POLAR

Exploring Human Physiology Underground

SNOLAB is located on the traditional territory of the Robinson-Huron Treaty of 1850, shared by the Indigenous people of the surrounding Atikameksheng Anishnawbek First Nation as part of the larger Anishinabek Nation.

We acknowledge those who came before us and honour those who are the caretakers of the land and the waters.

Szymon Manecki, May 26th, 2026

POLAR

- **P**hysiology **o**f **L**ife in **A**ustere **R**egions
- **P**oint **o**f **C**are **U**ltra**s**ound (POCUS)

POCUS

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Medical Diagnostic Ultrasound: A Retrospective on Its 40th Anniversary" published in 1988, by Kodak Eastman with the National Museum of American History.

POCUS

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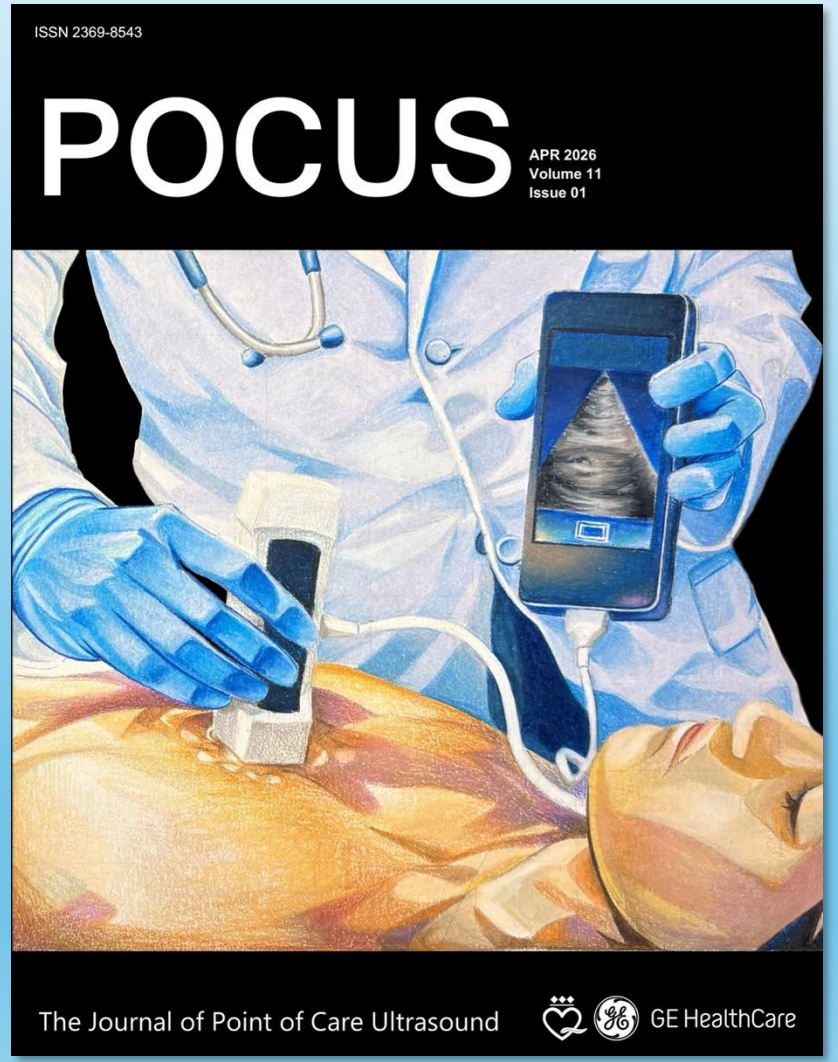


