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Blood Typing and Clinical Use

What are the blood types?
Why do they matter?

Michael Smith

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Island Medical Program

May 10, 2023
6:15PM – 7:30 PM PST



THE UNIVERSITY OF BRITISH COLUMBIA
Faculty of Medicine



University
of Victoria

let's talk  science

About Me

Intro and Medical School



Hello! I'm Michael Smith, a 1st year medical student from UBC's Island Medical Program.

I'm from White Rock, BC, went to Earl Marriott Secondary (Class of 2016) and UBC Vancouver (Class of 2020, BSc Major in Pharmacology).

Medical School:

I started medical school in August 2022 and will graduate in 2026. I am happy to answer to any questions you may have at the end of this lecture where I will talk a bit about my journey and what I wish I knew when I was your age!

My Why:



Territorial Acknowledgement

I would like to begin by acknowledging that I am joining you from the unceded territory of the Kumeyaay nation. The Kumeyaay people continue to maintain their political sovereignty and cultural traditions as vital members of the San Diego Community. I am grateful for the opportunity to work, live, and play on their lands.

I also acknowledge the audience joins from the unceded territory of the ləkʷəŋən (Lekwungen) speaking peoples, including the Songhees, Esquimalt, and W̱SÁNEĆ (hwha - say - netch) peoples whose historical relationships with the land continue to this day.





Disclosure and Acknowledgements

I am a first year medical student. While some clinical information will be presented in this presentation, these talks do not constitute or substitute for medical advice. Please consult with a healthcare provider if you or others you know have any personal health-related concerns.

I am a member of the Island Medical Program Blood Donors Club that volunteers in collaboration with Canadian Blood Services, however there are no financial incentives or other conflicts of interest to declare.

I would like to thank Dr. Laura Tapley for her permission to utilize some of her medical school lecture content in the production of these lecture slides.



Today's Agenda

Blood Typing and Clinical Use

Blood – Structure and Types

Blood Typing Tests

Why Type? Clinical Use

Case Study

Medical School

Let's get started!



Today's Agenda

Blood Typing and Clinical Use

Blood – Structure and Types

Blood Typing Tests

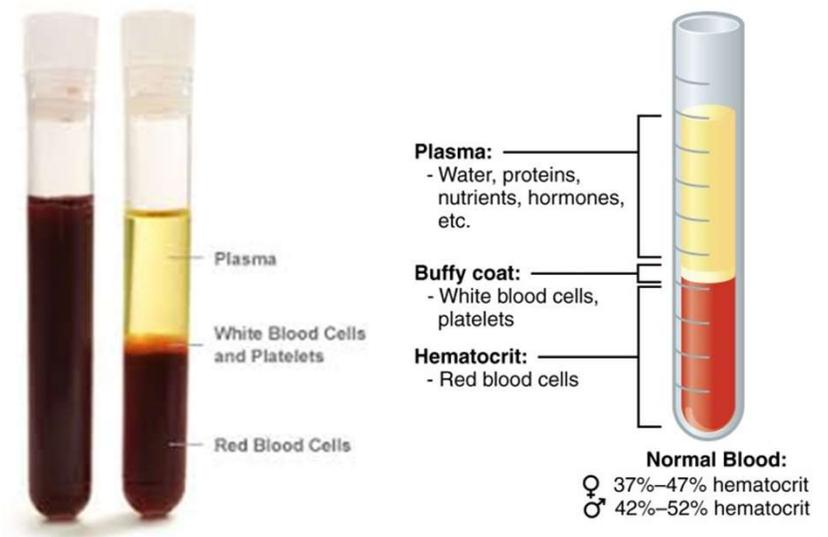
Why Type? Clinical Use

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Blood: What is it?

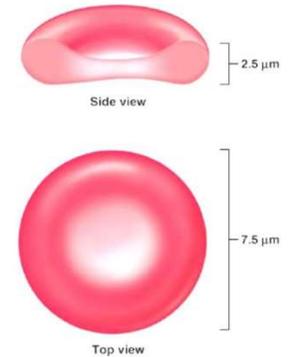
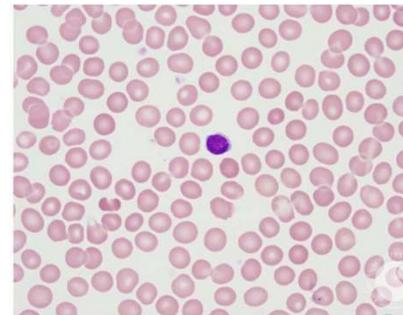
- **Structure:** special type of connective tissue made up of (2) – Formed elements (cells, proteins, etc.) and Plasma.
- **Function:** Many!
- Structure determines function:
 - 1) Transporting oxygen to and CO₂ away from tissues
 - 2) Forming blood clots
 - 3) Cells and antibodies that fight infection
 - 4) Homeostasis regulation (fluids and waste, temperature, etc.)



