CAROLINA
UNLEASH LEARNING™



Vital Labs

Training for the Health Sciences

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Vital Labs: Carolina® Healthcare Simulation Kits

- Students practice clinical skills, techniques, and procedures that can be used in a healthcare setting
- Each simulation includes a case study that provides students with background information about a patient who presents with relevant symptoms
- At the completion of the lab, students can assess their patient's health and make determinations about a diagnosis
- Today we will explore blood hematocrit, blood typing, and blood glucose: urinalysis



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Building Toward 3-Dimensional Learning

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions ▪ Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**LS1.A: Structure and Function** ▪ Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. ▪ Systems of specialized cells within organisms help them perform the essential functions of life.	**Structure and Function** ▪ Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

NGSS Lead States, *Next Generation Science Standards: For States, By States* (Washington, DC: The National Academies Press, 2013), retrieved from www.nextgenscience.org or ngss.nsta.org

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Demo: Blood Hematocrit



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Demo: Blood Hematocrit

Case Study

Megan is a 26-year-old second grade teacher who is five months pregnant with her first child. Teaching is a demanding profession, but Megan has been feeling unusually tired over the past few weeks. She has also suffered periods of dizziness and cramping in the legs. A couple of times she has experienced a rapid heartbeat. On several days, she has had to leave school early to go home and rest. Even though Megan attributes these symptoms to her pregnancy, she decides to make an appointment with her doctor.

The first thing her doctor notices is that Megan's skin and gums are pale. As part of her examination, the doctor orders a complete blood count (CBC). This test will help her evaluate Megan's overall health and determine if there are any blood-related conditions. The results are in the chart below.

Section of Megan's CBC

Analyzed	Results	Normal Range (female)
Red blood cell count (RBC)	3 million cells/mcL	3.90–5.03 million
Hemoglobin (Hb)	7 g/dl	11.6–15 g/dl
Hematocrit (Hct)	30%	35.5%–44.9%
White blood cell count (WBC)	3,500 cells/mcL	3,400–9,600 cells/mcL
Platelet count (plt)	200,000 cells/mcL	157,000–371,000/mcL

Note: mcL = microliter g/dl = grams per deciliter

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Demo: Blood Hematocrit

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Section of Megan's CBC

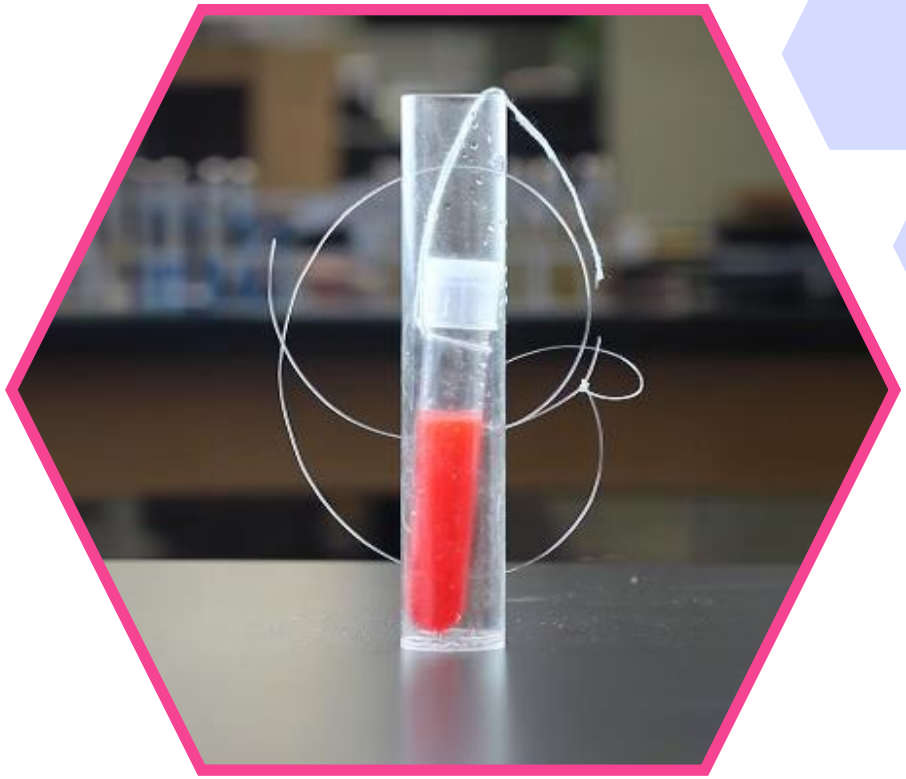
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Demo: Blood Hematocrit