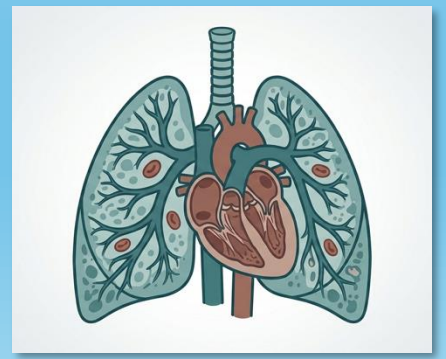
POCUS - diagnostics

System	Example Conditions Diagnosable with POCUS
Cardiac	Pericardial effusion/tamponade, RV dilation, LV dysfunction
Respiratory	Pleural effusion, edema, atelectasis
Abdominal	AAA, bowel obstruction, stones, appendicitis
Musculoskeletal	Effusions, tendon tear (rotator cuff, Achilles)
Obstetrics	Ovarian cyst, confirm pregnancy location
Vascular	Deep vein thrombosis, perfusion
Trauma	FAST (free fluid), eFAST (pneumothorax), RUSH, ACES

POLAR – applications

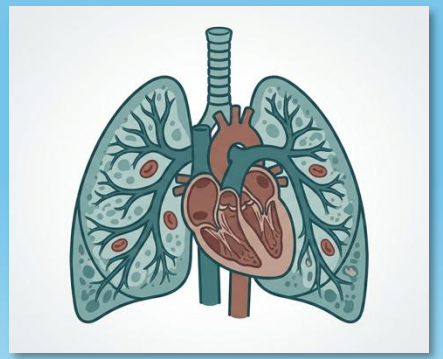
POLAR – austere challenges

- Delayed access to advanced care
- Limited diagnostic infrastructure
- Difficult evacuation and rescue
- Environmental stress on cardiopulmonary physiology
- Lack of real-time physiological monitoring

