

Self-Guided Learning Module Handout

Day 1 Bell Ringer Quiz (5 minutes)

Identify the following separation techniques as being suitable for separating liquid-based homogeneous or heterogeneous mixtures. Write “homo” or “hetero” next to each technique word.

filtration: _____ sedimentation: _____ distillation: _____

chromatography: _____ centrifugation: _____ coagulation: _____

Activation Strategy (Total time: 13 to 15 minutes)

Task 1 (10 minutes)

Transfer the composition of urine, blood and milk onto the circle maps on the next page. Also indicate the material type by checking the correct box for each liquid: pure substance, mixture or compound.

Table 1. Composition of the characteristics of three everyday liquids.

Normal Human Urine	Normal Human Blood	Normal Cow's Milk
<p>Urine is an aqueous solution of greater than 95% water, with the remaining constituents, in order of decreasing concentration: urea 9.3 g/l, chloride 1.87 g/l, sodium ion 1.17 g/l, potassium ion 0.750 g/l, creatinine (a chemical waste product excreted in the urine), 0.670 g/l and other dissolved ions, inorganic and organic compounds.</p>	<p>Nearly 44% of blood is composed of red blood cells (aka erythrocytes). A red blood cell has hemoglobin—a red-colored protein-based pigment, rich in iron. Nearly 55% of blood is composed of a fluid called plasma that contains 92% water and 8% of the following constituents: lipids, proteins, glucose (sugar), mineral ions including sodium and chloride ions, hormones, fibrinogen and carbon dioxide. About 1% of the blood is made of white blood cells (aka leukocytes) and platelets (aka thrombocytes).</p>	<p>Cow's milk is about 87% water in which are 4% sodium ions and 10% potassium ions. Fat constitutes approximately 4%, casein (white-colored protein-based pigment that is rich in calcium) constitutes about 4% and lactose (sugar) constitutes 5%.</p>
		
<p>Source: 2011 Turbotorque, Wikimedia Commons</p>	<p>Source: 2005 Crystal, Wikimedia Commons</p>	<p>Source: 2003 Stefan Kühn, Wikimedia Commons</p>

What type of material is **urine**? pure substance mixture compound

The diagram for urine classification features a central circle labeled "Normal human urine". To its left is a box labeled "Dispersion medium or the solvent" with a downward arrow pointing to an empty box. To its right are two boxes: "Dispersed solutes" with a downward arrow to an empty box, and "Dissolved solutes" with a downward arrow to an empty box. A large blue oval encircles the "Dispersed solutes" box, the central circle, and the "Dissolved solutes" box. A curved line connects the top of the "Dispersed solutes" box to the top of the "Dissolved solutes" box.

What type of material is **blood**? pure substance mixture compound

The diagram for blood classification features a central circle labeled "Normal human blood". To its left is a box labeled "Dispersion medium or the solvent" with a downward arrow pointing to an empty box. To its right are two boxes: "Dispersed solutes" with a downward arrow to an empty box, and "Dissolved solutes" with a downward arrow to an empty box. A large blue oval encircles the "Dispersed solutes" box, the central circle, and the "Dissolved solutes" box. A curved line connects the top of the "Dispersed solutes" box to the top of the "Dissolved solutes" box.

