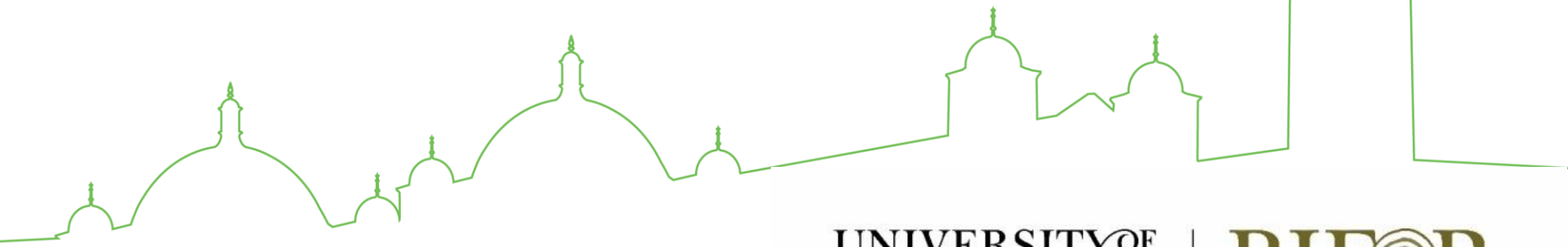
UNIVERSITY OF BIRMINGHAM | COLLEGE OF LIFE AND ENVIRONMENTAL SCIENCES

Why Plants Haven't (quite) Conquered the Land

Professor Jeremy Pritchard

@DrJPritchard