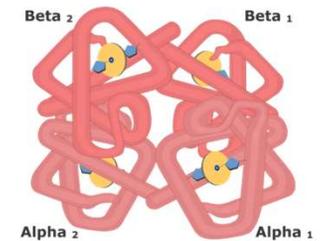
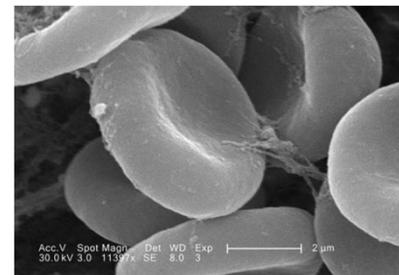
[HTTPS://GIVINGBLOOD.ORG/ABOUT-BLOOD/BLOOD-COMPONENTS.ASPX](https://givingblood.org/about-blood/blood-components.aspx)
[HTTPS://COURSES.LUMENLEARNING.COM/SUNY-AP2/CHAPTER/AN-OVERVIEW-OF-BLOOD/](https://courses.lumenlearning.com/suny-ap2/chapter/an-overview-of-blood/)

The Red Blood Cell

- **Structure:** Anuclear biconcave disc filled with hemoglobin (Hb)
- **Function:**
- Structure determines function:
 - 1) Transporting oxygen to and CO₂ away from tissues – maximizing surface area
 - 2) Flexible and malleable to navigate capillaries and organs



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<https://askhematologist.Com/blood-morphology/>

https://www.Researchgate.Net/figure/erythrocyte-biconcave-shape-c2006-pearson-education-from_fig1_324473100

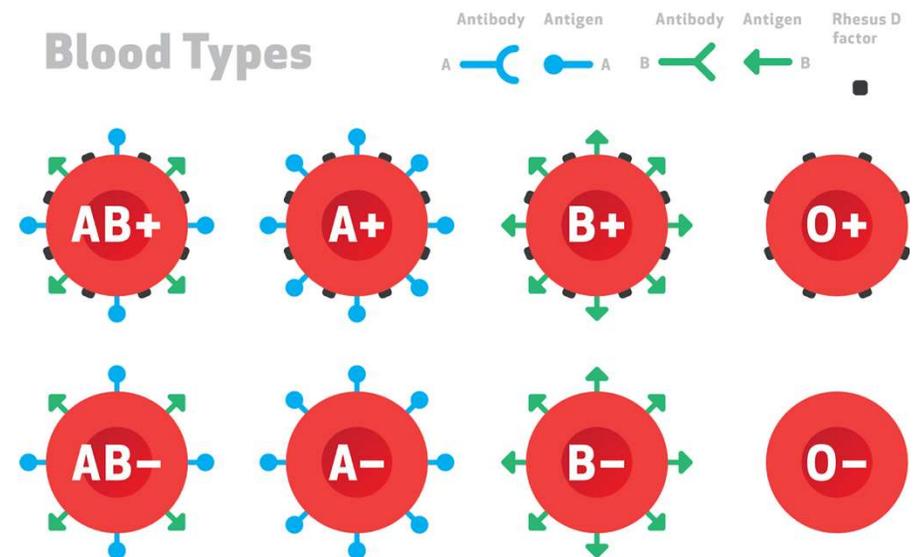
<https://www.Nisenet.Org/catalog/scientific-image-human-red-blood-cells-sem>

<https://www.Getbodysmart.Com/respiratory-gases-and-their-transport/hemoglobin-structure/>

Blood Types

- Determined by the presence of carbohydrates and proteins on the surface of Red Blood Cells
- 2 Systems of Classification*
 - 1) ABO
 - 2) Rh Factor

*Other surface antigens exist (Kell, Kidd, Duffy, Ro (Rh +) etc.) which don't determine type but ARE clinically relevant



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Blood Types: ABO

- **Function:**
 - 1) Cell Surface Recognition – immune system to identify self
 - 2) Identify what is foreign and destroy it (directly / indirectly)
- **Structure:**
 - Carbohydrates (oligosaccharides) present on the RBC surface
 - + Antibodies against what we don't have

	Group A	Group B	Group AB	Group O
Red blood cell type				
Antibodies in plasma	 Anti-B	 Anti-A	None	 Anti-A and Anti-B
Antigens in red blood cell	 A antigen	 B antigen	 A and B antigens	None