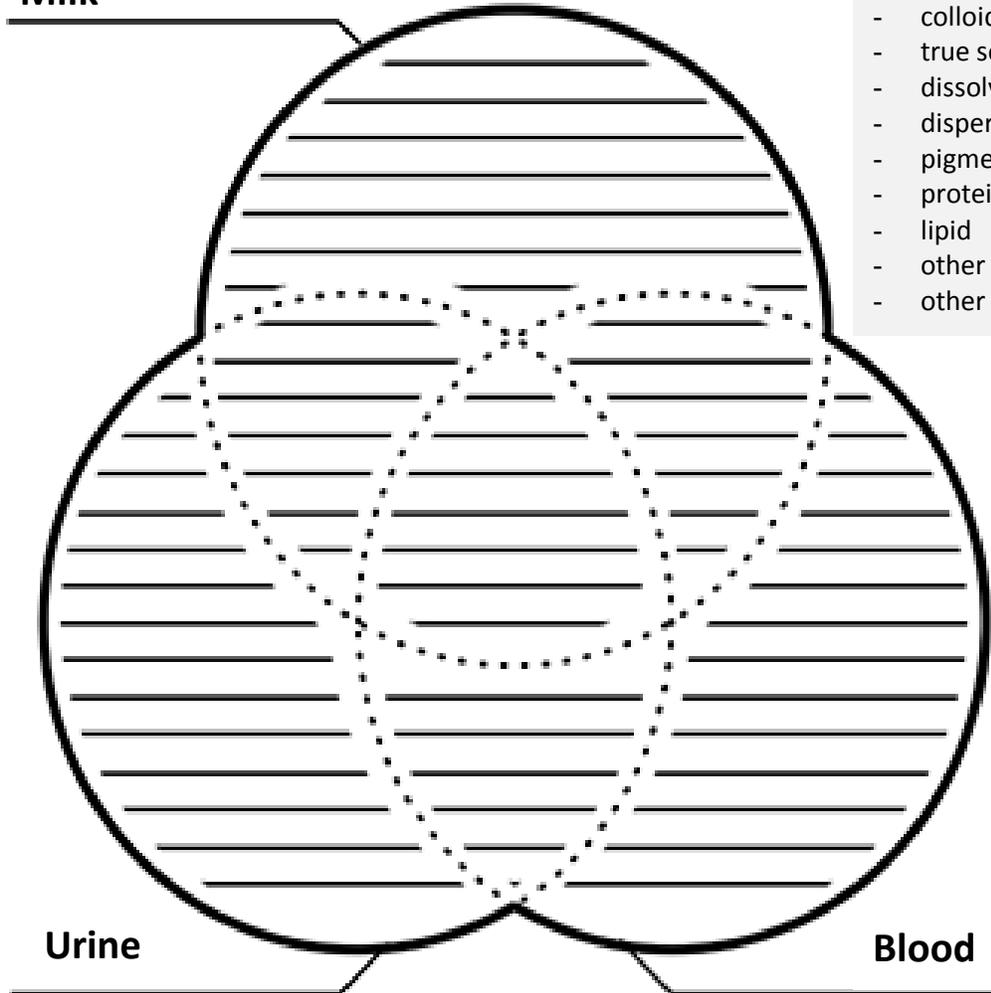
What type of material is **milk**? pure substance mixture compound

The diagram for milk classification features a central circle labeled "Normal cow's milk". To its left is a box labeled "Dispersion medium or the solvent" with a downward arrow pointing to an empty box. To its right are two boxes: "Dispersed solutes" with a downward arrow to an empty box, and "Dissolved solutes" with a downward arrow to an empty box. A large blue oval encircles the "Dispersed solutes" box, the central circle, and the "Dissolved solutes" box. A curved line connects the top of the "Dispersed solutes" box to the top of the "Dissolved solutes" box.

Task 2: Warm-Up Summarization: (5 minutes)

Summarize the Table 1 analysis of the composition of urine, blood and milk in the three-circle Venn diagram below. Use the terms and phrases from the provided list. Complete your summarization by answering the questions below the diagram.

Milk



Use the correct terminology:

- aqueous solution
- colloidal solution
- true solution
- dissolved solutes
- dispersed solutes
- pigment
- protein
- lipid
- other specific constituents
- other characteristics

Question 1: From your analysis of solution properties, is it correct if we arrange these three liquids in the following order of their number of mixture contents? “Urine has fewer mixture contents than milk, and milk has fewer mixture contents than blood, so: urine < milk < blood.” Yes or No (circle the correct answer)

Question 2: Urine, blood and milk: Which two of these liquids three are closely similar in solution characteristics? Write your answer and explanation below.

Class Work-1

Task 3: Brainstorming Exercise and Formulating Hypothesis (20 minutes)

What type of mixture is blood? Homogeneous or heterogeneous?

In your warm-up exercise, you found a number of similarities in the solution properties of blood and milk. You inferred that both milk and blood are homogeneous solutions, which are colloidal in nature. You may now want to make a more detailed analysis of facts about milk and blood to establish your earlier inference. You are provided with a set of visuals and a note on the ESR test below. Analyze them.

Additionally, as you watch a few video clips, record your analytical viewpoints in the Table 2 chart.

