

A1.1

Water

What physical and chemical properties of water make it essential for life?
What are the challenges and opportunities of water as a habitat?

Just over 70% of the Earth's surface is covered by water.

If the Earth had a smooth surface topography, then it would be completely covered in water and to a depth of more than 2.5km.



[via R Nasibov](#)

View of Earth over the Pacific Ocean, with white reflective clouds removed.

Wonderful World
William Brighty Rands

*Great, wide, beautiful, wonderful World,
With the wonderful water round you curled,
And the wonderful grass upon your breast,
World, you are beautifully drest.*

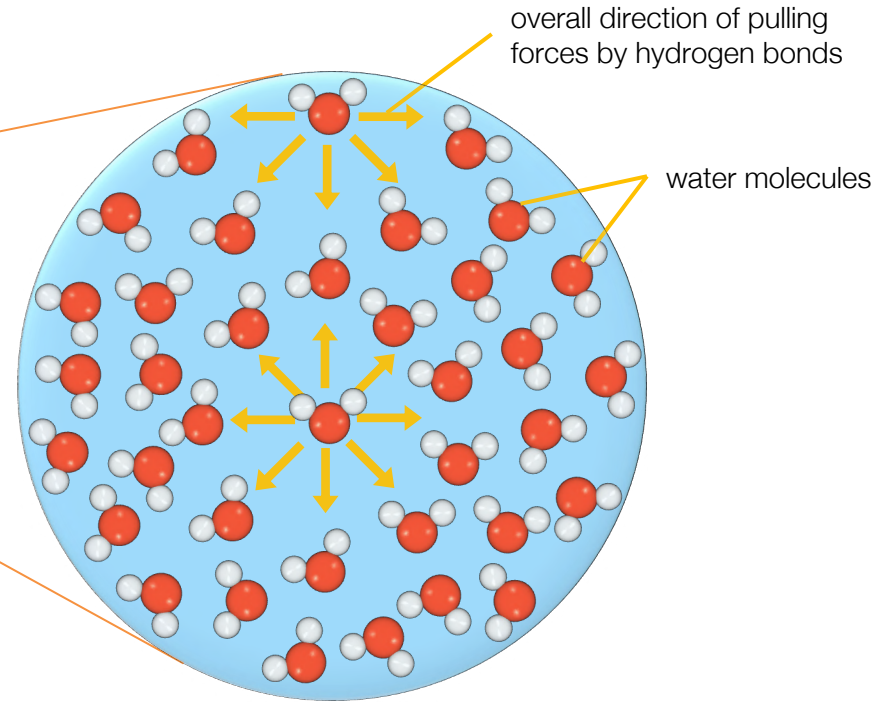
*The wonderful air is over me,
And the wonderful wind is shaking the tree—
It walks on the water, and whirls the mills,
And talks to itself on the top of the hills.*

*You friendly Earth, how far do you go,
With the wheat-fields that nod and the rivers that flow,
With cities and gardens, and cliffs and isles,
And people upon you for thousands of miles?
Ah! you are so great, and I am so small,
I hardly can think of you, World, at all;
And yet, when I said my prayers to-day,
A whisper within me seemed to say,
“You are more than the Earth, though you are such a dot!
You can love and think, and the Earth cannot!”*



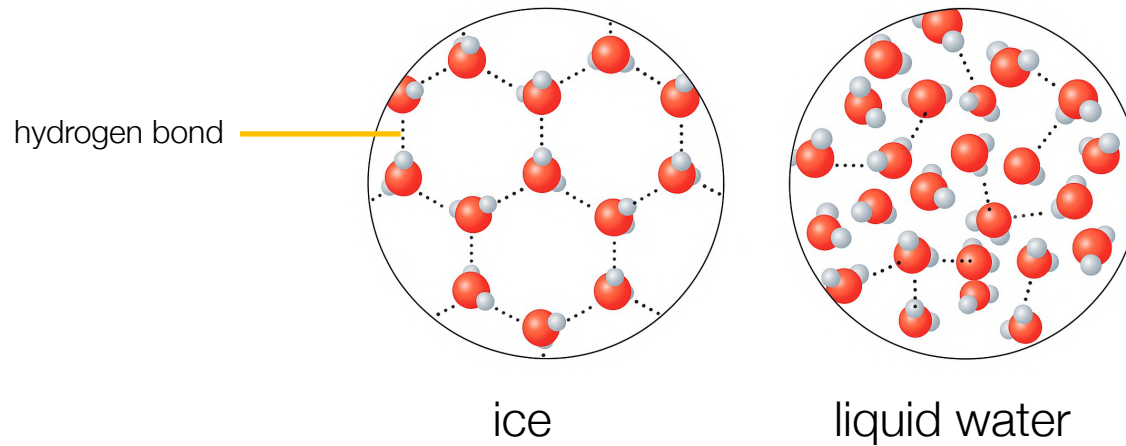


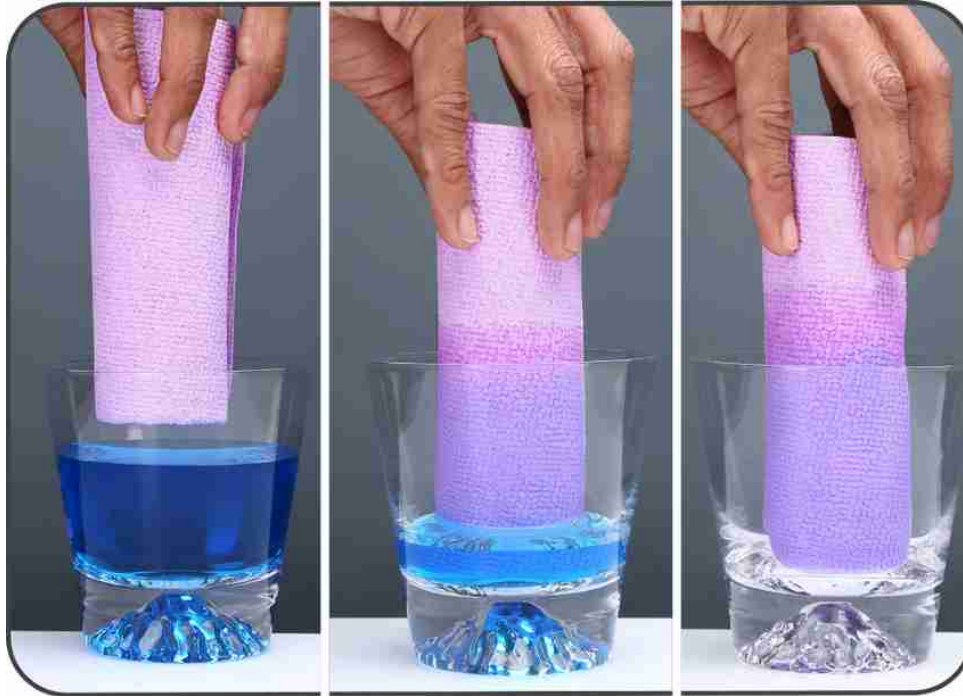
[Anees Ur Rehman Unsplash](#)



[biocode.co](#)

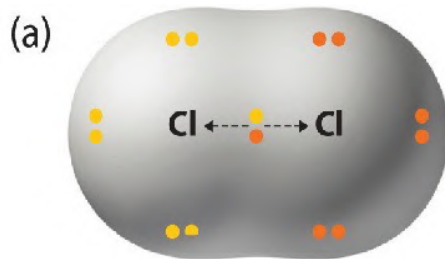
Water is sticky due to cohesion between water molecules.