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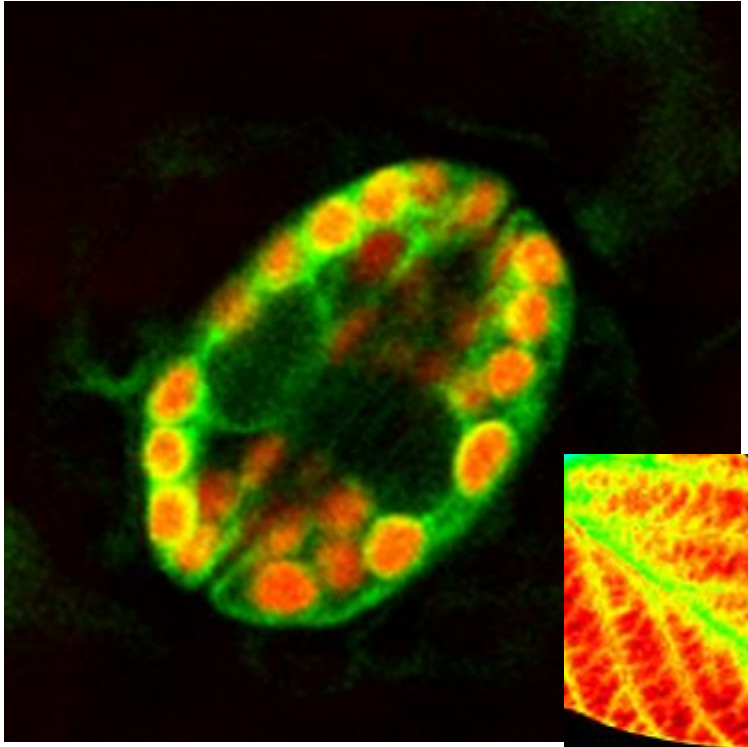
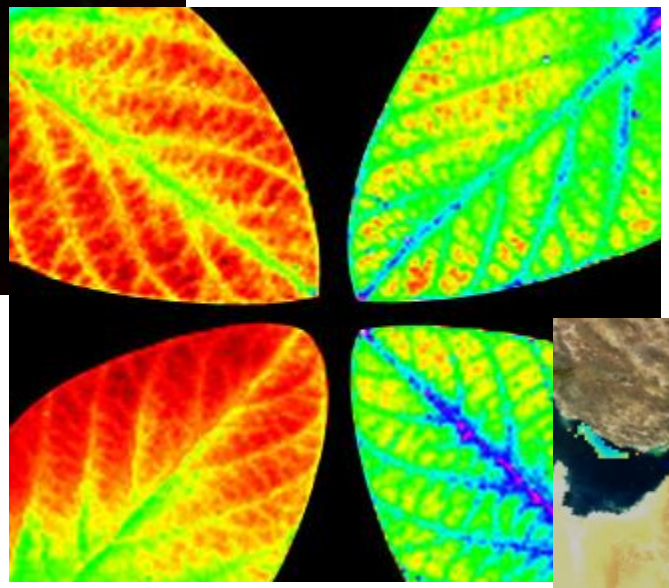
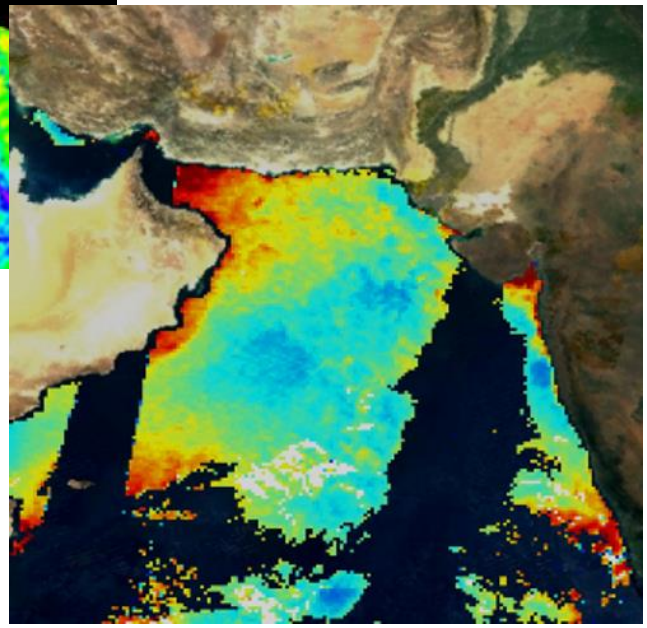
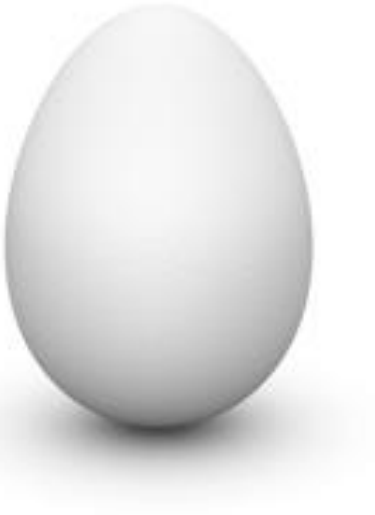
6Q