Finally, formulate a hypothesis to answer the question: *What type of mixture is blood?*

Task 3.1: Analyze the Visuals (3 to 4 minutes)

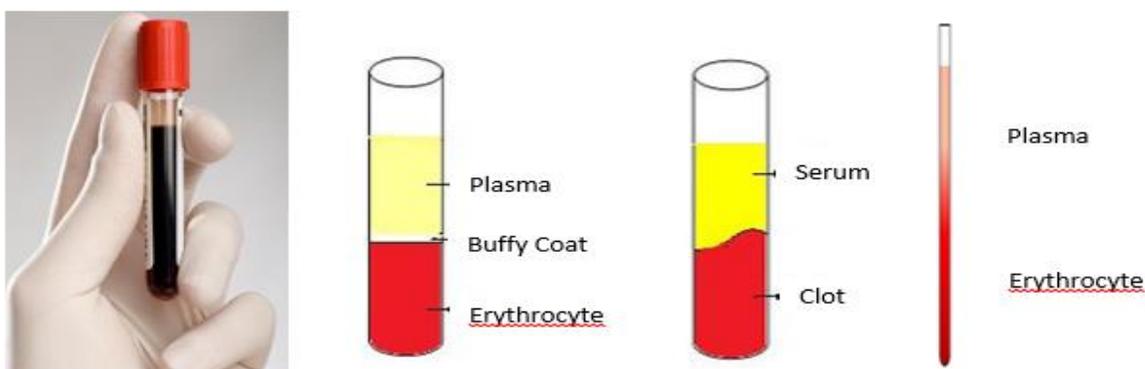


Figure 1. Whole blood and separated blood. Whole blood does not have a long shelf life. Whole blood can be stored at 4 °C for 48-72 hours prior to separation. Blood can separate into three parts or two parts; and in two parts, it has two different modes. The segregation of erythrocytes from blood (far left) is used as a clinical tool (ESR test¹) for the identification of several disease conditions.

¹ The erythrocyte sedimentation rate (ESR) is a relatively simple, inexpensive, non-specific long-used test to detect inflammation associated with conditions such as infections, cancers and autoimmune diseases. The EST test is a measure of the settling of red blood cells in a thin, tall, vertical tube of blood during one hour.

Task 3.2: Watch Video Clips (5 to 6 minutes)

As you watch the online videos, record your notes in the chart below.

Video URL and Your Notes	
1	Blood clotting by snake’s venom: http://www.youtube.com/watch?v=4WvniCkLbvY (1.1 mins) 1. 2. 3.
2	Demonstration of milk curdling: www.youtube.com/watch?v=m9sIBgfllFs (1.29 mins) 1. 2. 3.
3	Blood testing facts: https://www.youtube.com/watch?v=wCyug61-r_c (View at 37 to 60 secs only) ² 1. 2. 3.
4	Sedimentation: https://www.youtube.com/watch?v=E9rHSLUr3PU (View at 0.00 to 0.29 secs only) 1. 2. 3.

²This is a long video; you are only required to watch the segment between 37 and 60 seconds.

Class Work-2

Tasks 4 to 7: Preparing for Experimental Design (20 minutes)

Evaluating the Suitability of a Given Model and Probing further to Ascertain Facts

Task 4 (3 to 4 minutes)

Question 4: Evaluation of Milk as a Model

How would you evaluate the use of milk as a model for blood given that direct use of blood in lab studies is not conducive for school settings because of its infectious nature? Indicate your answer in the chart.

A	Milk can be used as a model for blood because it closely resembles it in its composition, features, stability, coagulation tendency and functions.	yes/no
B	Milk cannot be used as a model for blood because it does not closely resemble it in its composition, features, stability, coagulation tendency and functions.	yes/no

Fully explain why you selected your answers for A and B:

Task 5 (8 min): Question 5:

Analyze the visual fact sheet in Figure 2. Calculate the weighted average density of blood. Then compare the calculated weighted average density with the density of normal human blood.