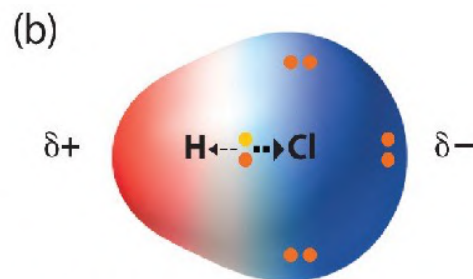
[GAI A Antifiber Sponose Cloth](#)

Capillary action between the fibers of a cloth.



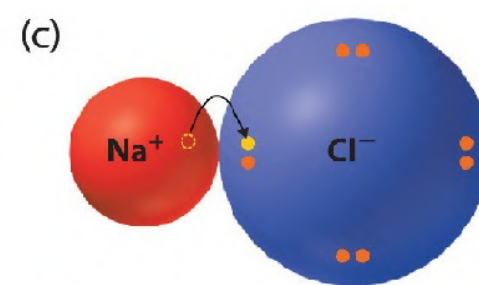
Nonpolar covalent bond

Bonding electrons shared equally between two atoms.
No charges on atoms.



Polar covalent bond

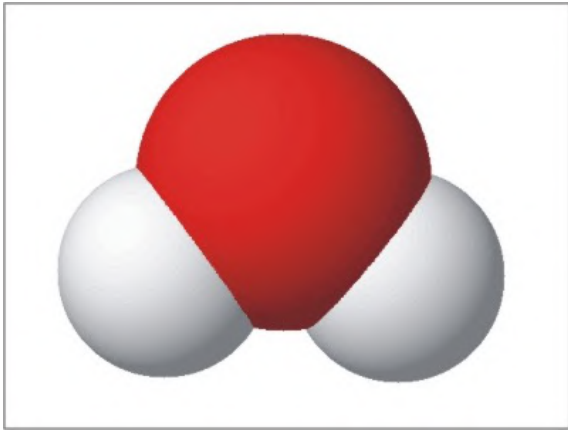
Bonding electrons shared unequally between two atoms.
Partial charges on atoms.



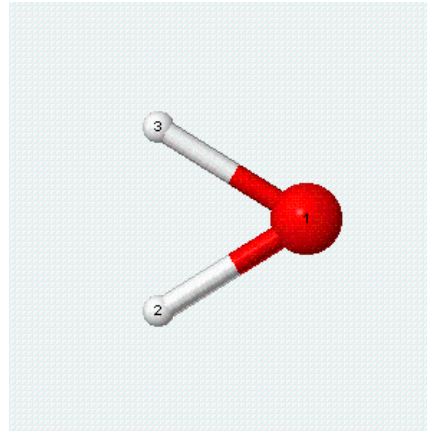
Ionic bond

Complete transfer of one or more valence electrons.
Full charges on resulting ions.

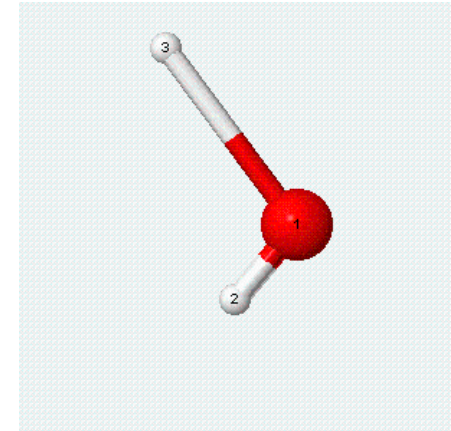
Cambridge Structural Database



[Юрок гланкий](#)

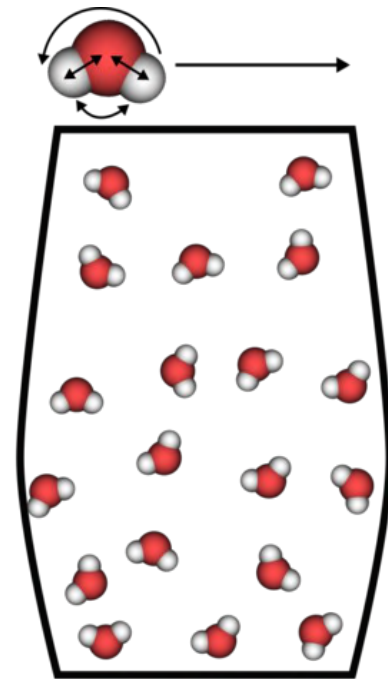
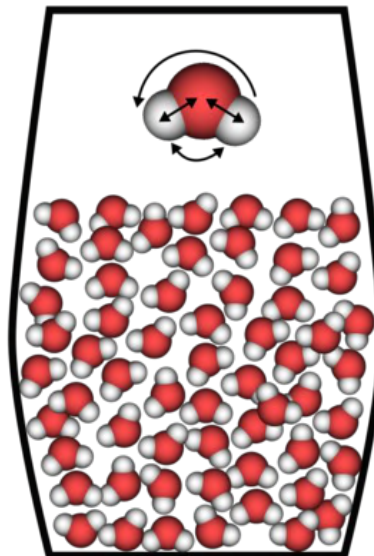
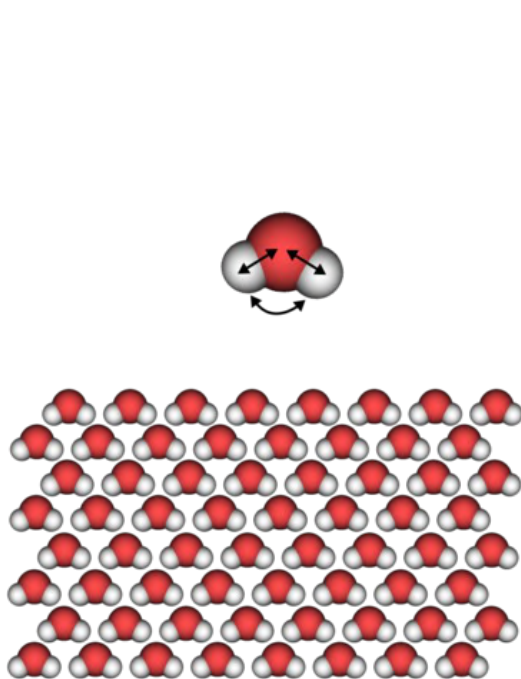