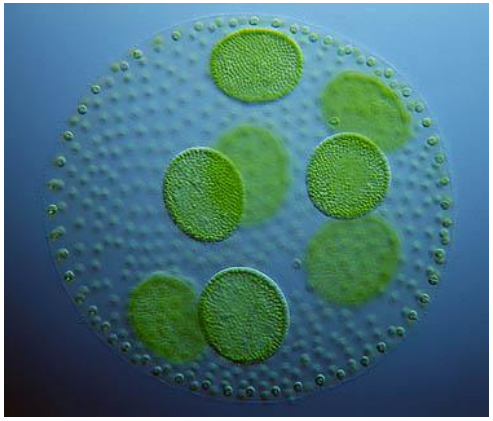


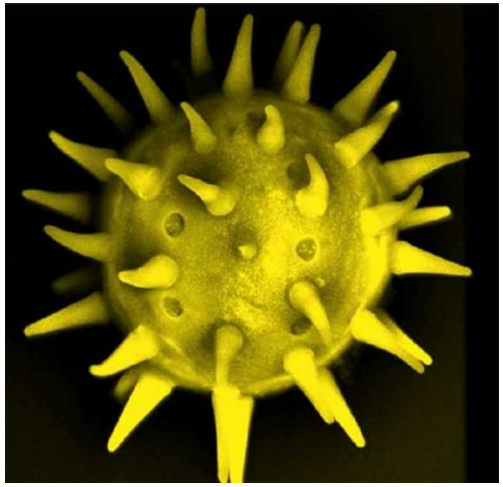




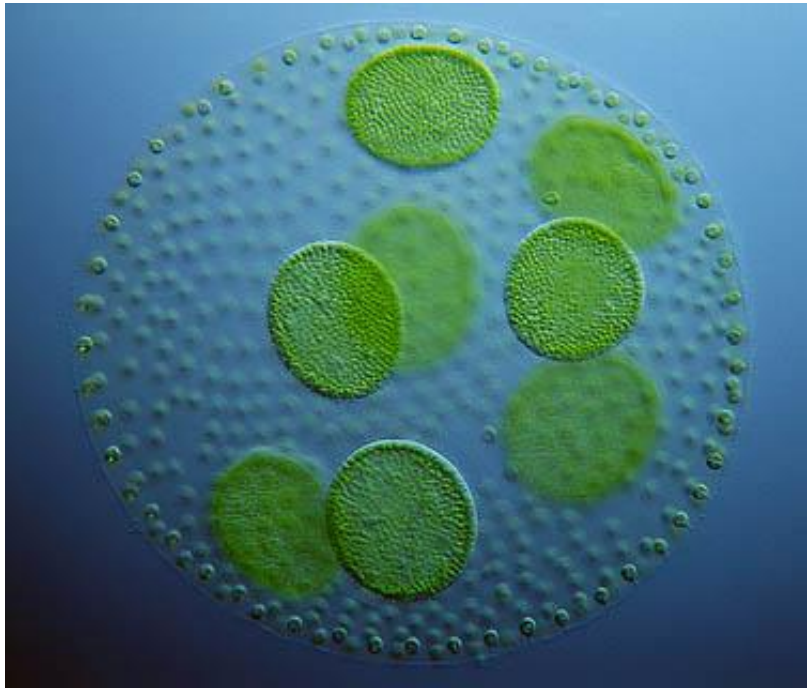

Shropshire Union Can