- **Driving Question**
  - How could the results of Megan's blood hematocrit level provide an explanation for the cause of her symptoms?
- **Investigation: Determining the Hematocrit**
  - **Activity:** Constructing and swinging a tube centrifuge
  - **Purpose:** Measure what percentage of the volume of a simulated blood sample is red blood cells to determine hematocrit



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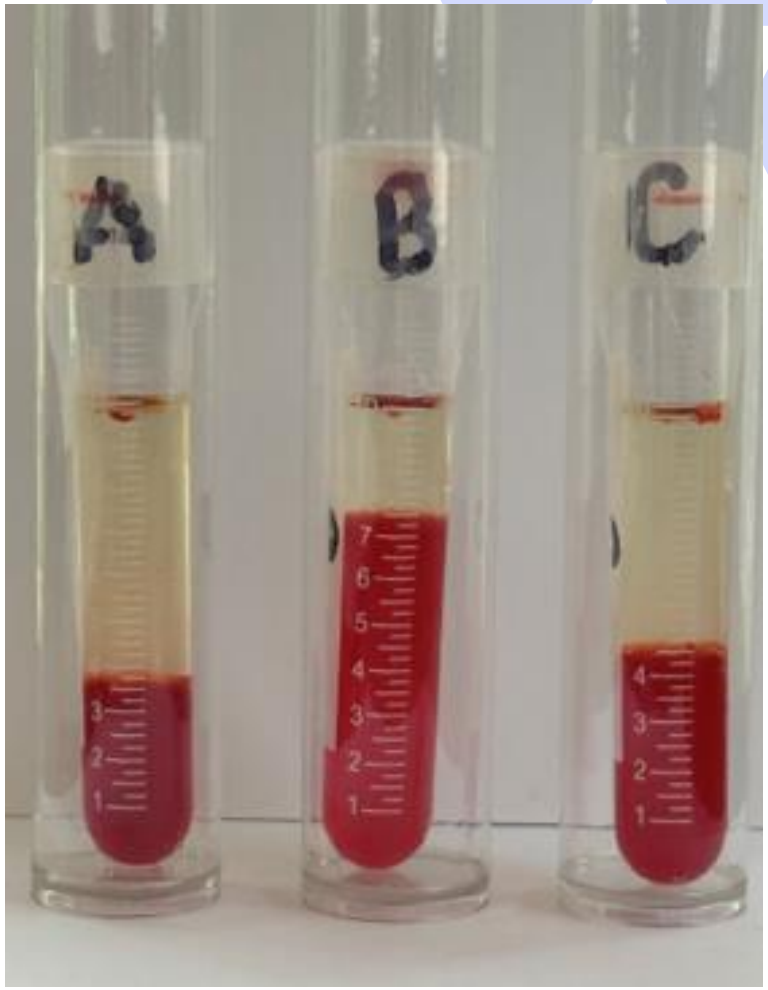
Demo: Blood Hematocrit

Data & Analysis

Culture Tube A (Female)	
Volume of whole blood	10 mL
Volume of blood cells (hematocrit)	3 mL
Hematocrit percentage	30%
Low, normal, or high	low

Culture Tube B (Female)	
Volume of whole blood	10 mL
Volume of blood cells (hematocrit)	7 mL
Hematocrit percentage	70%
Low, normal, or high	high

Culture Tube C (Female)	
Volume of whole blood	10 mL
Volume of blood cells (hematocrit)	4 mL
Hematocrit percentage	40%
Low, normal, or high	normal