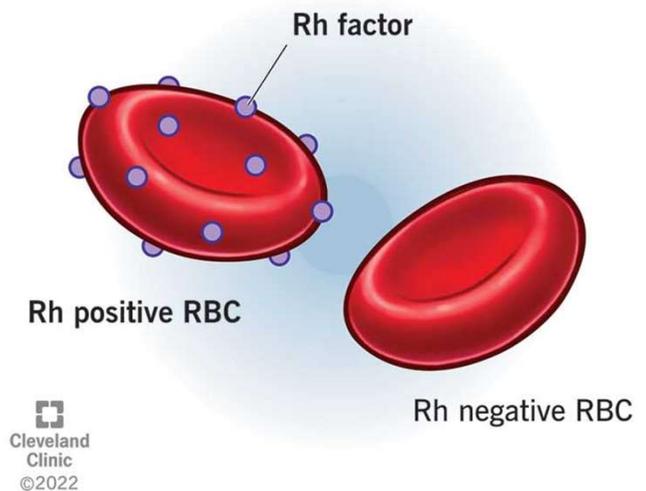
https://en.wikipedia.org/wiki/ABO_blood_group_system

Blood Types: Rh Factor

- **Structure:**
 - Protein present on the RBC surface
 - + Antibodies against what we don't have*
- **Function: (similar to ABO)**
 - 1) Cell Surface Recognition – immune system to identify self
 - 2) Identify what is foreign and destroy it (directly / indirectly)

Rh factor

Rh factor (or Rhesus factor) is a type of protein on the outside of your red blood cells (RBCs)



<https://my.clevelandclinic.org/health/diseases/21053-rh-factor>

Blood Types: Genetics!

How do you get your type?

= Mendelian Inheritance

- Autosomal genes
- ABO
 - A + B (dominant / codominant) = encodes enzyme types
 - O (recessive) = no enzyme
- Rh
 - Rh / D Antigen (dominant)
 - Or non-functional gene (d)

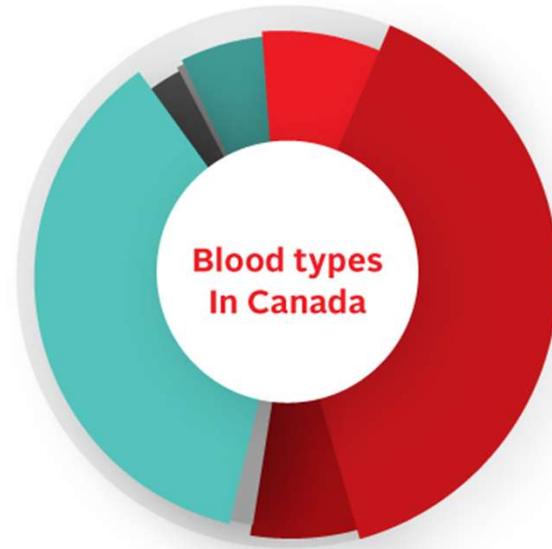
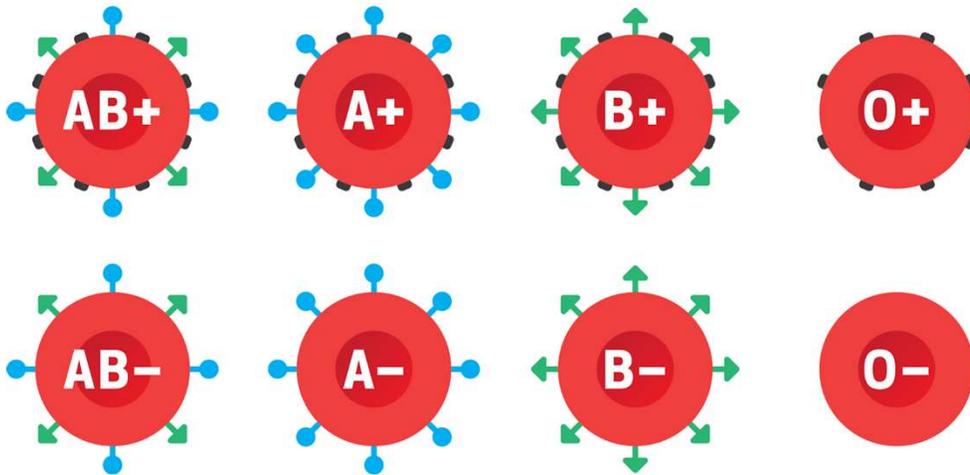


		SPERM	
		A	o
EGG	B	AB	Bo
	o	Ao	oo

		SPERM	
		D	d
EGG	d	Dd	dd
	d	Dd	dd

Summary

Blood Types



A+ 36%	B+ 7.6%
A- 6%	B- 1.4%
O- 7%	AB- 0.5%
O+ 39%	AB+ 2.5%

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Testing

How can we tell them apart?
= the same way our body does!