[Evan585619](#)



[Evan585619](#)

see links above for animations





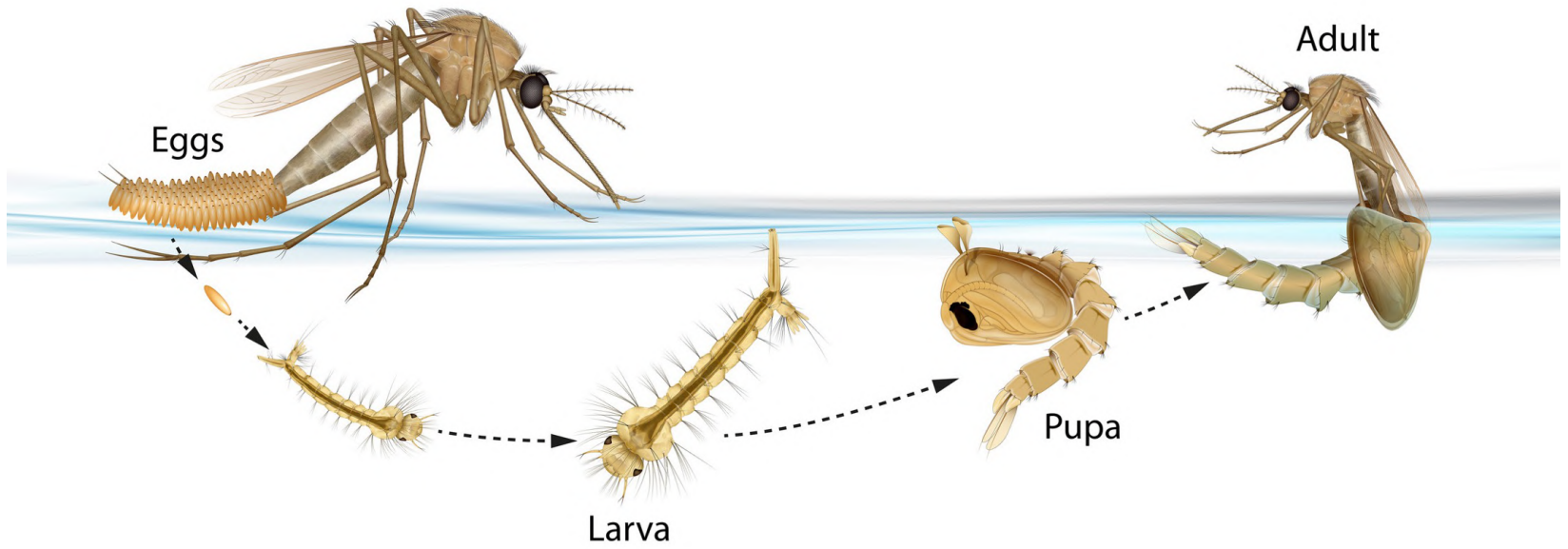
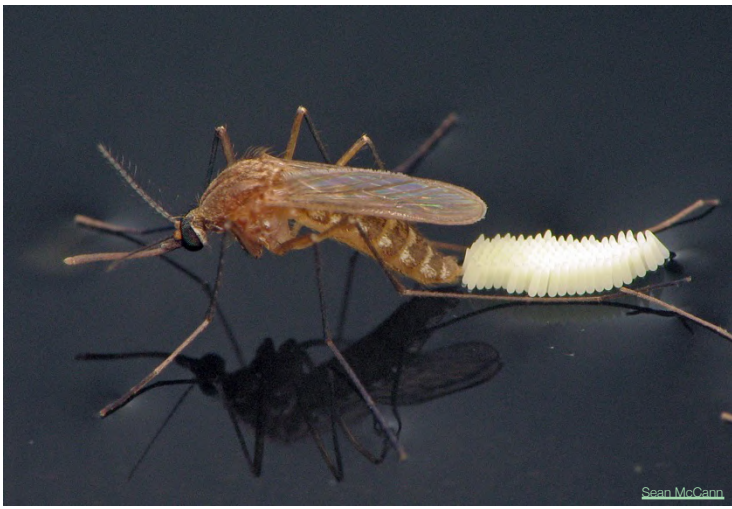
[David Brown](#)

Water forms reflective white clouds and snow.
Ice floats on the surface of liquid water – maintaining habitat for fish beneath.



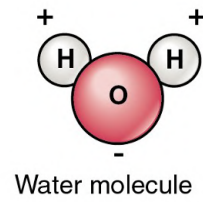
[Gorby Wikimedia](#)