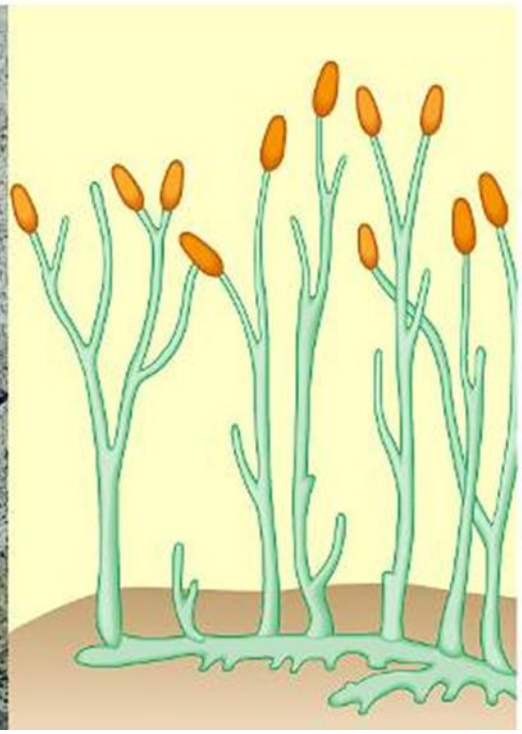


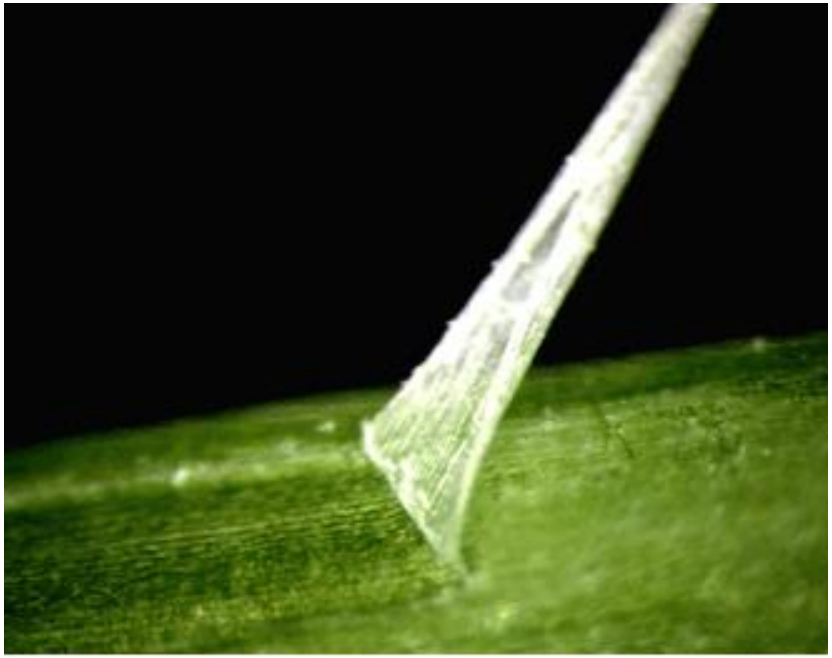


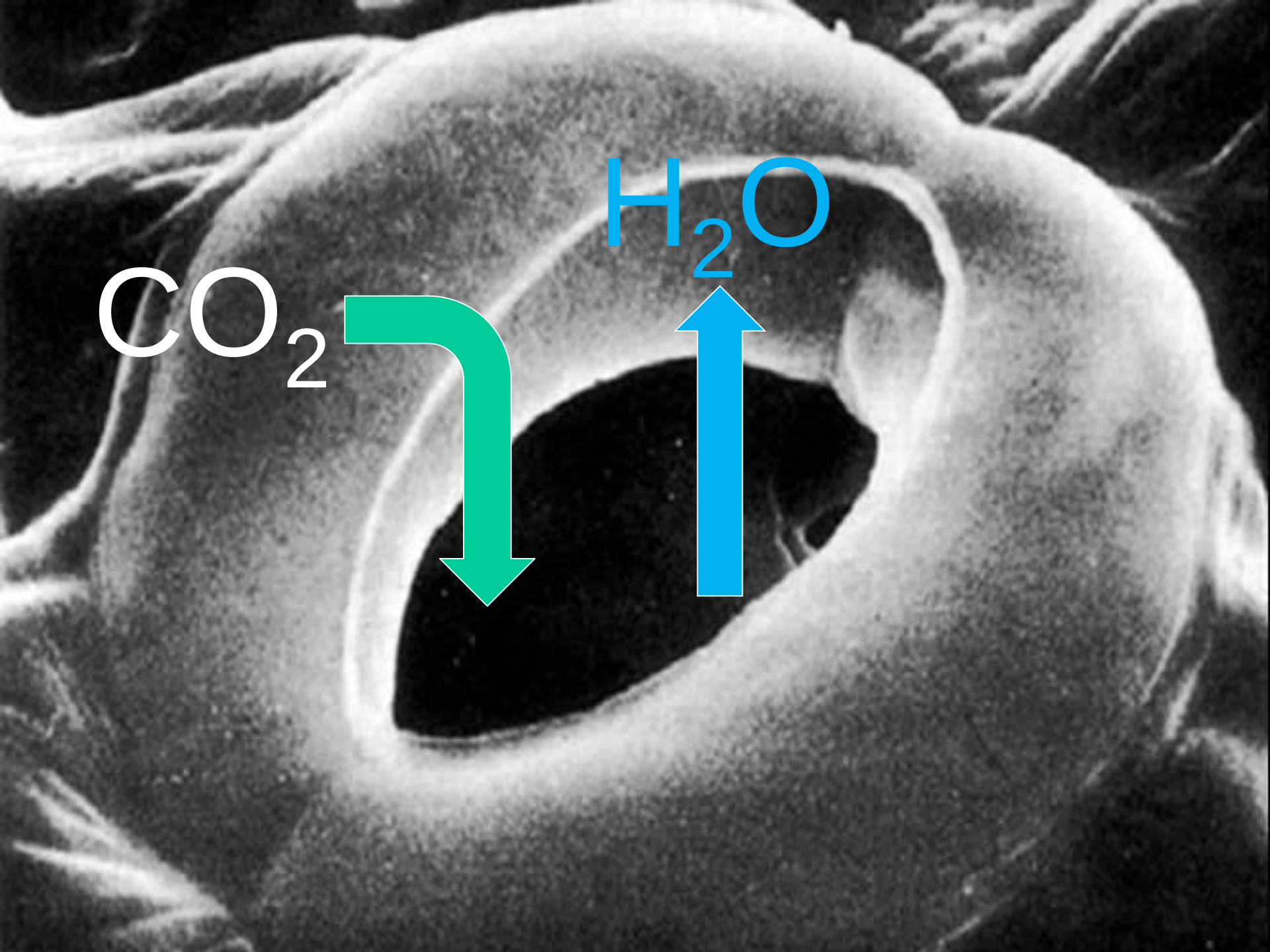
Land plants evolved from an algal ancestor that lived in water.