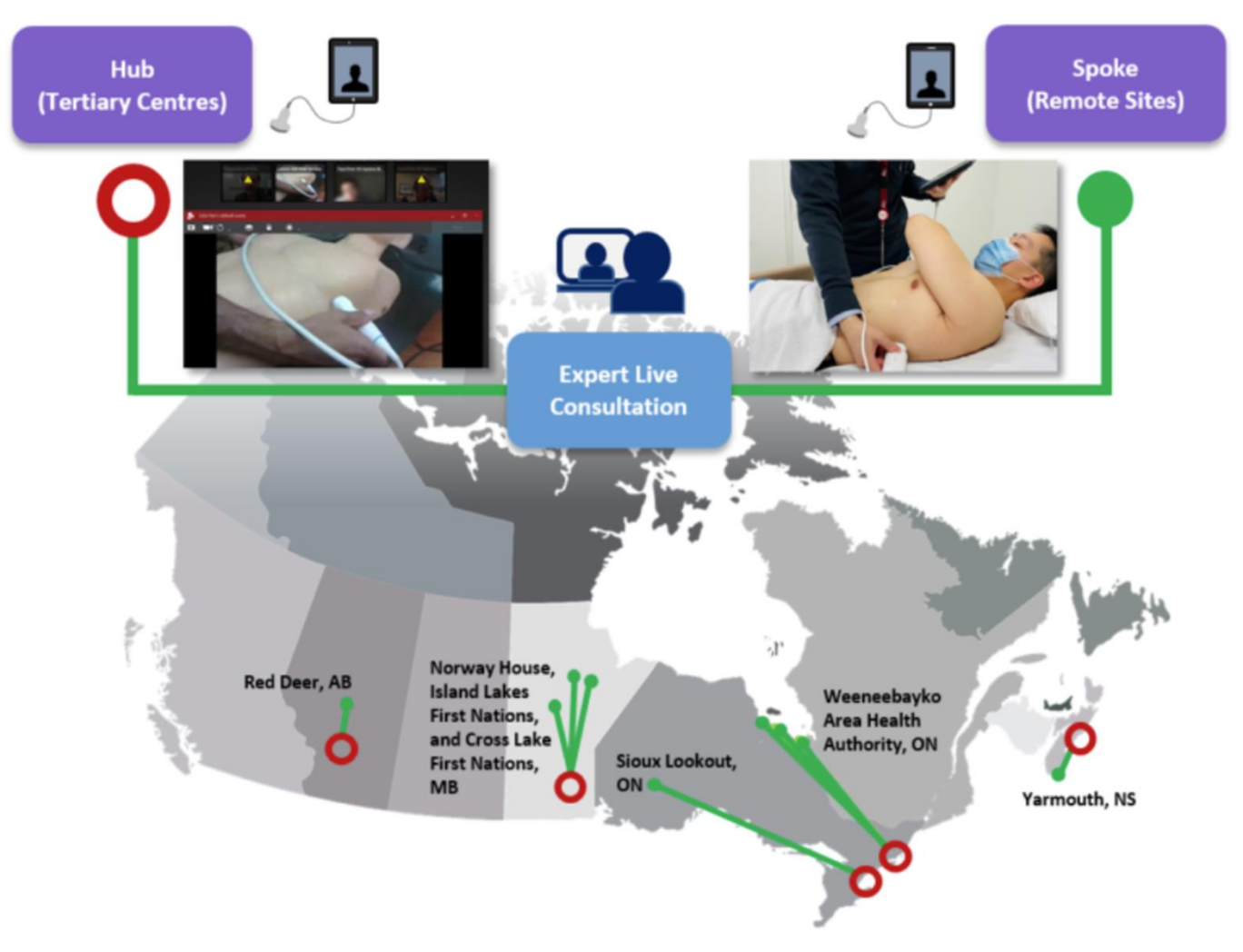


POLAR – advantages

- Rapid, real-time diagnosis
- Portable and compact
- Radiation-free and repeatable
- Improves diagnostic accuracy
- Cost-effective



POLAR - ARCTICA



POLAR Team @ SNOLAB

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Stage A

- Equipment Feasibility Testing
- Evaluate:
  - Device performance at 1.2 atm, humidity, and variable temperatures
  - Environmental interference (RF, EM fields)
  - Image quality
- No human subjects involved