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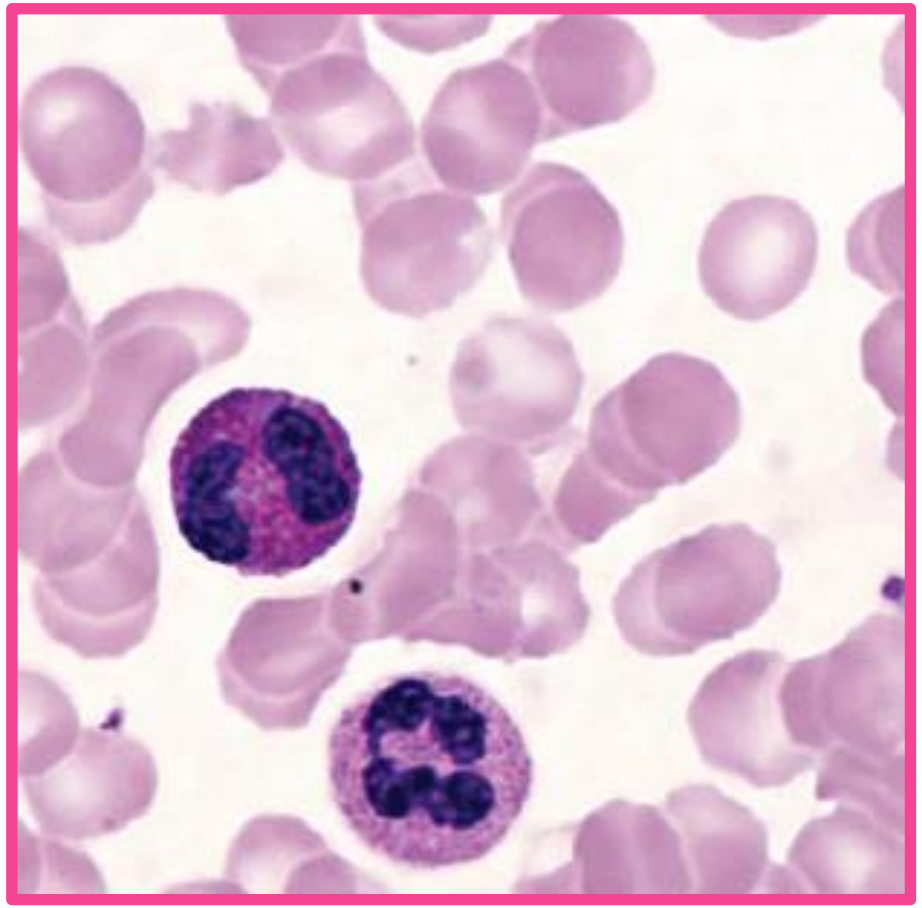
Demo: Blood Hematocrit

Driving Question

- How could the results of Megan's blood hematocrit level provide an explanation for the cause of her symptoms?

Discuss

- What is blood hematocrit and why is it important?
- What is the advantage of swinging the tubes vs. just placing them in a test tube rack and waiting?
- Why is it important to identify hematocrit values during diagnostic testing?