raft spider *dolomedes fimbriatus*

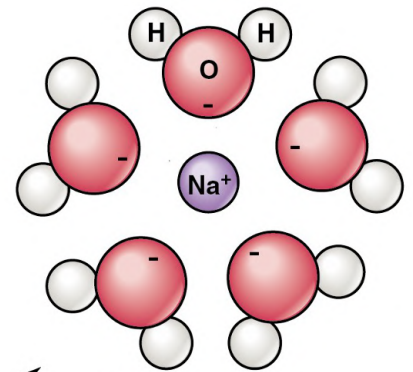




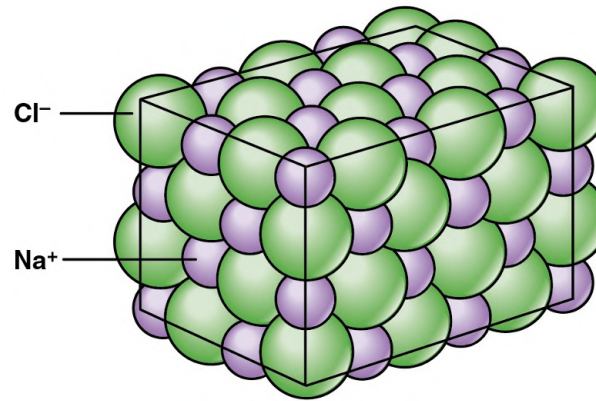
Weinrich Minerals



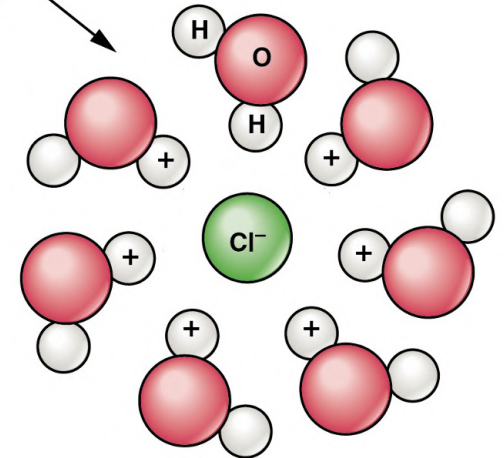
Water molecule



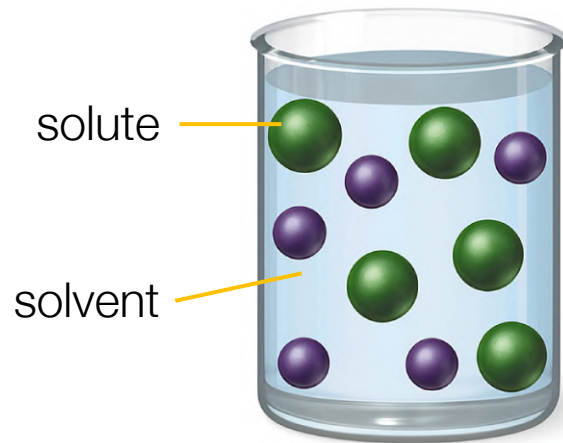
Hydrated sodium ion



Crystal of NaCl



Hydrated chloride ion

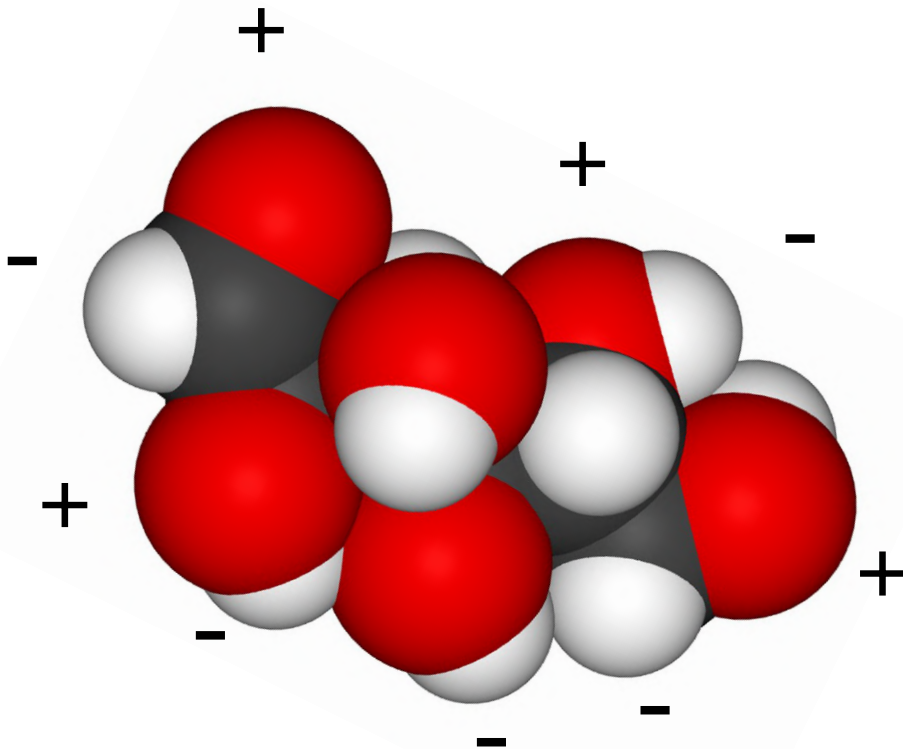


solute

solvent

solution

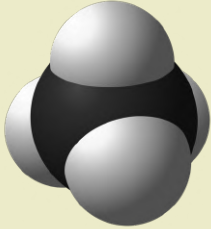
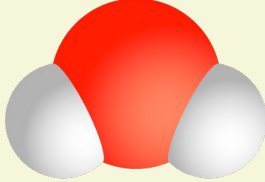
[adapted from OpenStax](#)



glucose molecules are hydrophilic



oil is hydrophobic

	methane	water
		
formula	CH ₄	H ₂ O
molecular mass	16	18
bonding	single covalent	
polarity	nonpolar	polar
density (g cm ⁻³)	0.46	1
specific heat capacity (J g ⁻¹ °C ⁻¹)	2.2	4.2
latent heat of vaporization (J g ⁻¹)	760	2257
melting point (°C)	-182	0
boiling point (°C)	-160	100

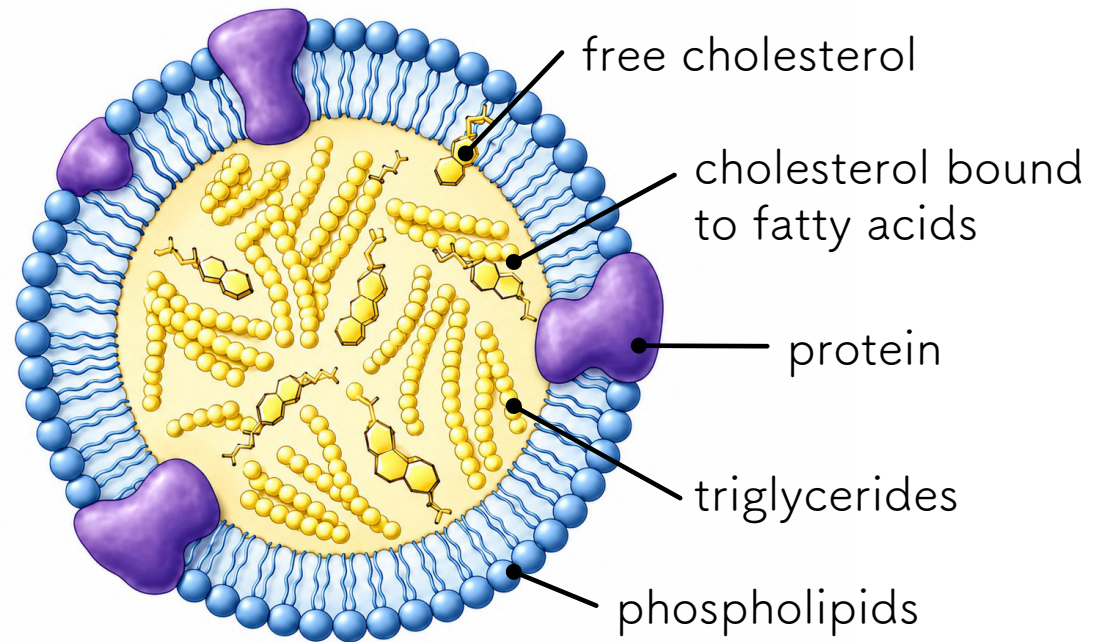
methane

- o waste product of anaerobic respiration in certain prokaryotes living in anaerobic conditions
- o can be used as a fuel
- o if present in the atmosphere it contributes to the greenhouse effect

key reason for different [properties](#)