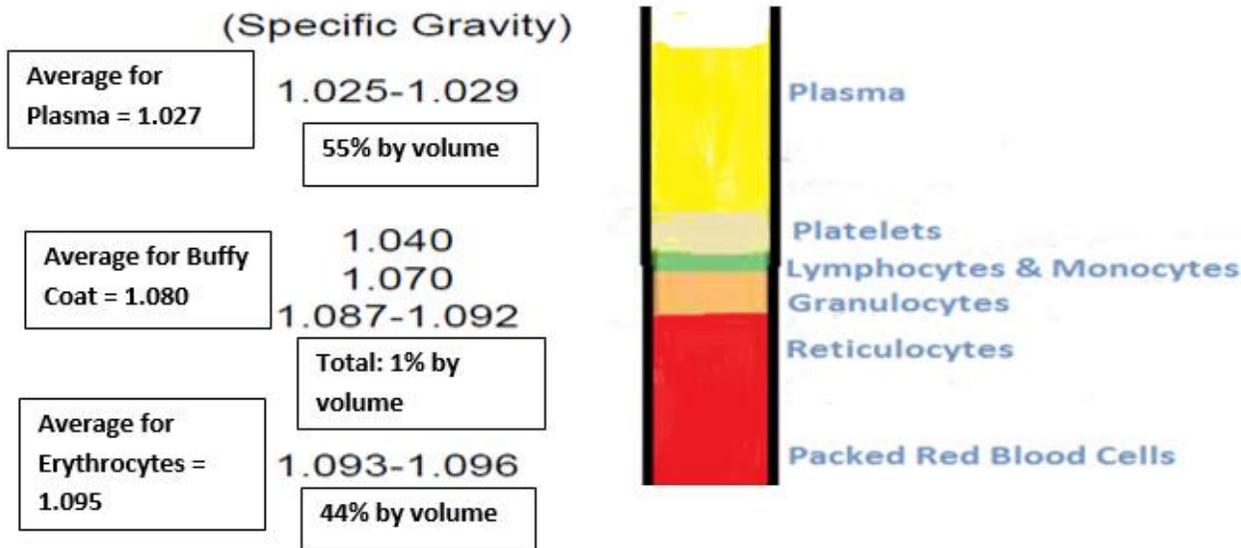


Figure 2. Specific gravity of separated layers of blood obtained by the centrifugation process. Knowing this information, what is the average specific gravity of normal human blood? Source: This fact sheet was adapted with permission from page 19 at: http://c.ymcdn.com/sites/www.apheresis.org/resource/collection/387FC8D3-D586-4DC2-A60D-EA1A83285A68/Fri_1515_2_ES_V_Stec_Seaciff_A_&_B_update.pdf

Specific gravity of plasma =
Specific gravity of the buffy coat =
Specific gravity of erythrocytes =
Weighted average specific gravity of blood (show your work) =
Average specific gravity of normal human blood =
Question 6: Does the weighted average specific gravity from the separated layers and the specific gravity of the whole blood agree? Explain your answer.
Question 7: What do you infer from this calculation? As a mixture, is blood homogeneous or heterogeneous? Explain your answer.
Question 8: What is the principle behind centrifugation? Write your answer in two complete sentences.

Task 6: Questions 9-10 (5 minutes)

Examine Figure 3 vis-à-vis Figure 2, and recall the observation you made in the video clip about the sedimentation of particles. Then answer the questions below.

Question 9: What does erythrocyte sedimentation rate indicate to you about the nature of blood as a mixture—homogeneous or a heterogeneous mixture? (You may want to refer to your earlier class notes on the techniques of separation for heterogeneous and homogeneous mixtures.)

Record your answer in the box on the next page.

Question 10: Why do erythrocytes sediment while other constituents of blood do not?

Record your answer in the box on the next page.

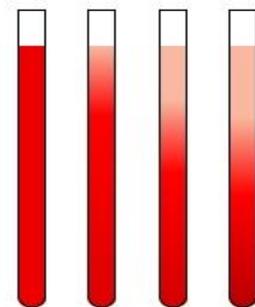


Figure 3. Erythrocyte sedimentation progression.

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Question 9 answer:

Question 10 answer:

Review what you have learned so far in this activity and prepare yourself to answer questions in the Interim Summarization (on the next page).