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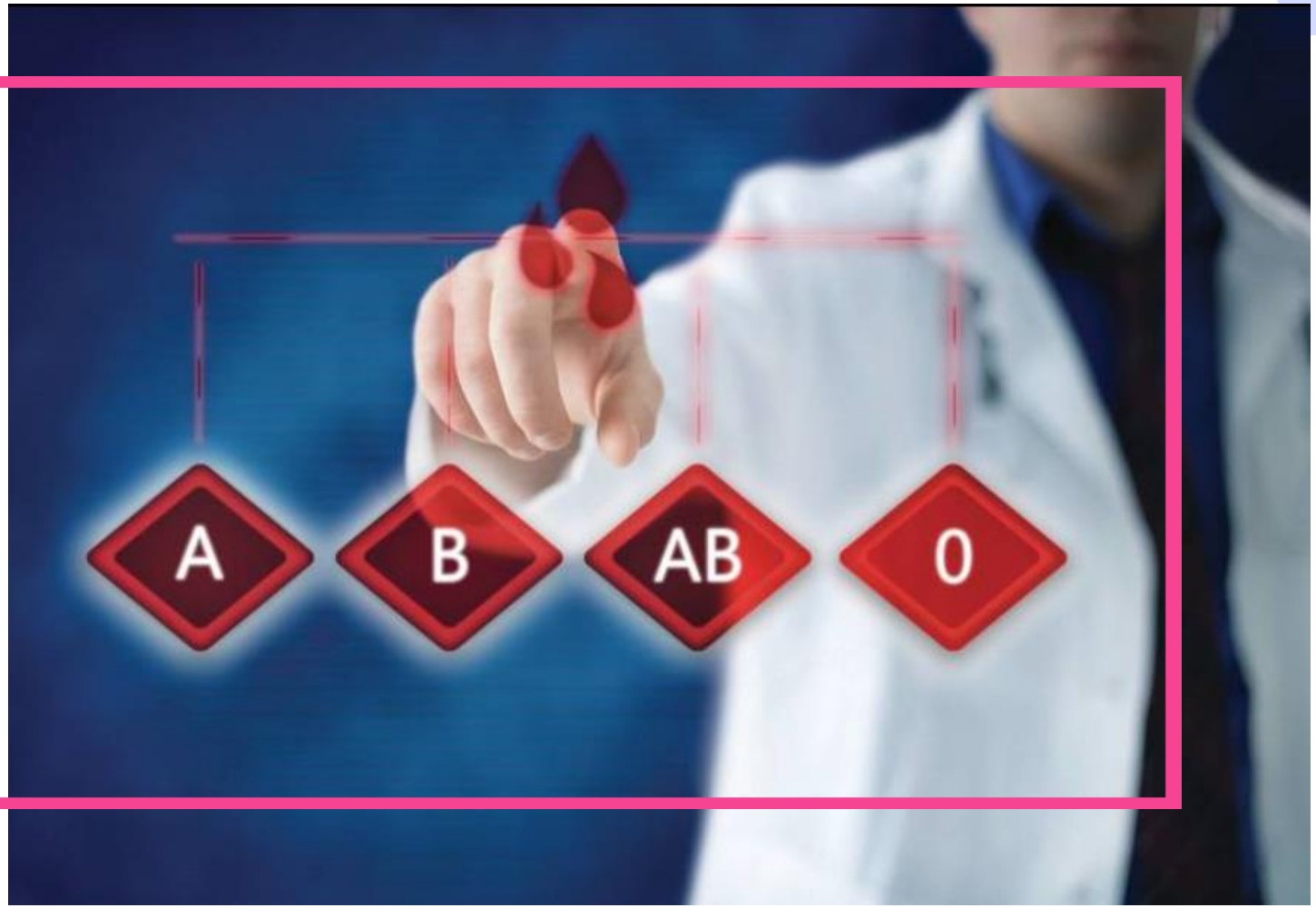
Workshop Safety

- **Personal protective equipment**
  Apron, gloves, safety goggles



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Blood Typing



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Lab: Blood Typing

Case Study

A 25-year-old male named Adam has been involved in a serious car accident. A police officer tells the responding EMTs that a tire blowout caused Adam to lose control of the vehicle and collide with a tree. Adam has multiple injuries, including broken bones and internal bleeding. His abdominal region is clearly swollen. He is vomiting and is dizzy. He is bleeding from a deep laceration on his upper thigh. In the ambulance on the way to Central Hospital, the EMTs apply a sterile dressing and pressure to the lacerated area. Luckily, the estimated time to the hospital is less than 15 minutes.

By the time Adam arrives at the hospital, he has lost a large volume of blood. The ER doctor immediately types Adam's blood so Adam can be stabilized with a blood transfusion. The doctor must determine if Adam's blood type is A, B, AB, or O, and whether his blood is Rh positive (Rh+) or Rh negative (Rh–). Agglutination occurred in both the A and B sites, but not in the Rh site. Compatible donated blood will be used for the transfusion.

After Adam is stable, the hospital doctors decide they must do an exploratory laparotomy (cut into the abdominal cavity) to examine his abdominal organs. Before this can be done, a pre-op blood test panel must be completed. The pre-op panel is more involved than just blood typing. It includes a complete blood count (CBC) as well as a comprehensive metabolic panel (CMP), which gives information about the patient's fluid balance, levels of electrolytes, and how well the liver and kidneys are functioning. The pre-op panel also tests to make sure the patient has normal clotting ability.