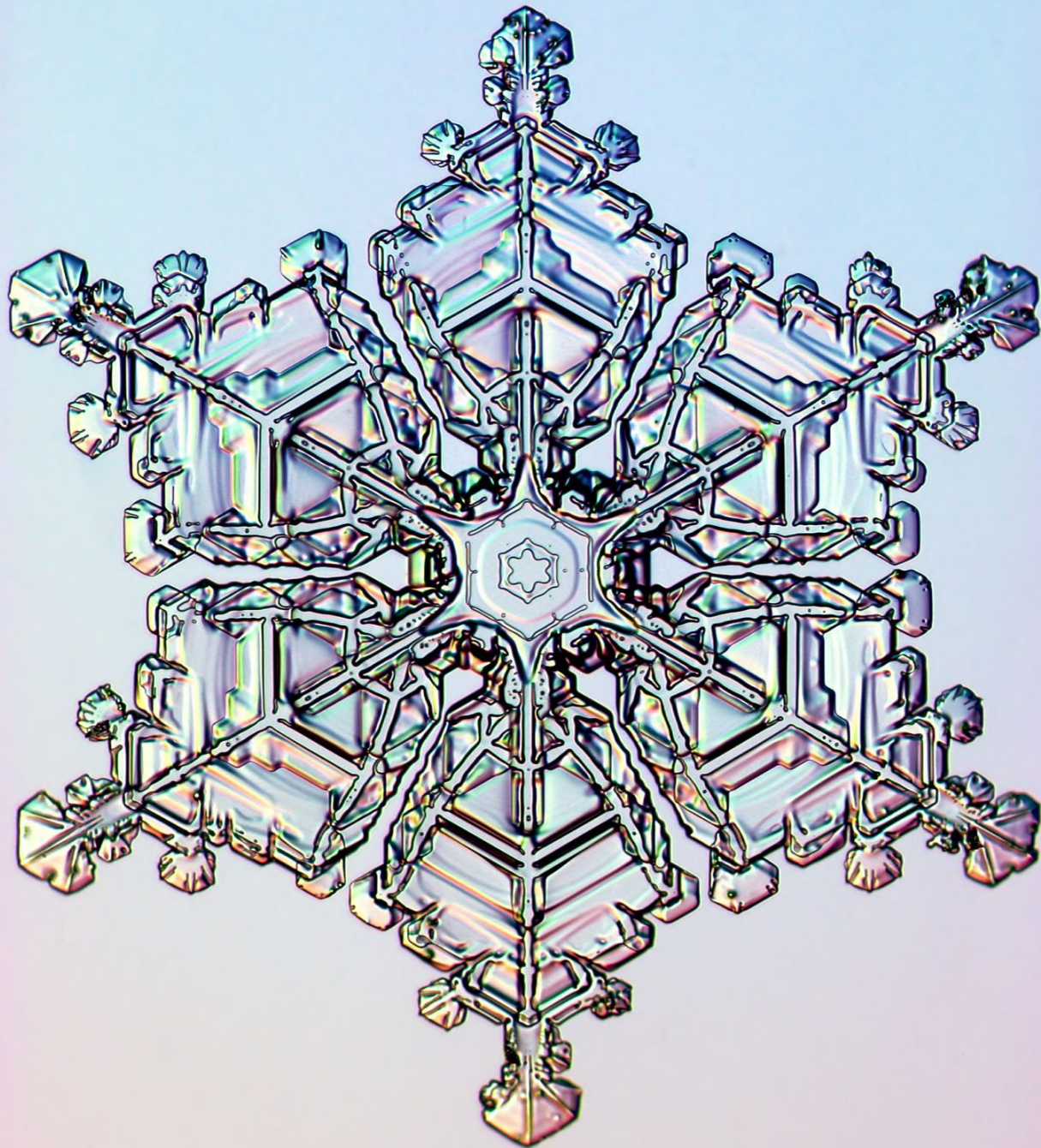
methanogenic prokaryotes are found in anaerobic:

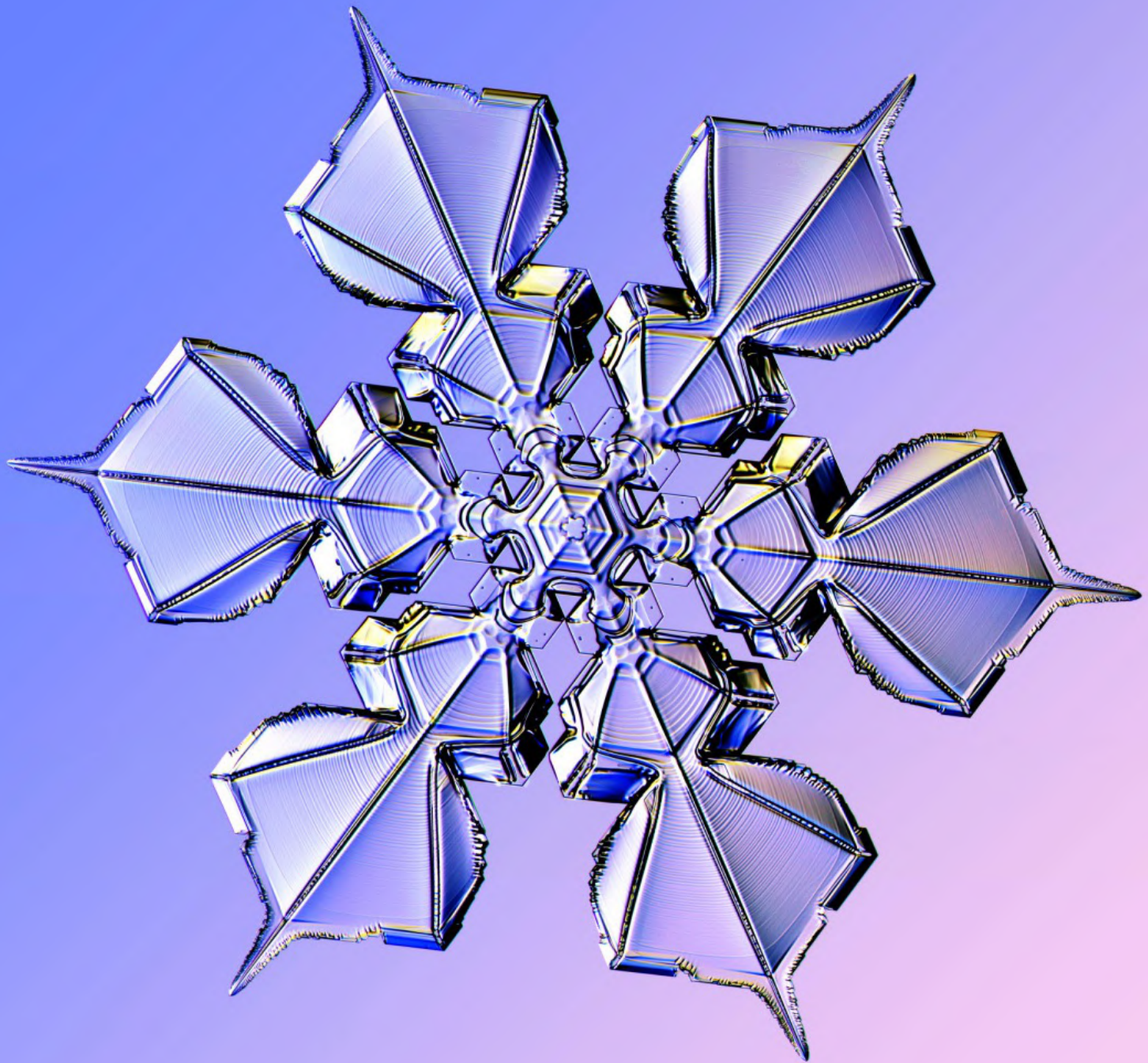
- o mud of wetlands
- o stomachs of ruminants such as cattle
- o decomposing waste