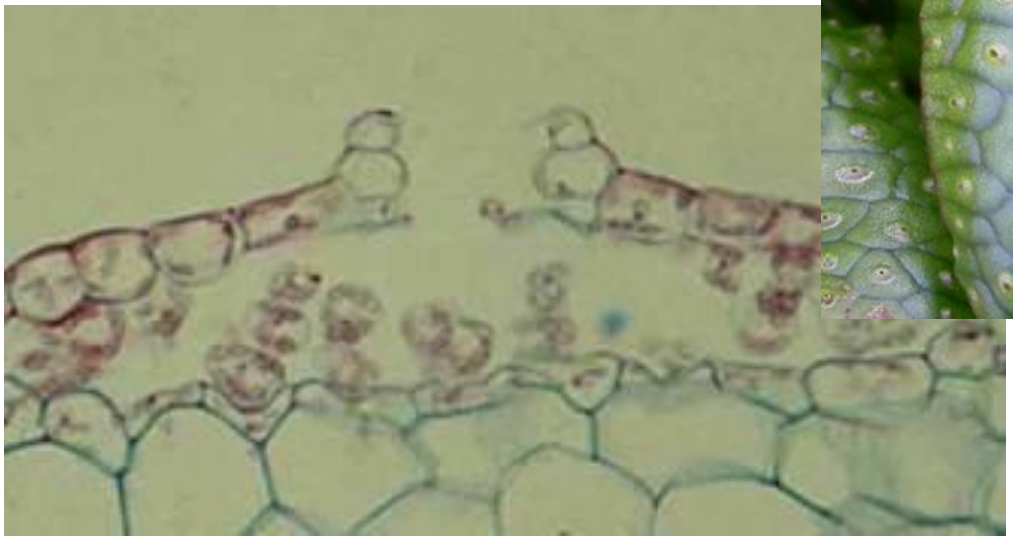
Early land:
A harsh environment