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Lab: Blood Typing

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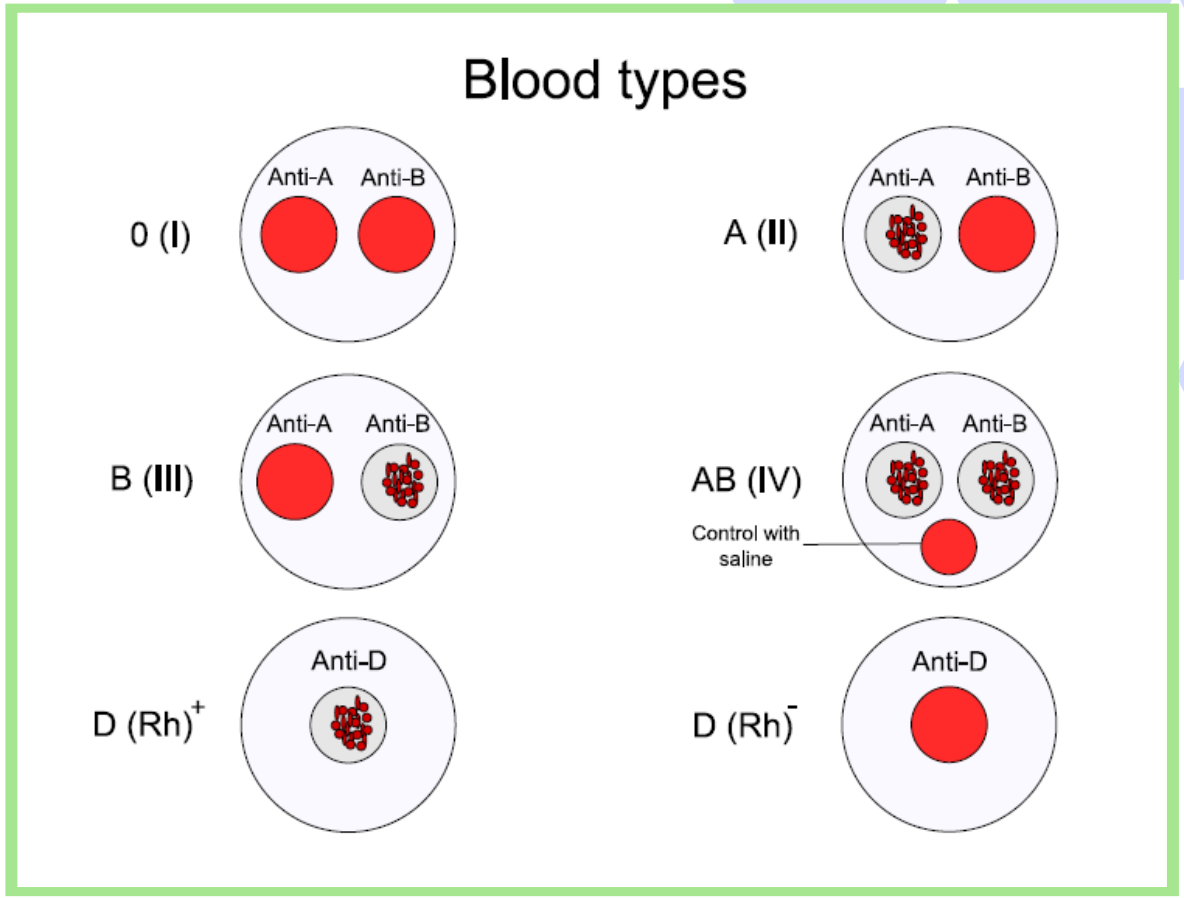
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Lab: Blood Typing

- **Driving Question**
  - How is blood typed, what is blood typing based on, and why is it important to know your own blood type?
- **Investigation: Blood Typing with Simulated Blood**
  - Determine the blood type of four different synthetic blood samples using antisera to the A, B, and Rh antigens that exist on human red blood cells.