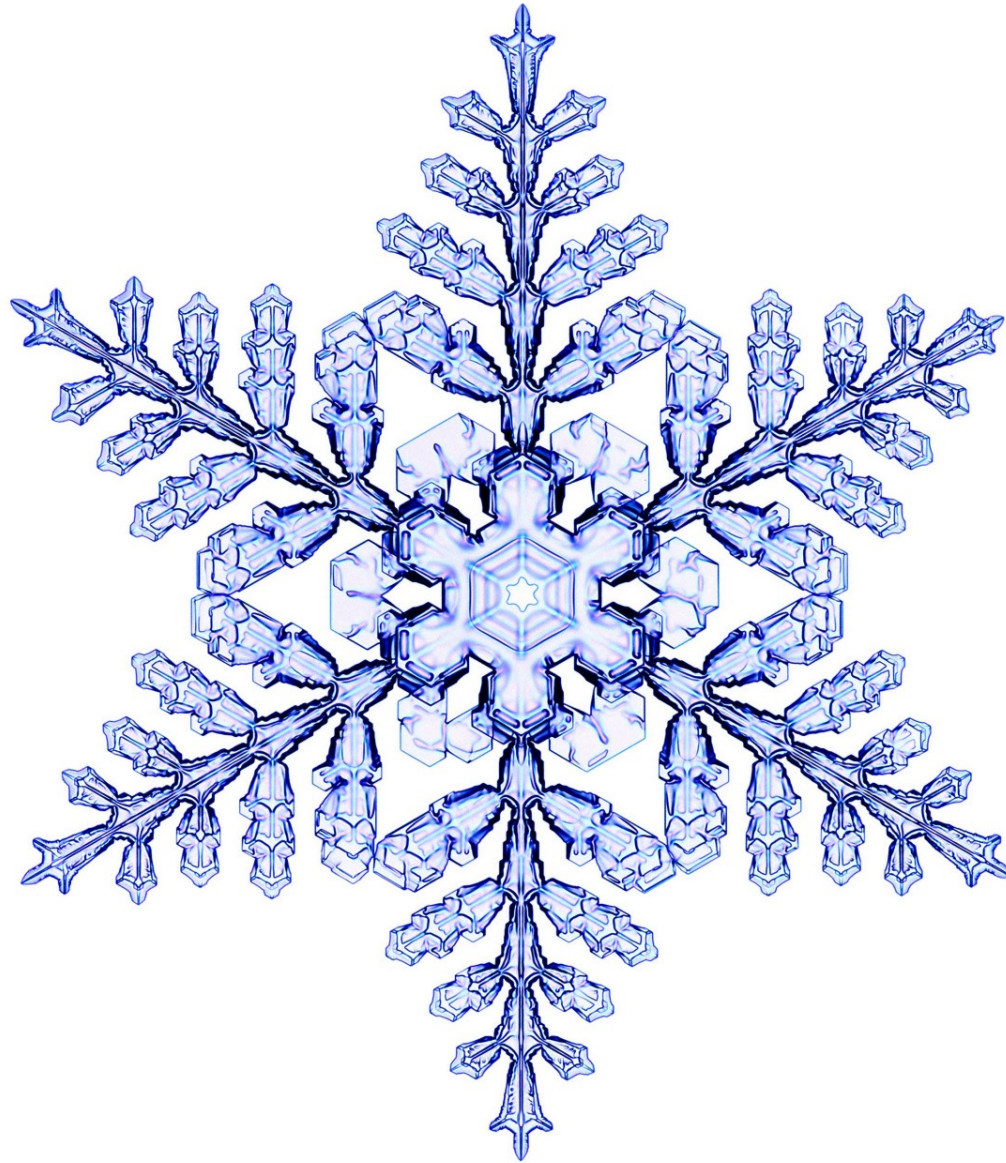


lipoprotein structure

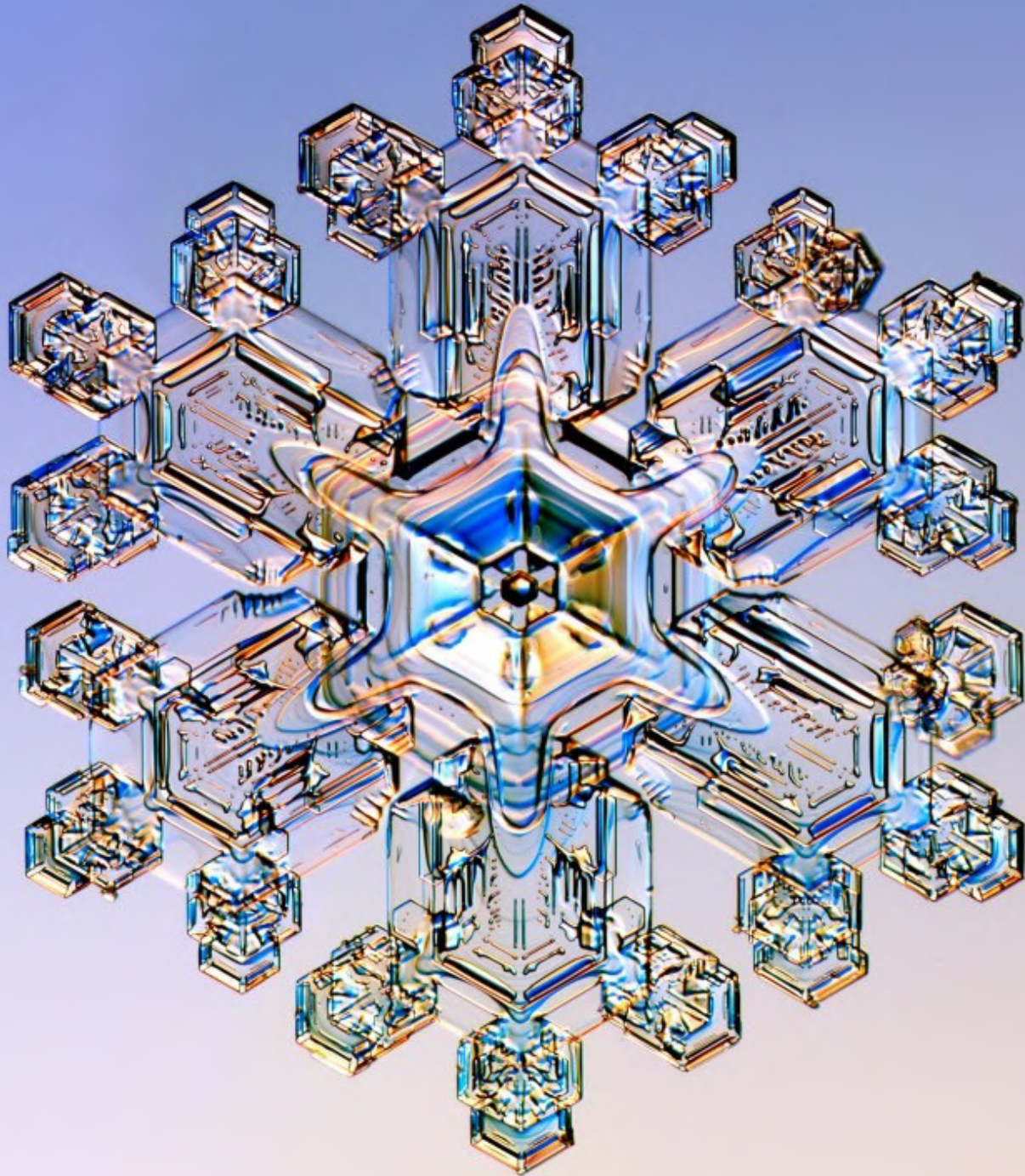
AI generated biocode.co







*Have you entered into the store houses of snow?
Job 38*



Optional Extension



"Under the microscope, I found that snowflakes were miracles of beauty; and it seemed a shame that this beauty should not be seen and appreciated by others. Every crystal was a masterpiece of design and no one design was ever repeated.