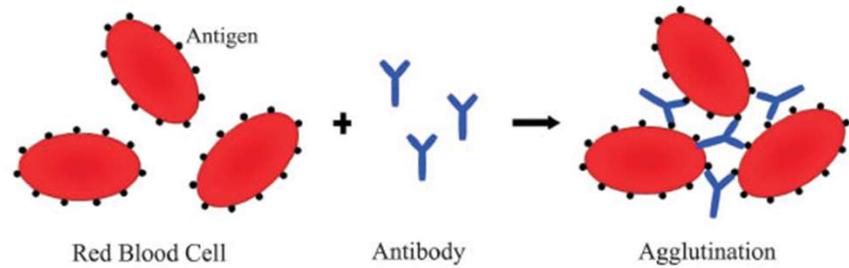
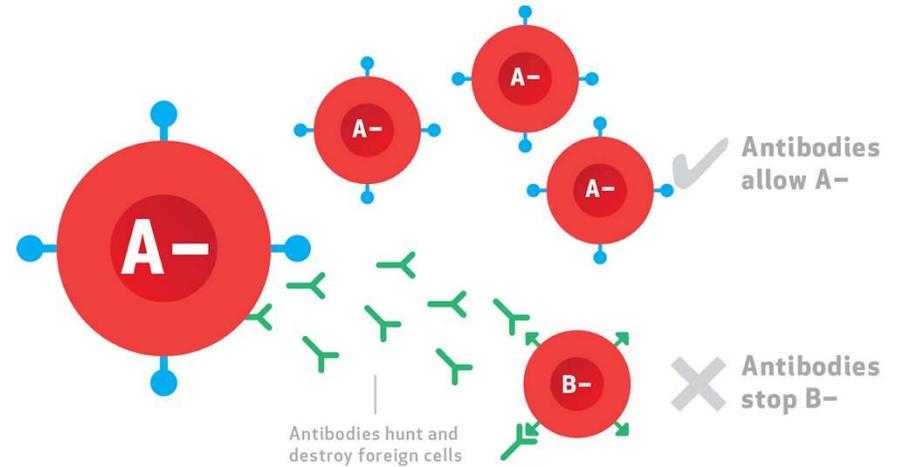


Figure 1 – Representation of the hemagglutination reaction. Blood group antigens and antibodies form a clumping of erythrocytes (modified from Parslow et al., 2004)⁽⁹⁾



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<https://biology.stackexchange.com/questions/72271/why-does-anti-a-antibodies-make-type-a-blood-type-clump>

BLOOD TYPING TESTS

Blood Type Test Kits



Anti-A	Anti-B	Anti-D	Control
Name - Nombre - Nome - Nome - Nom - Name - Név - Navn - Navn - Namn - Nimi		Address - Dirección - Endereço - Direzione - Adresse - Adressieren - Cím - Adresse - Adresse - Adress - Osoite	
XYP			
Born - Nacimiento - Aniversário - Nato - Date de naissance - Geboren - Született - Fødselsdato - Fødselsdato - Födelsdatum - Syntymäaika		Signature - Firma - Signer - Firma - Signature Unterschrift - Aláírás - Underskrift - Underskrift - Namnteckning - Allekirjoitus	
ABO	Rhesus (D)	Date - Fecha - Date - Data - Date - Datum - Datum - Dato - Dato - Datum - Päivämäärä	
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<https://www.nationalhealthexecutive.com/News/gp-finger-prick-blood-test-copd>
<https://eldoncard.dk/about-eldon/>
<https://www.indiamart.com/proddetail/blood-group-test-kit-biolab-22864583233.html>

Testing Results

Test yourselves in the lab! I won't reveal the results but you will find out what these mean soon.

Hint: your blood is on the spots, and we add antibodies against the different surface antigens. What does it mean if you see clumping (agglutination?)



HOW TO READ YOUR RESULTS

BLOOD TYPE	ANTI-A	ANTI-B	ANTI-D	CONTROL

INVALID

https://www.biologycorner.com/anatomy/blood/blood_typing_lab.html



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Clinical Use of Blood Typing

What do we use it for?

- 1) Blood Transfusions
- 2) Pregnancy
- 3) Organ Transplants, etc.

Why does it matter if we blood type?

- Each of the above has associated risks and complications. **Blood typing helps minimize, but doesn't eliminate, those risks.**
- Ex: Acute Hemolytic Transfusion Reaction, Hemolytic Disease of the Newborn, etc.