Clumping/Agglutination: Reaction to antibody



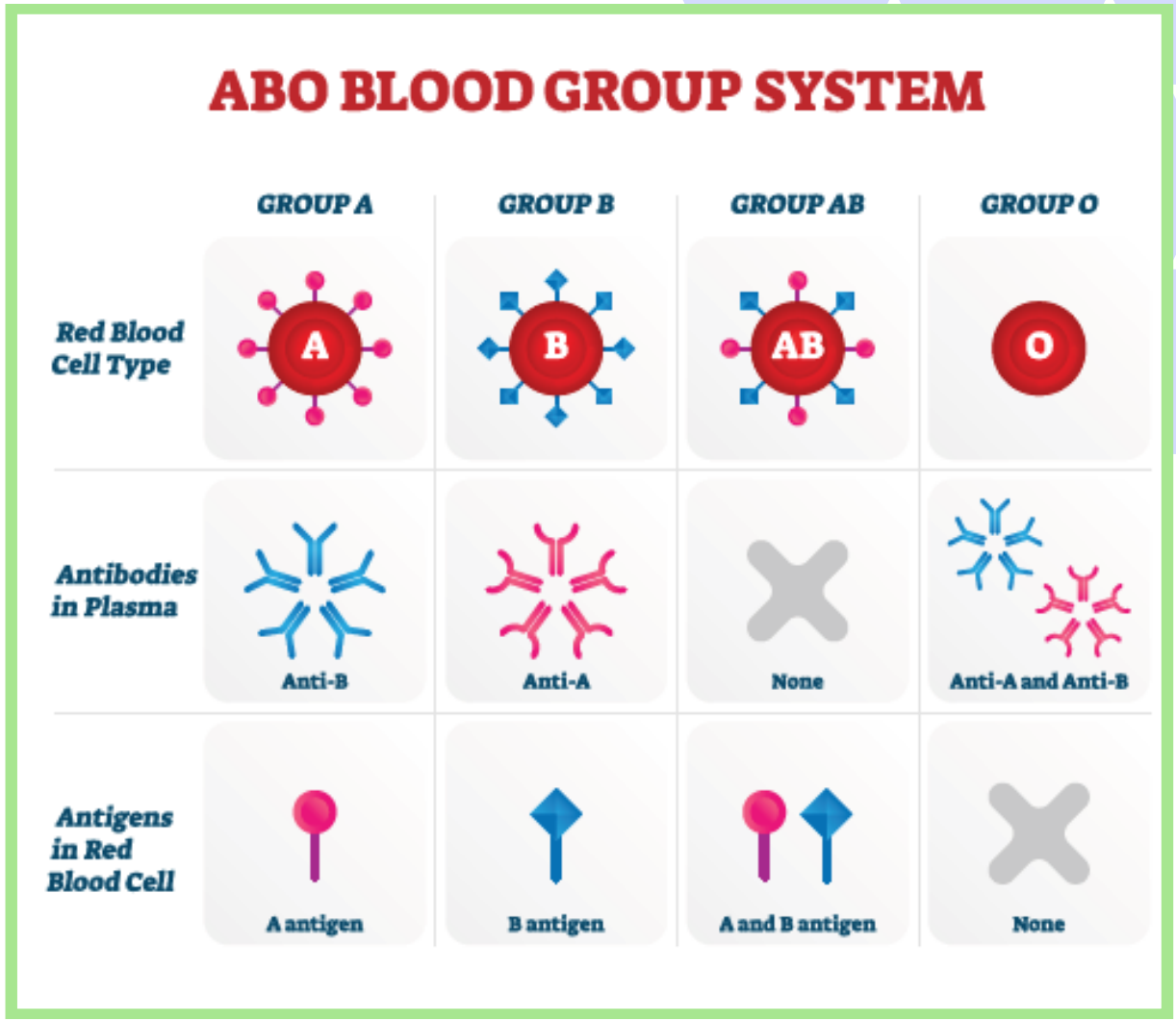
No Agglutination: No binding of antigens to antibody

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Lab: Blood Typing

- **What is blood typing? What are we looking for?**
  - ABO blood groups (types) result from the presence or absence of two antigens, A & B, on the surface of red blood cells.
  - To type, the blood sample is mixed with antibodies against A & B. If blood cells agglutinate or clump it means the blood reacted with that antibody.
  - Rh blood groups an antigen found on the surface of blood cells. This is a whole group of closely related antigens. Blood containing an Rh antigen is Rh positive (Rh+). Blood lacking the Rh antigen is Rh negative (Rh–).