When a snowflake melted, that design was forever lost.

Just that much beauty was gone, without leaving any record behind."

— Wilson A. Bentley [The Snowflake Man](#) America's First Cloud Physicist



[Benot Nyman](#)

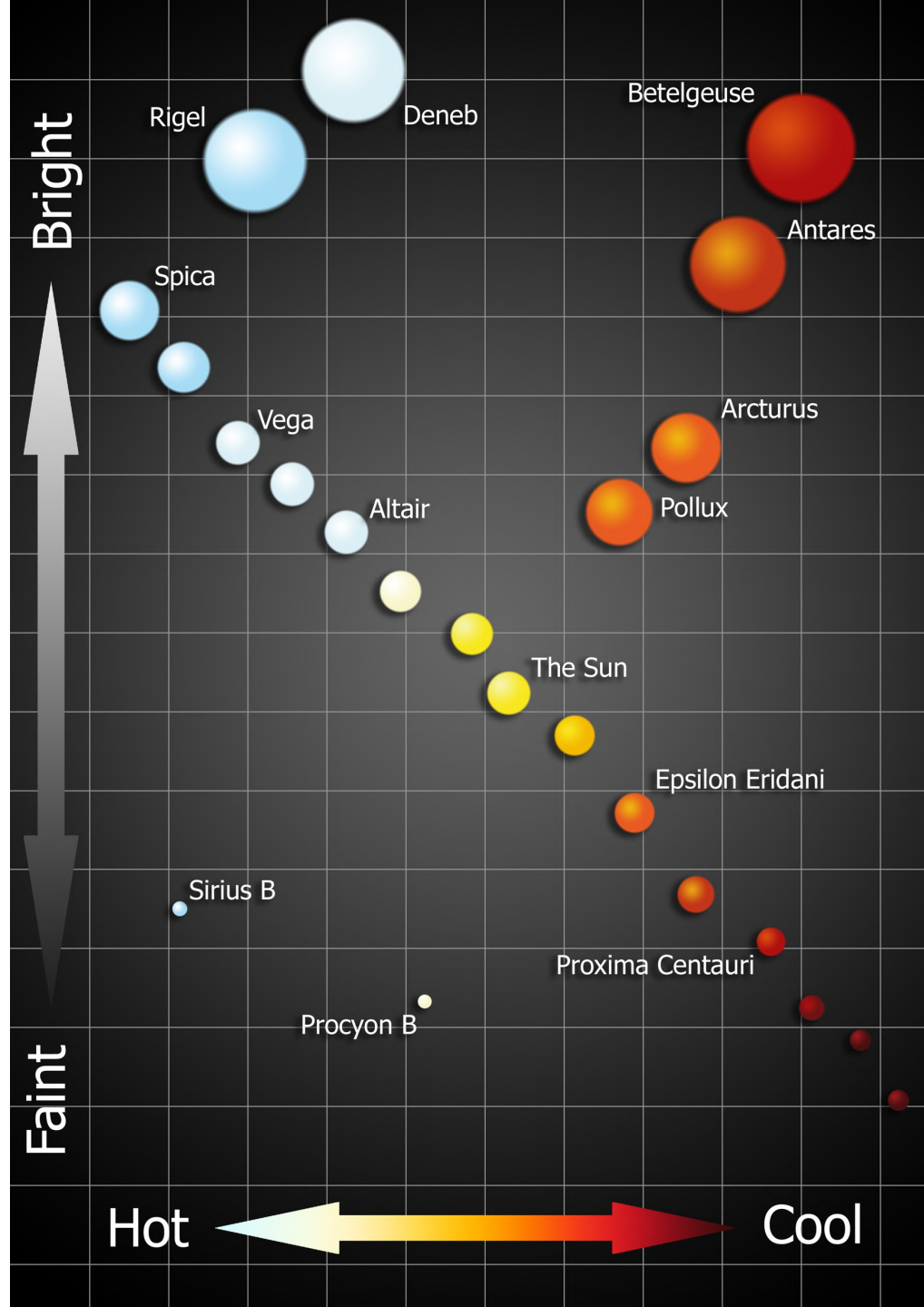
black throated loon



[alaska sealife center](#)

Arctic ringed seal

Star size and mass usually determines brightness and temperature.