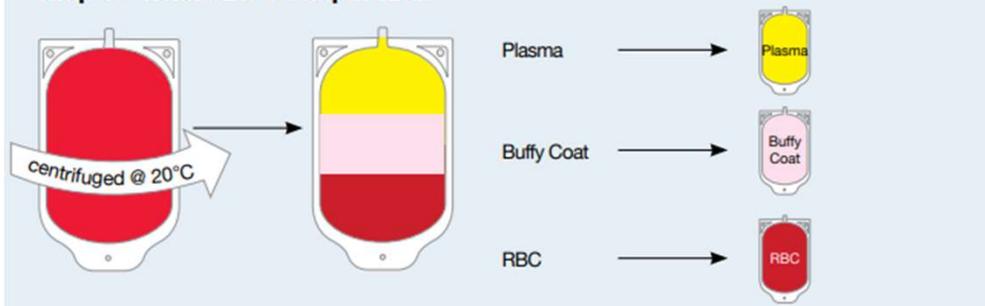
Transfusions

Components (units):

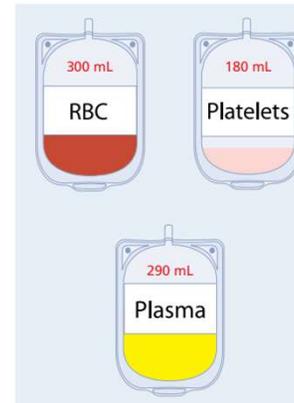
- **(Packed) Red Blood Cells**
 - Fridge
- **Platelet Pool**
 - Room temp.
- **Frozen Plasma**
 - Freezer, thawed for use

Process for Preparing Blood Components from Donated Units

Step 1 - Whole Blood Separation



<https://transfusionontario.org/wp-content/uploads/2022/10/Bloody-Easy-5-EN.pdf>



WHY TYPE? – CLINICAL USE

Packed RBCs

When do we give them?

- 1) Symptoms of Anemia (low RBC/Hb*)
 - Tachycardia (elevated HR)
 - Hypotension (low BP)
 - Shortness of Breath
 - *Impaired oxygen delivery
- 2) Acute Blood Loss (Trauma/Surgery)
- 3) Chronic Anemia**
 - Ex: Thalassemia, Sickle Cell Anemia



<https://saskblood.ca/blood-products/red-blood-cells/>

WHY TYPE? – CLINICAL USE

Giving a Transfusion

WAIT! What do we need to do first?

= Test the Patients Blood

- Group and Screen (G&S)

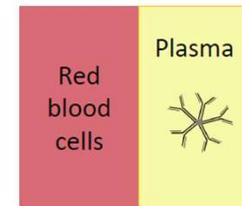
= Recheck the Donor Blood (Compatibility)

- Crossmatch (XM)



Immediate Spin • < 20 mins	Indirect Antiglobulin • 45-60 min	Electronic • 5-10 min!

Group



- Tells us about ABO and D (Rh) group
- Tests RBCs and plasma separately

Screen



- Looking for non-ABO alloantibodies
- Tests plasma
- Positive in < 5%

Giving a Transfusion

Check In!

- **Group** = ABO and Rh of recipient
- **Screen** = non-ABO antibodies that could attack the donor blood
- **Crossmatch** = makes sure donor blood is compatible with recipient blood (ABO, Rh, and non-ABO)

		DONOR BLOOD TYPES							
		O-	O+	B-	B+	A-	A+	AB-	AB+
RECIPIENT BLOOD TYPES	AB+	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ
	AB-	Ⓢ		Ⓢ		Ⓢ		Ⓢ	
	A+	Ⓢ	Ⓢ			Ⓢ	Ⓢ		
	A-	Ⓢ				Ⓢ			
	B+	Ⓢ	Ⓢ	Ⓢ	Ⓢ				
	B-	Ⓢ		Ⓢ					
	O+	Ⓢ	Ⓢ						
	O-	Ⓢ							

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Risks of Transfusion

What could go wrong?

- Acute/Delayed Transfusion Reactions
 - Allergy / Anaphylaxis
 - Febrile non-hemolytic reaction
 - Acute hemolytic transfusion reaction
- + Others

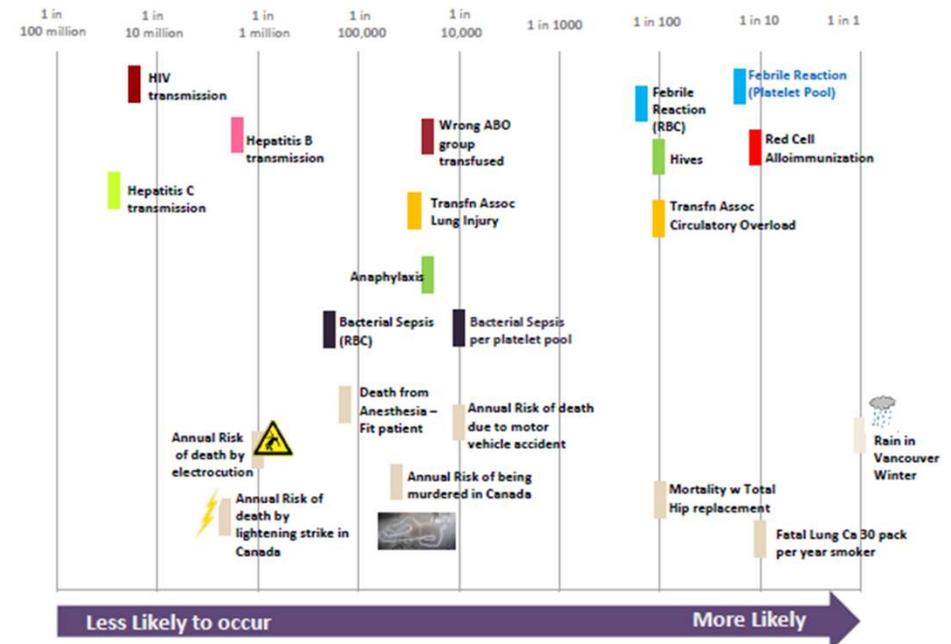
What are the alternatives?