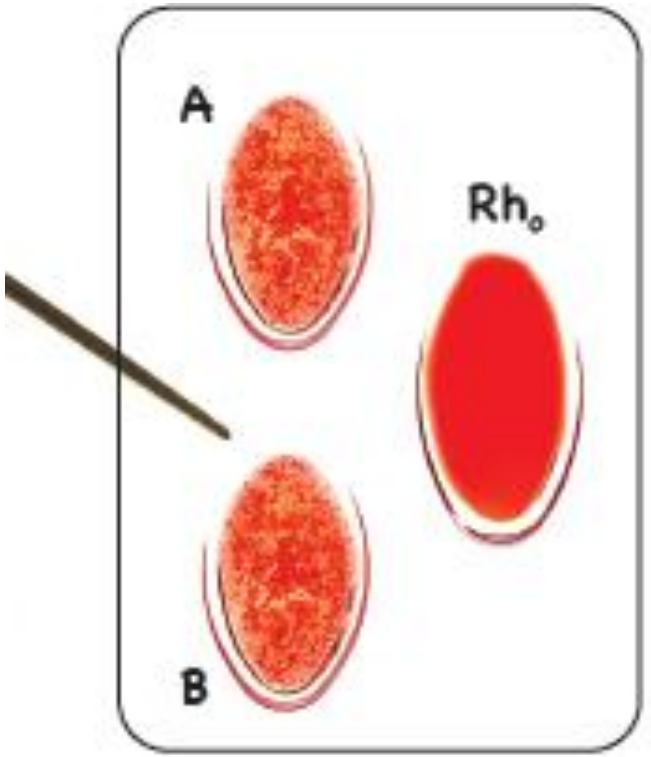


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Lab: Blood Typing

Procedure Overview

- Use synthetic blood and antisera to determine blood types.
- Observe the presence or absence of agglutination in each well.
- Clumping, or agglutination, indicates that the blood has reacted with a specific antibody serum (Anti-A, Anti-B, or Anti-Rh) and therefore has antigens that are incompatible with that type of antibody.
- If the blood does not agglutinate when mixed with a specific antibody serum, the results indicate that the blood does not possess the antigens binding the specific antibody in the reagent.



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Lab: Blood Typing

Sample Data-empty

	Sample 1	Sample 2	Sample 3	Sample 4
Anti-A				
Anti-B				
Rh				
Blood Type				

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Lab: Blood Typing

Sample Data

	Sample 1	Sample 2	Sample 3	Sample 4
Anti-A	Yes	No	Yes	No
Anti-B	No	Yes	Yes	No
Rh	Yes	Yes	No	Yes
Blood Type	A+	B+	AB–	O+

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Lab: Blood Typing

Driving Question

- How is blood typed, what is blood typing based on, and why is it important to know your own blood type?

Discuss

- Why is it important to know your own blood type?
- What blood type is known as the “universal donor” type? Why?
- What blood type is known as the “universal recipient” type? Why?
- How does the Rh factor of donated blood determine who can receive it?



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Blood Glucose



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Lab: Blood Glucose

Case Study

John is a 65-year-old retired teacher. His medical records indicate that he has had only one surgery, at 45 years of age, for a broken wrist. In general, he has been remarkably healthy for many years. Two years ago, he was feeling unusually tired. He set up an appointment with his physician, Dr. Shaw.

Dr. Shaw advised him to lose weight, eat a healthier diet (more vegetables, low calorie, high fiber), and become more active. Since John has a family history of diabetes, he was also asked to return to Dr. Shaw in 3 months to have his glucose levels monitored. Instead, he waited 2 years to return. Even though he has tried to lose weight, John has gained 10 pounds.

John's results from initial appointment

- Weight: 210 lbs
- Height: 5′8″
- Body mass index (BMI): 31.9 kg/m2 (Obese)
- Fasting blood glucose: 120 mg/dL
- Blood pressure: sitting, right arm 130/90 mmHg
- Pulse: 90 bpm
- Respiratory Rate: 25 breaths per minute
- Lungs: clear
- Heart: Regular rate and rhythm
- SpO2 (oxygen saturation) level: 97

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Lab: Blood Glucose

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Lab: Blood Glucose

Case Study (cont.)

During his latest examination, John mentioned that he is still feeling tired throughout the day. He also mentioned that he has an upcoming appointment with his ophthalmologist to check some vision problems. In the last 2 months, John has experienced some numbness in his left foot.