[Cambridge University](#)

left - an iron meteorite from the core of a melted planetesimal – contains little water
right - chondrite unmelted meteorite, from a 'primitive', unmelted planetesimal – contains some water
Credit: Rayssa Martins/Ross Findlay

Barrington Crater or Meteor Crater in Arizona USA

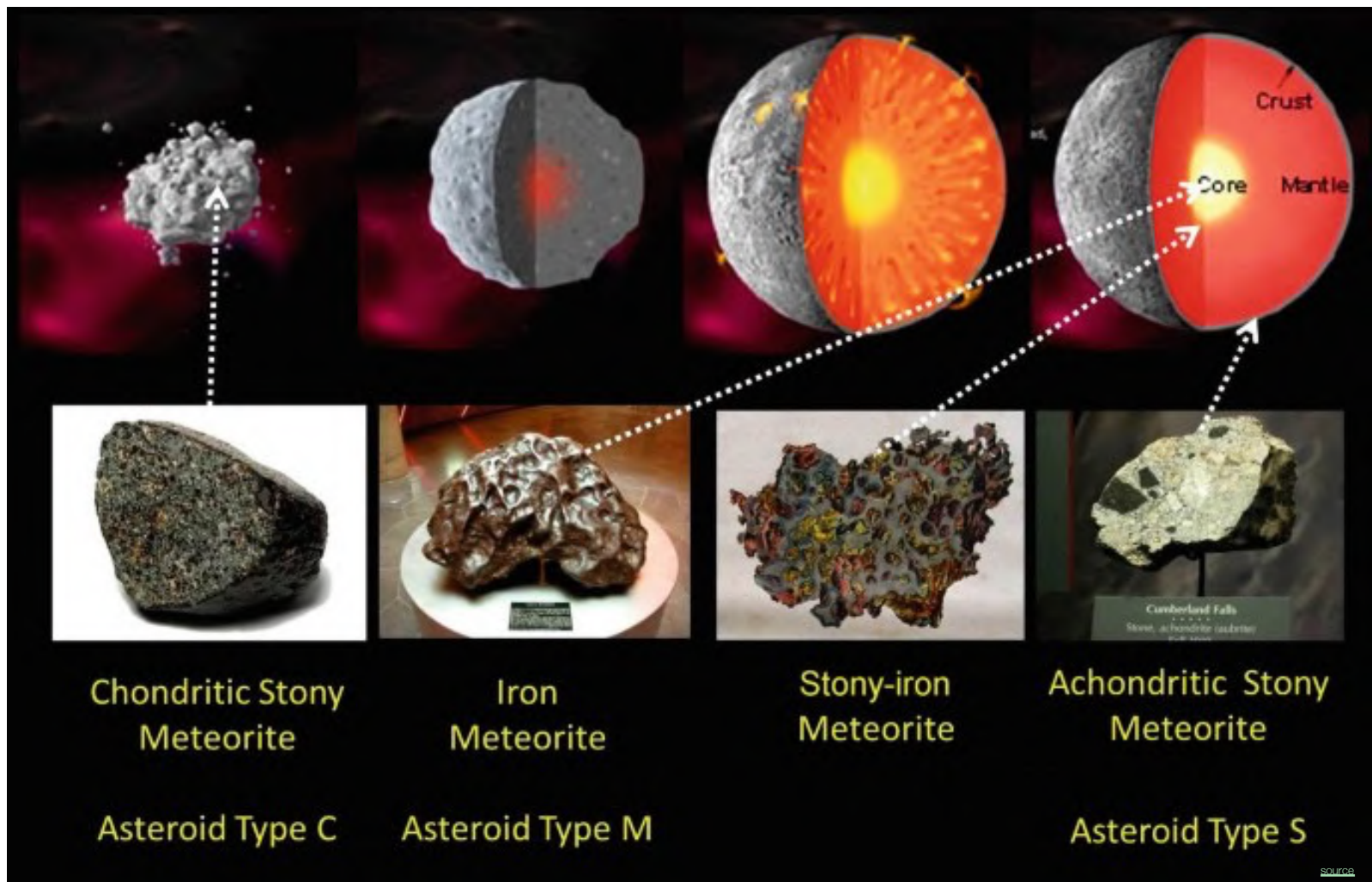


Emma Buchanan

Q: How many asteroids would be needed every year to supply 1 386 000 000 km³ of water if each asteroid contained

a) 25% water and was 40km³ in volume over 200 000 000 years?

b) 10% water and was 0.1km³ in volume over 4 billion years?



*Water makes up 71% of Earth's surface, but
no one knows how or when such massive
quantities of water arrived on Earth.*
University of Maryland [CMNS News](#)

*“One of the most fundamental questions
on the origin of life
is where the materials we need for life to evolve came from”*
Dr Rayssa Martins
Cambridge's Department of Earth Sciences

ANSWERS

Q: How many asteroids would be needed every year to supply 1 386 000 000 km³ of water if each asteroid contained

a) 25% water and was 40km³ in volume over 200 000 000 years?

b) 10% water and was 0.1km³ in volume over 4 billion years?

A:

a) Step 1 — Water per asteroid:

$$40 \text{ km}^3 \times 0.25 = 10 \text{ km}^3 \text{ of water per asteroid}$$

Step 2 — Total asteroids needed:

$$1,386,000,000 \div 10 = 138,600,000 \text{ asteroids}$$

Step 3 — Asteroids per year:

$$138,600,000 \div 200,000,000 = 0.693 \text{ asteroids/year}$$

Roughly ~1 asteroid every 1.44 years

(a 40km³ asteroid is bigger than the one that was thought to have selectively wiped out the dinosaurs)

b) 10% water, 0.1 km³ volume, over 4,000,000,000 years

Step 1 — Water per asteroid:

$$0.1 \text{ km}^3 \times 0.10 = 0.01 \text{ km}^3 \text{ of water per asteroid}$$

Step 2 — Total asteroids needed:

$$1,386,000,000 \div 0.01 = 138,600,000,000 \text{ asteroids}$$

Step 3 — Asteroids per year:

$$138,600,000,000 \div 4,000,000,000 = 34.65 \text{ asteroids/year}$$

Roughly ~35 asteroids every year or 1.5 a week

(not required for the IB exam)

Optional Extension

(not required for the IB exam)

The solar corona with
streamer and prominences
(in red).

Moon is illuminated by
earth shine. Aug 21 2017



Optional Extension

(not required for the IB exam)

Was the
Universe
Designed?
with Dr Faulkener

Annular solar eclipse with
diamond ring effect.