- Intraoperative cell salvage
- Antifibrinolytic drugs

What is important to get from the patient?

- = Informed Consent!

Potential adverse effects of Transfusion, relative to Other Risks



Adapted from: Carson J L et al. *Ann Intern Med* doi:10.1059/0003-4810-156-12-201206190-00429 And *Bloody Easy 4* (2010) and CBS 2018 Surveillance report

O- For All?

If we just had enough O- for everyone, couldn't we avoid most of these risks?

- = **No! O- is not the safest option always**

Best for emergency situations, but when available, a Crossmatched transfusion is the safest option for patients

RBC Product Status	Time to get it from the lab	Risks
Uncrossmatched Group O Pre-tagged units	Immediate (transport time)	<ul style="list-style-type: none"> • Limited supply • Delayed hemolytic transfusion reaction
Uncrossmatched ABO-specific units	<10 minutes after patient sample received in lab	<ul style="list-style-type: none"> • Delayed hemolytic transfusion reaction
Crossmatched units	~ 1 h (after sample received in lab)	<ul style="list-style-type: none"> • Safest, STANDARD OF CARE in elective non-emergent situations

Reduced Risk

WHY TYPE? – CLINICAL USE

Summary: Transfusions

Blood Donations -> Packed Red Blood Cells

Given to patients experiencing acute blood loss, chronic anemia*, and symptoms of anemia (tachycardia, hypotension, and shortness of breath)

Perform a Group & Screen and Crossmatch before giving a transfusion

Obtain Informed Consent! There are risks associated with transfusions.

BLOOD TYPING AND CLINICAL USE



Pregnancy (If Time)

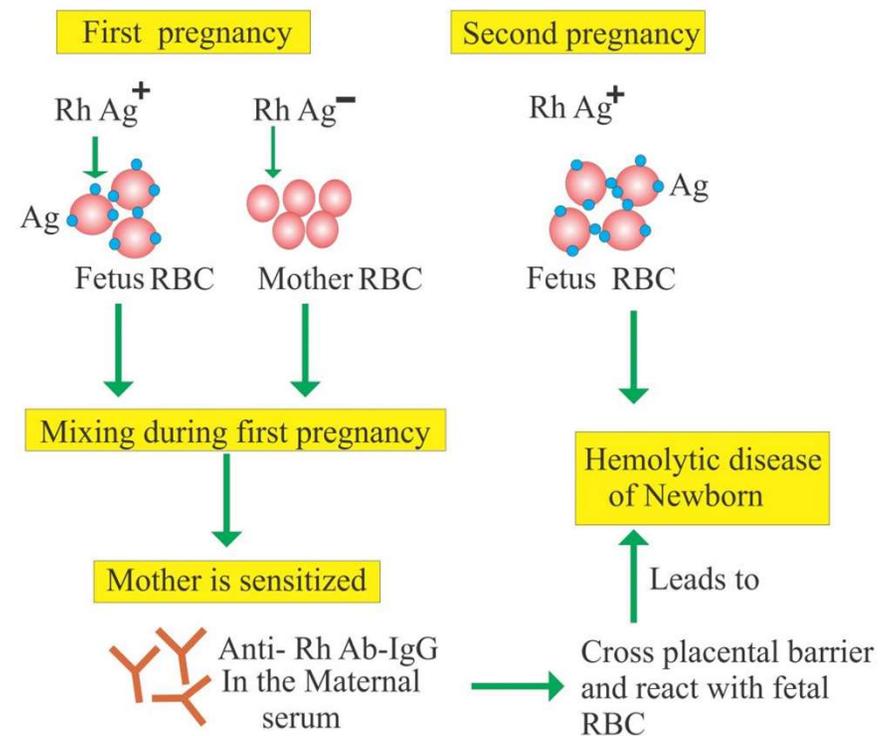
Group and Screen of the Mother

If Rh negative, fetus could be at risk of Hemolytic Disease of the Newborn

- Test for sensitization to Rh (Rh antibodies) that occurs due to blood mixing
- Particularly important for miscarriages or second pregnancies

Solution: test mother early, give Anti-D antibodies (RhoGAM) to prevent sensitization, and assess need for fetal blood transfusion

Hemolytic disease of Newborn





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Time For A Case Study!