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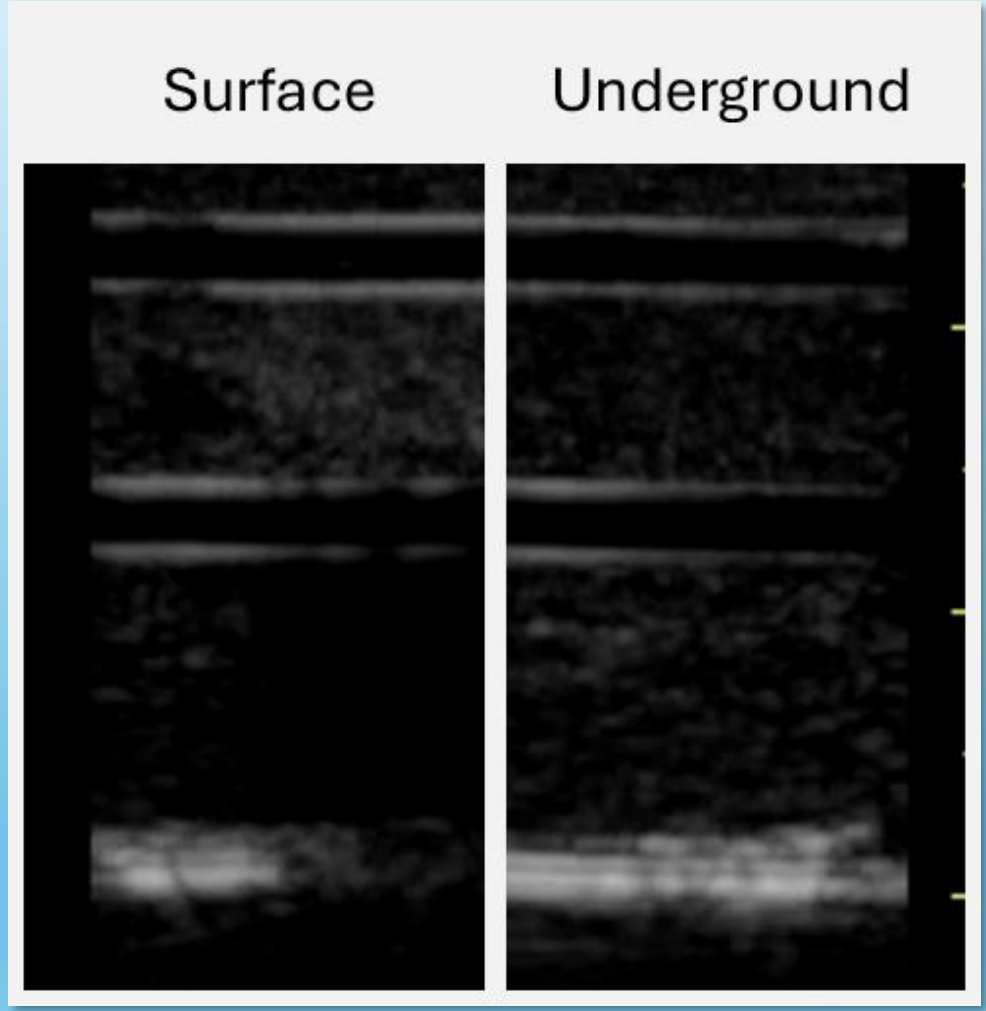
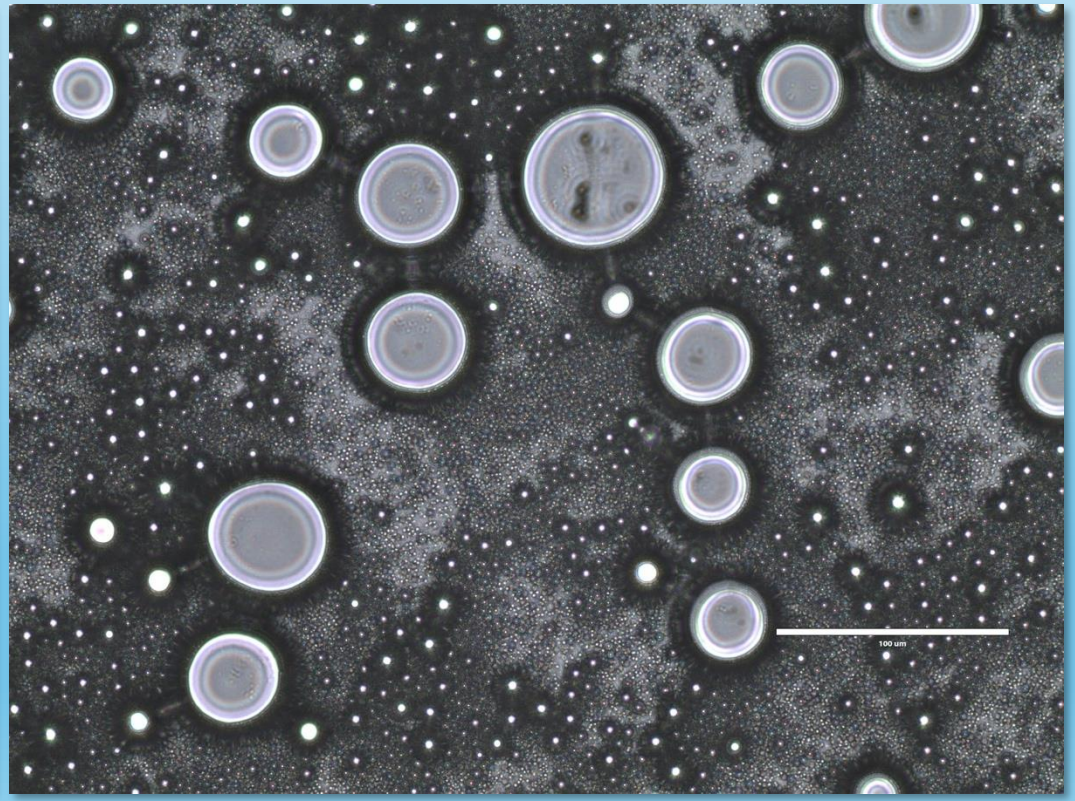