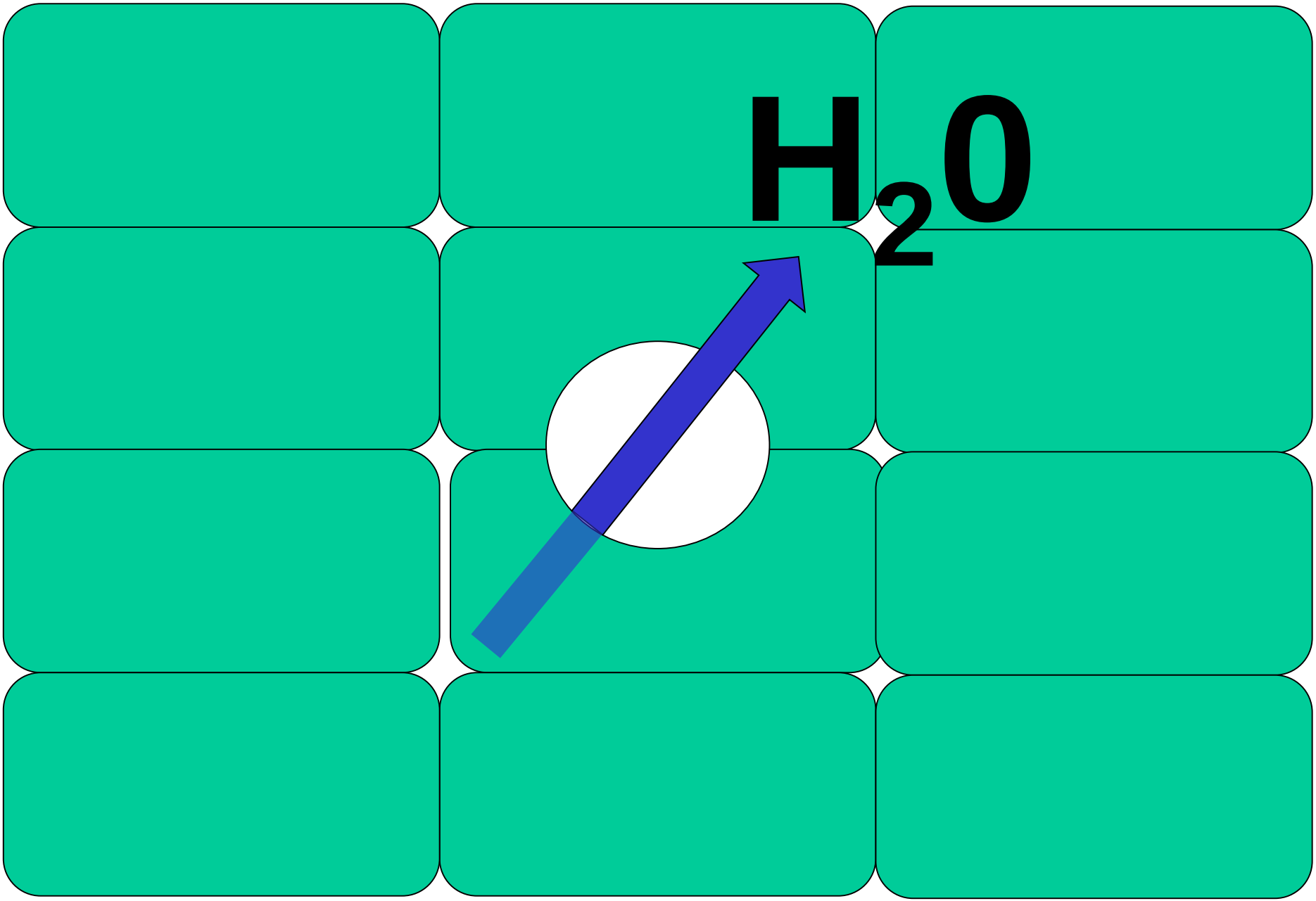



H_2O
CO_2

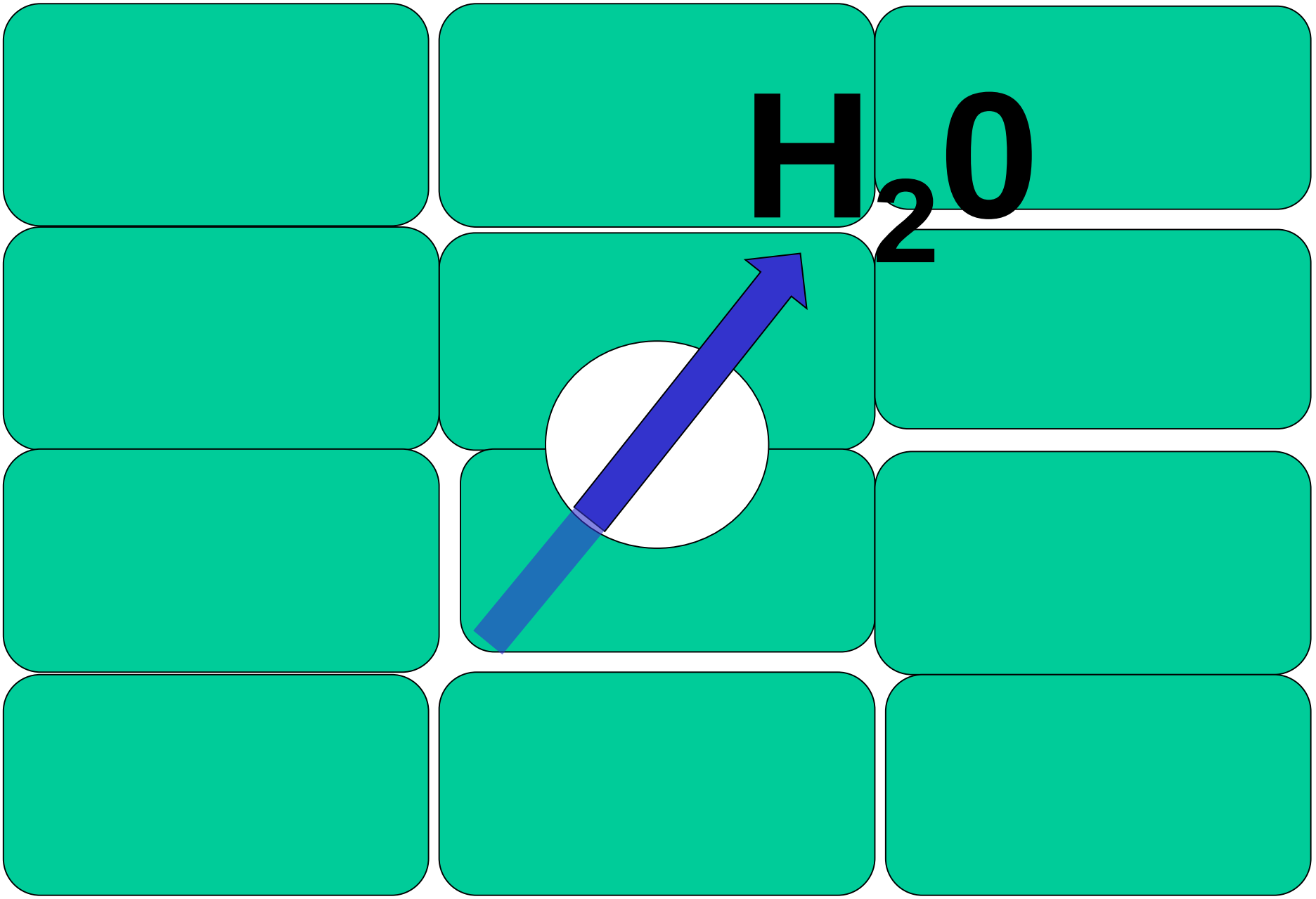