John's results two years after initial

- Weight: 220 lbs
- Height: 5′8″
- Body mass index (BMI): 33.4 kg/m2
- Fasting blood glucose: 180 mg/dL
- Blood pressure: sitting, right arm 150/100 mmHg
- Pulse: 90 bpm
- Respiratory Rate: 25 breaths per minute
- Lungs: clear
- Heart: Regular rate and rhythm
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Lab: Blood Glucose

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Lab: Blood Glucose

Case Study: Patient Data

John's results from initial appointment

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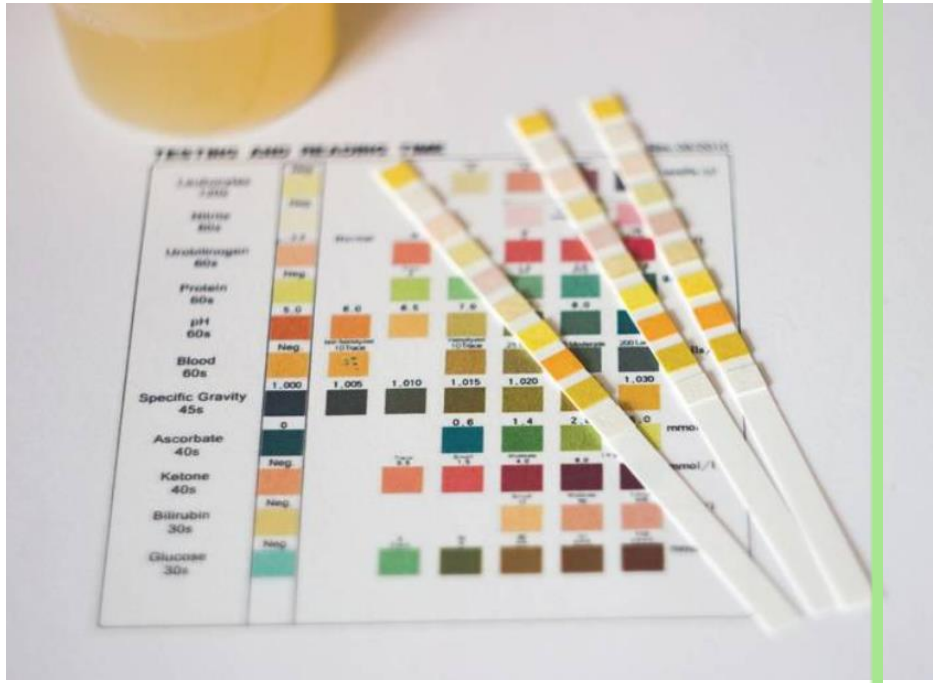
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Lab: Blood Glucose-Urinalysis

- **Driving Question**
  - How can blood glucose levels be monitored and why is it important to monitor those levels?
- **Investigation:**
  - Urinalysis with Simulated Urine



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Lab: Blood Glucose

Procedure Overview

1. Perform three important parts of a clinical urinalysis, testing simulated urine samples for color, pH, and glucose.
2. First, test “Low,” “Normal,” and “High” simulated urine samples.
3. You will also be provided with 2 unknown simulated urine samples for urinalysis.
4. Report and interpret the results.



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Lab: Blood Glucose

Data & Analysis

	Simulated Urine Samples				
Test	Low	Normal	High	Unknown A	Unknown B
Color of Urine					
pH #					
Glucose test strip color					
Glucose (positive or negative)					

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Lab: Blood Glucose

Data & Analysis

	Simulated Urine Samples				
Test	**Low**	**Normal**	**High**	**Unknown A**	**Unknown B**
Color of Urine	clear to light yellow	yellow to amber	dark amber to brown	clear to light yellow	dark amber to brown
pH #	3	6	8	3	8
Glucose test strip color	green	green	brown	brown	green
Glucose (positive or negative)	negative	negative	positive	positive	negative

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Lab: Blood Glucose

Procedure Analysis

- What results would you expect to see from a normal urine sample?
- Can the measurement of glucose in the urine give a definitive diagnosis for diabetes?
- What glucose test strip color result would you predict if a urinalysis were used to test John's sugar level?



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Lab: Blood Glucose

Driving Question

- How can blood glucose levels be monitored and why is it important to monitor those levels?

Discuss

- What is blood glucose, and why is it important to understand it?
- What are some of the effects of high blood sugar?
- What are some of the effects of low blood sugar?
- What are some ways to deal with diabetes?



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Carolina® Healthcare Simulation Series Kits



Vital Signs
Item #694508



Blood Glucose
Item #700106



Urinalysis
Item #700119



Blood Typing
Item #700117



Blood Hematocrit
Item #700109

New Kit Coming Soon!

Pulmonary Function
Item #692642

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