Stage A

- Ultrasound Contrast Microbubbles



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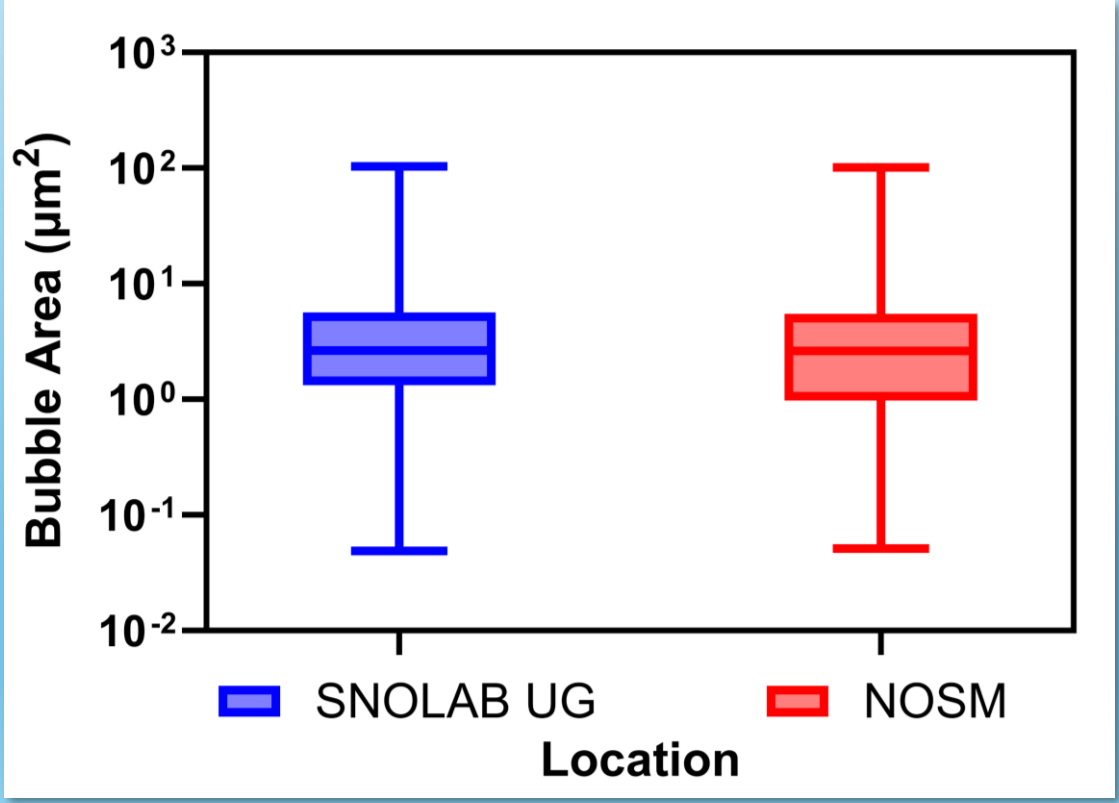
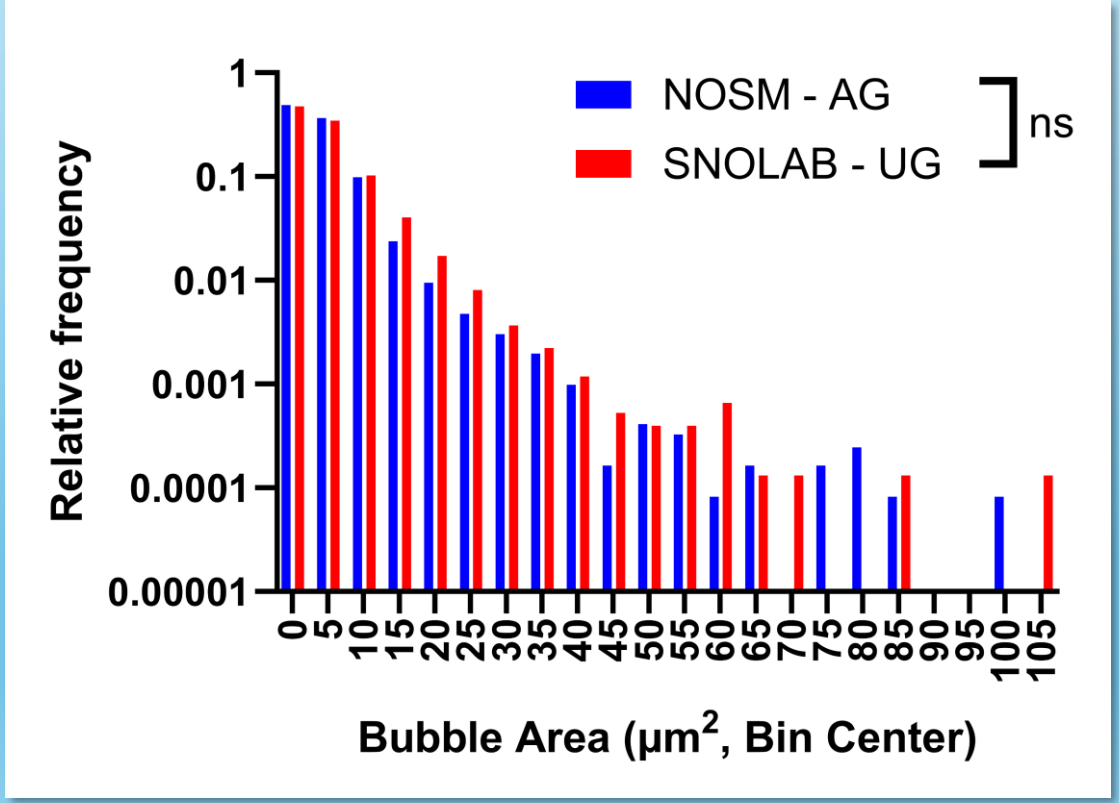