Bryophytes



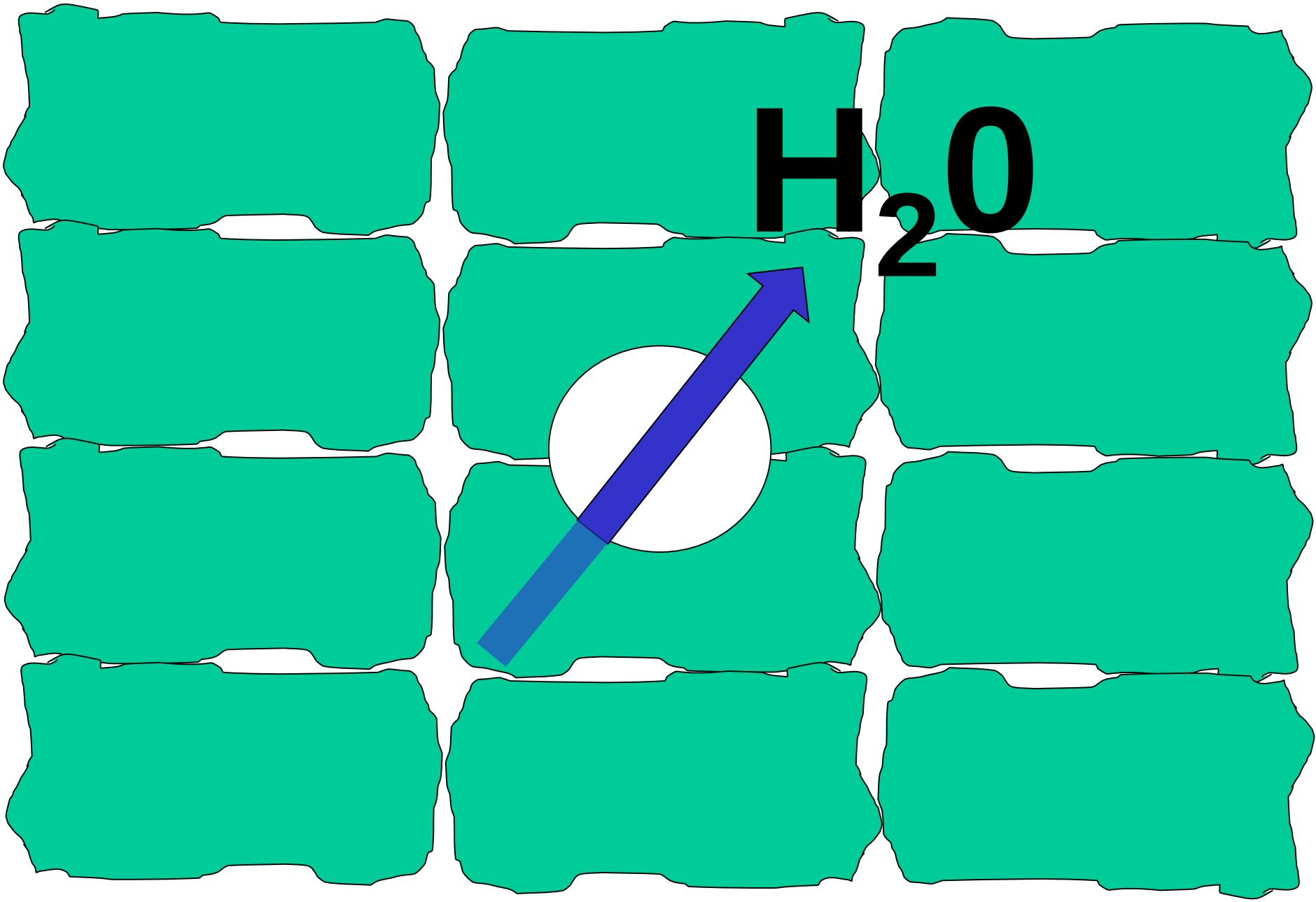
Bryophytes



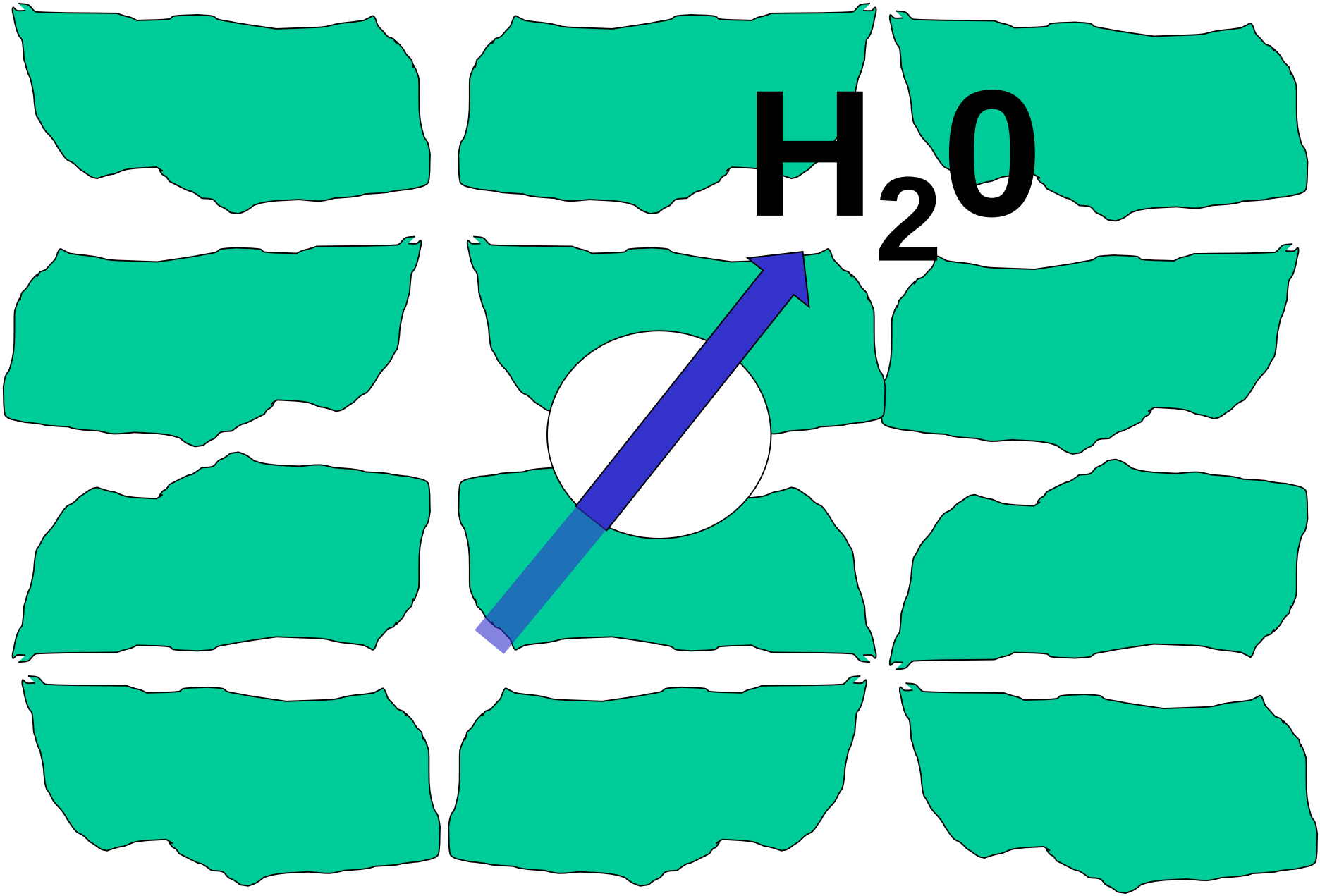
