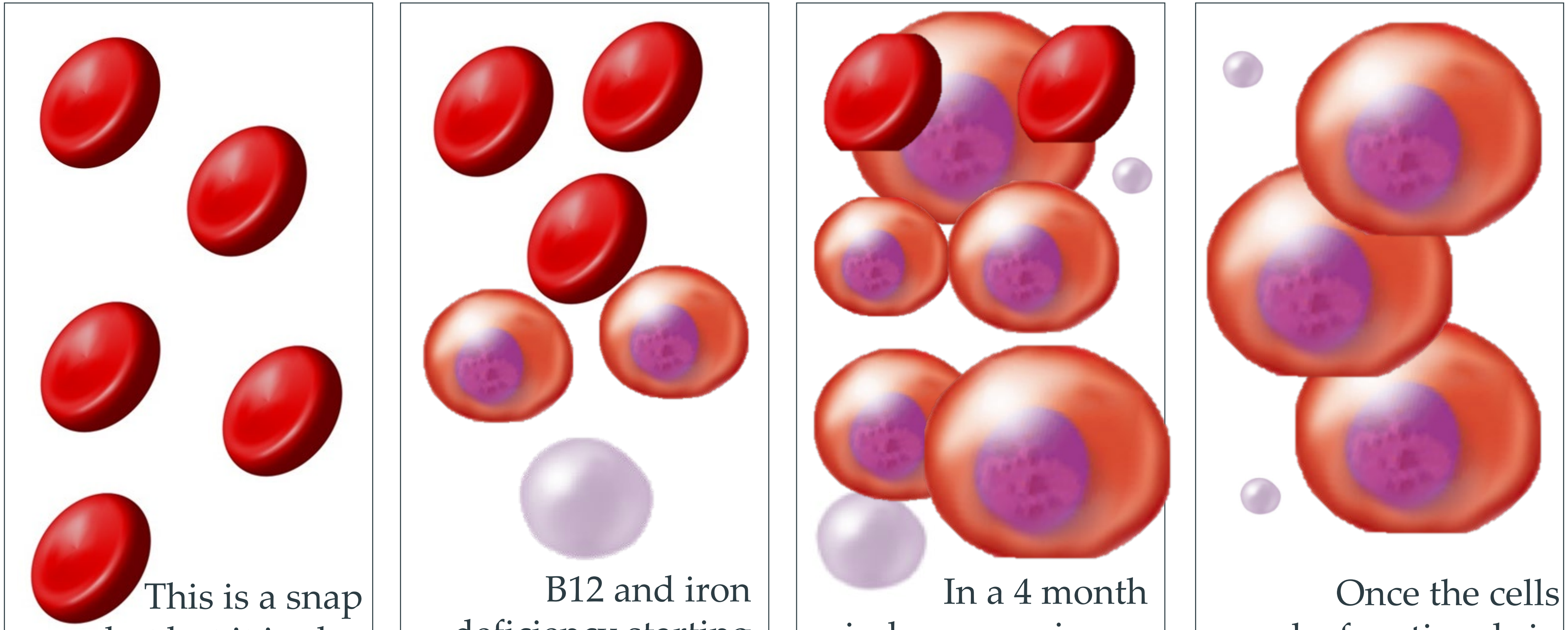


Month 1 – RDW 12

Month 2 – RDW 12.9

Month 3 – RDW 14.5

Month 4 – RDW 12.5



This is a snap shot but it is also a 4 month view.

B12 and iron deficiency starting to show up and variability is rising.

In a 4 month window, anemia can have many cell sizes.

Once the cells reach their dysfunctional size, the RDW lowers as the variability changes.

RBC [Female]	4.20	3.9 - 4.5 x10^6/µL
Hemoglobin [Male]		13.5 - 14.5 g/dL
Hemoglobin [Female]	13.5	13.0 - 14.0 g/dL
Hematocrit [Male]		38 - 46%
Hematocrit [Female]	41	37 - 44%
MCV	85	82.0 - 89.9 fL
MCH	30	28.0 - 31.9 pg
MCHC	34	32 - 35 g/dL
RDW	12	11 - 13%