Stage B

- Physiological Measurements
- Evaluate if there are cardiopulmonary physiological changes in response to deep underground exposure using POCUS.
- Sample population → people working underground (SNOLAB)→ n = 20
- Queen's University HSREB approved (# 6046323)

Stage B

Experimental – Workday Underground

T0 (surface baseline, pre-descent)

T1 (arrival underground, acute exposure)

T2 (end-of-shift underground, sustained exposure)

T3 (post-ascent, recovery)

Control – Workday surface

C0 (start of workday)

C1 (end of workday)

Stage B

Cardiac parameters

Left ventricular ejection fraction

Stroke volume (LVOT VTI)

Cardiac output

Right ventricular function

Tricuspid regurgitation velocity

Inferior vena cava diameter/collapsibility

Doppler-derived diastolic indices

→ **Preload**
Afterload
Ventricular coupling

Lung parameters

B-line quantification

Pleural line morphology

Lung sliding

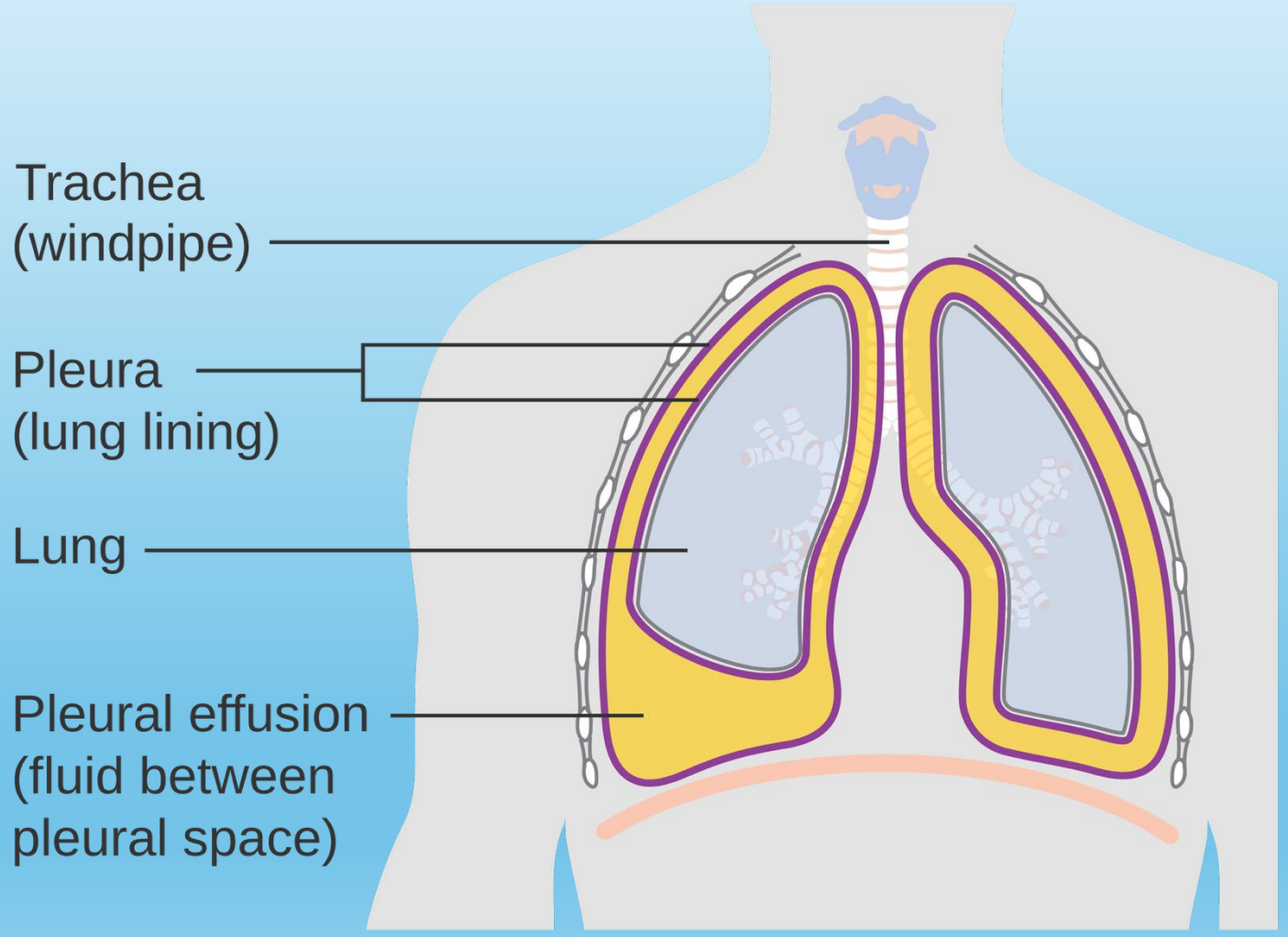
Pleural effusions

→ **Lung water distribution**
Aeration patterns

Thank You


1
What are the most pressing physiological or health challenges in extreme, remote, or underground environments?
Where can this laboratory make the greatest impact?
2
What research questions or use cases would you prioritize studying in this deep underground environment?
Are there gaps in knowledge we should focus on?
3
How can we best design the lab and its capabilities to support your research or operational needs?
What tools, protocols, or partnerships are essential?
4
What collaborations or partnerships would strengthen this platform and expand its impact?
Who should be at the table?
5
How can we ensure the research translates into real-world benefits for workers, communities, and missions?
What outcomes matter most?
6
What ideas, opportunities, or considerations have we not thought of that we should explore together?
What should we be thinking about next?

Backup


Trachea
(windpipe)
Pleura
(lung lining)
Lung
Pleural effusion
(fluid between
pleural space)