Let's apply our knowledge

CASE STUDY

- A 65 y/o former firefighter comes into the hospital for a scheduled knee replacement surgery this evening.
- They are otherwise healthy, are on no medications, and have no relevant personal or family history of blood/bleeding disorders.
- Vitals are normal and the patient appears well.
- You are a clerk (3rd/4th year med student) and have been tasked with writing the “blood orders” for the operating room in case of the need for transfusion due to surgical complications.



<https://medlineplus.gov/kneereplacement.html>

<https://www.fireapparatusmagazine.com/fire-apparatus/langford-bc-fire-rescue-goes-to-brindlee-mountain-for-its-heavy-rescue/#gref>



1. What should you next first steps be before the operation? Select all that apply:

A: Order a Group and Screen

B: Order a Crossmatch

C: Get the patient's informed consent

D: Prepare 2 units of O- blood on standby



1. What should you next first steps be before the operation? Select all that apply:

A: Order a Group and Screen

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D: Prepare 2 units of O- blood on standby



2. You are asked to interpret the results of the Group test. What is this patient's blood type?

1: O Positive

2: A Positive

3: B Negative

4: O Negative

BLOOD TYPE	ANTI-A	ANTI-B	ANTI-D	CONTROL
?				



2. You are asked to interpret the results of the Group test. What is this patient's blood type?

1: O Positive

2: A Positive

3: B Negative

4: O Negative

BLOOD TYPE	ANTI-A	ANTI-B	ANTI-D	CONTROL
A-POSITIVE				



3. The patient has a complication in surgery. Post-op they show signs of anemia. What types of blood can this patient receive? Select all that apply:

1: O positive

3: A negative

2: B negative

4: A positive



3. The patient has a complication in surgery. Post-op they show signs of anemia. What types of blood can this patient receive? Select all that apply:

1: O positive

3: A negative

2: B negative

4: A positive



4. Bonus: Patient is also indicated to receive frozen plasma. What types of plasma can this patient receive? Select all that apply (Hint – blood plasma contains the antibodies!)

1: Plasma from Type O

3: Plasma from Type B

2: Plasma from Type A

4: Plasma from Type AB



4. Bonus: Patient is also indicated to receive frozen plasma. What types of plasma can this patient receive? Select all that apply (Hint – blood plasma contains the antibodies!)

1: Plasma from Type O

3: Plasma from Type B

2: Plasma from Type A

4: Plasma from Type AB

LECTURE SUMMARY

Summary

Blood: Structure and Types

- ABO
- Rh factor

Blood Typing Tests

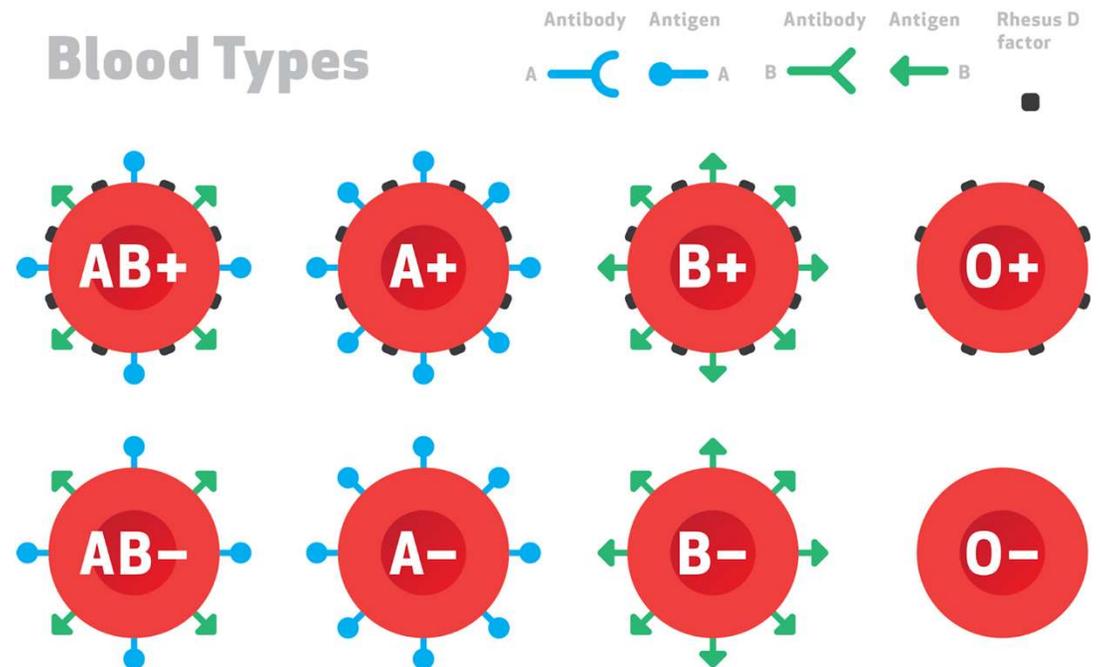
Why Type? – Clinical Use

- Transfusions & Pregnancy

Case Study

Structure determines function!