Interim Summarization: Formative Assessment (10 to 12 minutes)

Task 7: Fill in the blanks in statements A through S:

- A. An ESR test is based on the separation technique of _____, normally used for _____ mixtures.
- B. The fractionation of blood into plasma, buffy coat and erythrocytes is based on the technique of _____, normally used for _____ mixtures.
- C. Centrifugation has _____ separation power than conventional sedimentation.
- D. The rate of fall of particles in sedimentation is dependent on particles' _____, _____, _____ properties, and acceleration due to _____.
- E. The rate of fall of particles in sedimentation is dependent on the _____ of the liquid.
- F. Coagulation is generally brought out by adding _____ to the _____ solution.
- G. Blood is a _____ and multifunctional _____.
- H. The three kinds of blood cells are: _____, _____ and _____.
- I. Erythrocytes sediment because of their _____ density.
- J. The color of erythrocytes can be attributed to the red pigment protein called _____.
- K. The density of erythrocytes can be attributed to the presence of _____ in their pigment.
- L. "Thrombocytes" is the alternate name for _____; whose primary function is _____.
- M. "Leucocytes" is the alternate name for _____; whose primary function is _____.
- N. Plasma contains _____ of water and several _____ and _____ solutes.
- O. Which blood cell can be described as being a biconcave disc? _____
- P. The liquid portion of blood is referred to as _____.
- Q. The formation of a blood clot is known as _____.
- R. The natural tendency of blood to arrest bleeding is known as _____.
- S. Whereas the previous tendency is a normal physiological process, _____ is an undesired event and can lead to fatal consequences.
- T. In the box below, outline the design principle you will be following to conduct the experiment with the blood model to prove your hypothesis on the nature of blood as a mixture:

Pre-Lab Activity—Day 1 Homework

Task 8: Recall your thoughts and plan your action for the experiments

Through the previous tasks, you have recognized that blood is either a homogenous or a heterogeneous mixture, or neither of them or both of them (highlight whichever applies to you).

You have also found that milk is not a good model for blood for the purpose of testing blood’s mixture behavior.

However, to test your hypothesis, you need to carry out experimentation with a blood model. To assist you with the modeling process, look at the provided materials, tools and data.

- V8 beverage
- petroleum jelly (100%, Vaseline)
- olive oil
- 15-ml graduated plastic test tube, screw cap
- plastic dropper
- 3 thin wooden coffee stirrer sticks
- 2 graduated centrifuge tubes
- access to a centrifuge
- test tube holder

Density Values

- V8 beverage: 1,030 kg/m³
- petroleum jelly: 920 kg/m³
- olive oil (as purchased from a store): 840 kg/m³

Question 11: How would you prepare a blood model from the given materials?

Question 12: How would you demonstrate erythrocyte sedimentation? What methodology would you follow?

Question 13: How would you demonstrate three-layer separation of blood into erythrocytes, buffy coat and plasma? What instrumental technique would you use?

In the chart below, jot down your experimental/instrumental approach for each question:

Q #	Your Answer
11	By mixing in the ratio of:
12	By
13	By

Day 2 Bell Ringer Quiz (10 minutes)

Discuss with your group the experimental approach each of you has described in the above chart. Check for inconsistencies and consolidate your experimental design. Review with your teacher to determine if your experimental design makes sense and if you are *good to go* with the experiment.

Tasks 9-10: Experimental investigations, validation of hypothesis and theory proposal (30 minutes)

Task 9: Experimental Investigations (20 minutes): Work in your same groups for the lab. As planned, do the sedimentation part independently and give your samples to the teacher for centrifugation. Record your observations and inferences in the chart below.

Experiment	Experimental Observation	Inference
Remove the screw cap and place equal volumes of the V8 beverage and olive oil in which 1% petroleum jelly has already been dissolved. Stir it with the wooden stirrer stick. Close the test tube with the screw cap and let the test tube stand in a test tube stand. Observe the sediment falling level every five minutes. Collect three to four values at five-minute intervals.	If the ESR value for normal human blood is about 15 mm per hour, how much of a fall in erythrocytes did you observe in your blood model?	
Carefully transfer the contents of the test tube from Experiment 1 into a centrifuge tube. Use the wooden stick to stir well without splashing. Centrifuge it at a speed of 500–600 rpm.		
Use the same centrifuge tube, place it back in the centrifuge and spin it at a speed of 2500–3000 rpm.		

Question 14: What is the effect of speed of rotation on the separation of blood in centrifugation?