Blood Types





References

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MEDICAL SCHOOL

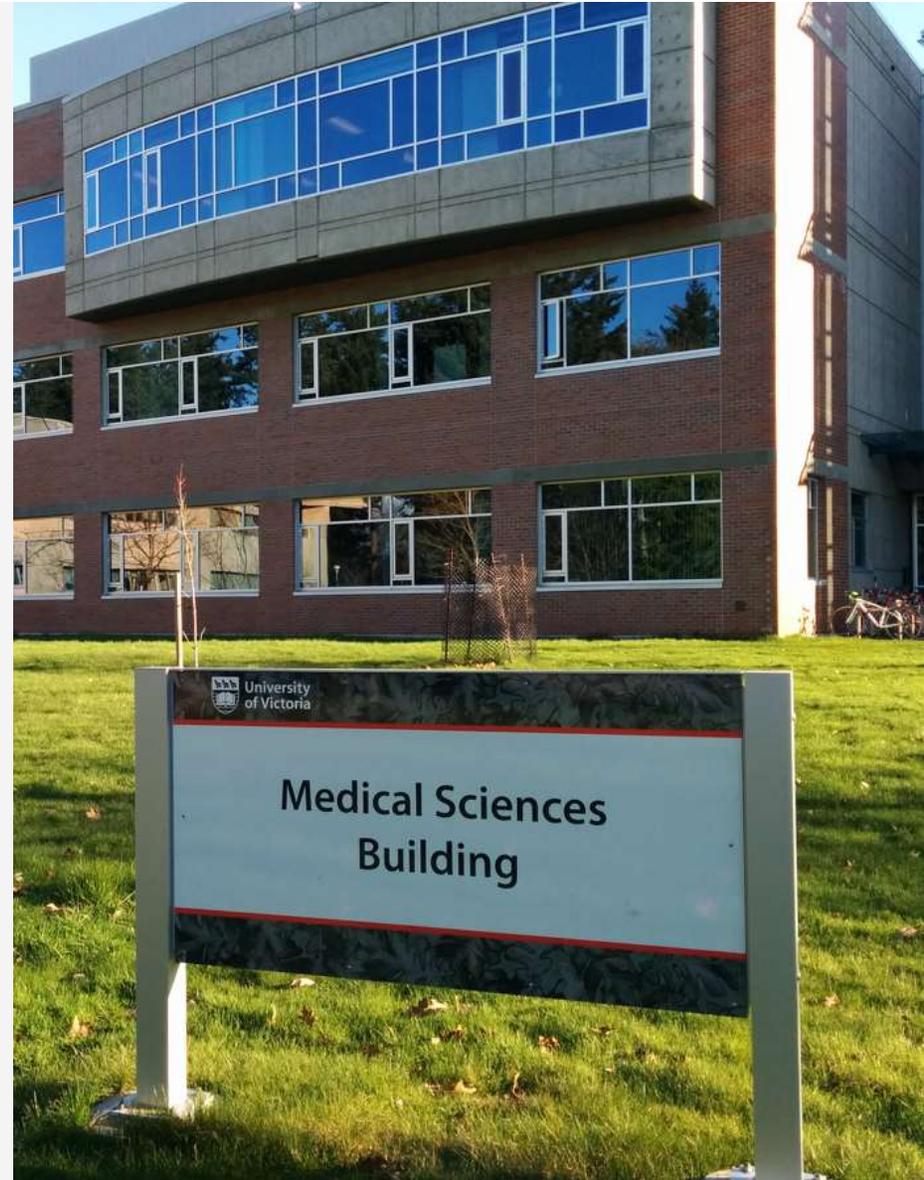
Medical School!

Earl Marriott Secondary (Class of 2016)
UBC Vancouver (Class of 2020, BSc Major in
Pharmacology)

Wrote MCAT in Summer 2020

Applied to UBC, Western, and McMaster for 2021
cycle. Interviewed and accepted to UBC, deferred to
start in 2022.

I'll do my best to answer any of your application
questions, but the UBC website is the best resource
(<https://mdprogram.med.ubc.ca/admissions/before-you-apply/>). Other sources for MCAT, etc.





Thank you!

Any Questions?



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