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Task 10: Post-lab inquiry: evaluating the hypothesis and proposing a theory (15 minutes)

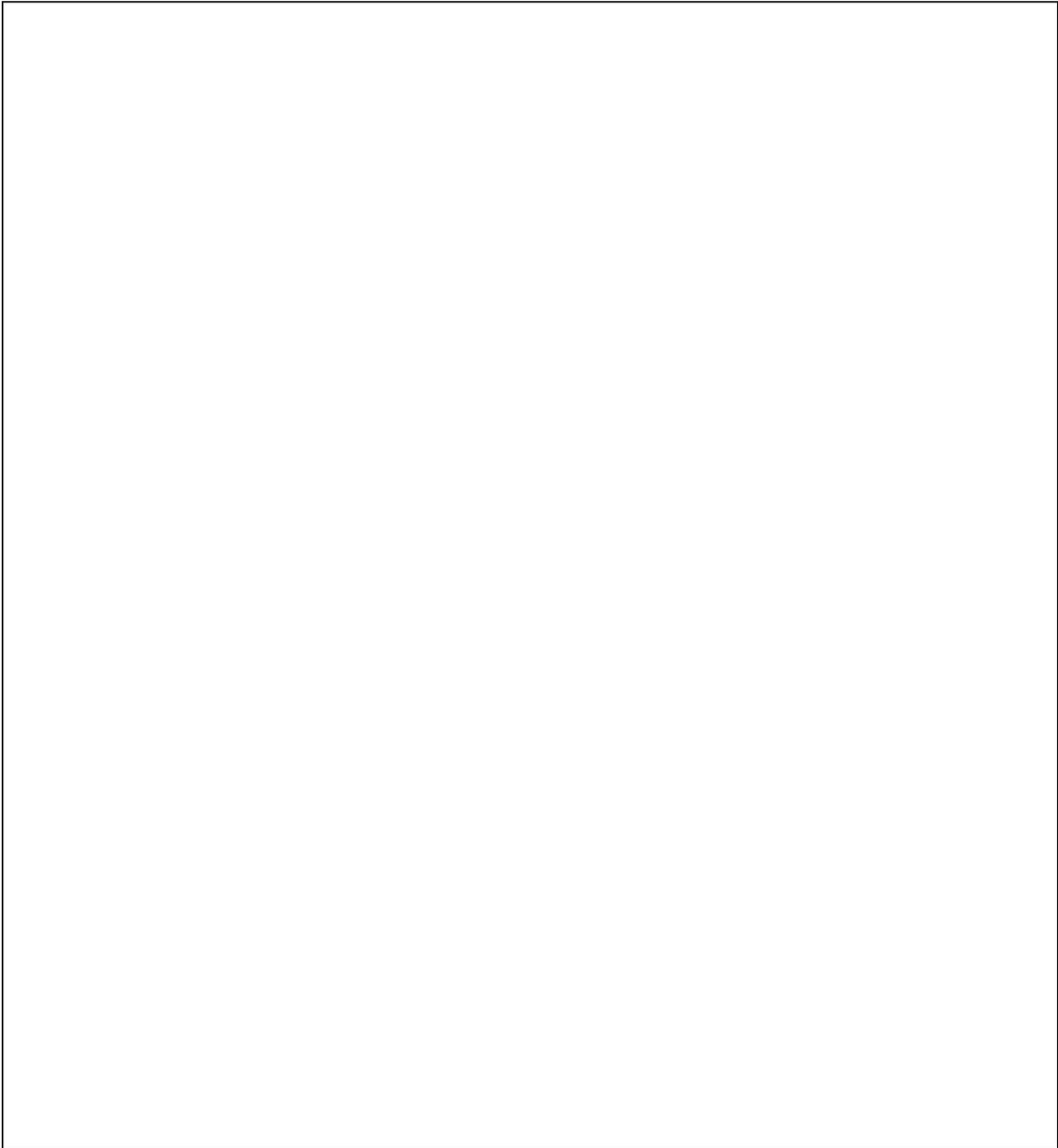
Develop a theory for the mixture nature of blood. Explain your theory and list your postulates below.

Can you think of any improvements or different ways to explain to someone the theory you have proposed? Write your answer in the box below.

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Task 11: How are sedimentation and centrifugation related? (30 minutes)

Explain your answer, including diagrams with cited references, as appropriate. Use the class computers or your own to access the *Basics of Centrifugation* article at <http://www.coleparmer.com/TechLibraryArticle/30>.



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Technical Essay Homework

Task 12: Research and describe the different types of centrifugation techniques, including the principle behind each and special applications of each.

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Task 13: Evaluate the importance of the blood processing industry and analyze its available career path options. List the pre-requisite educational qualifications, skills, attitude and personality required for the wide range of jobs in this industry.