Bryophytes



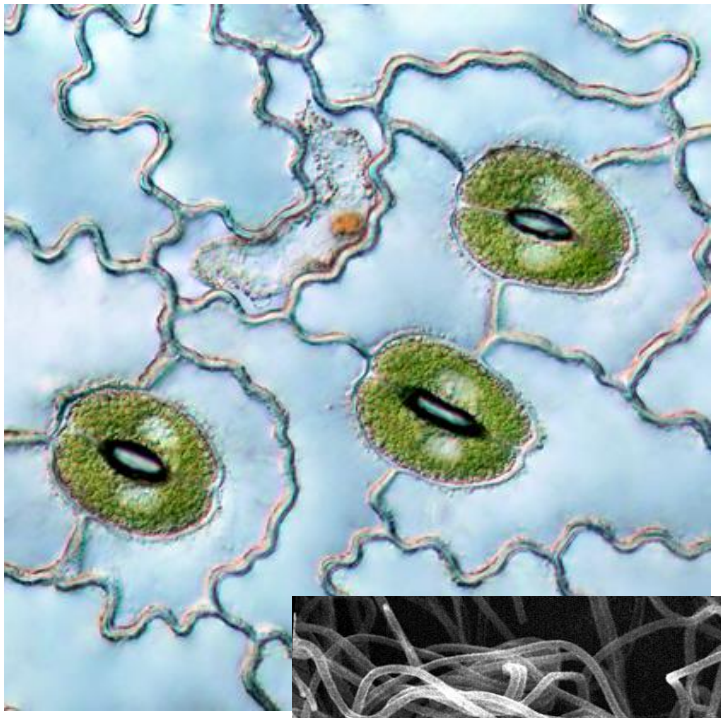
Bryophytes

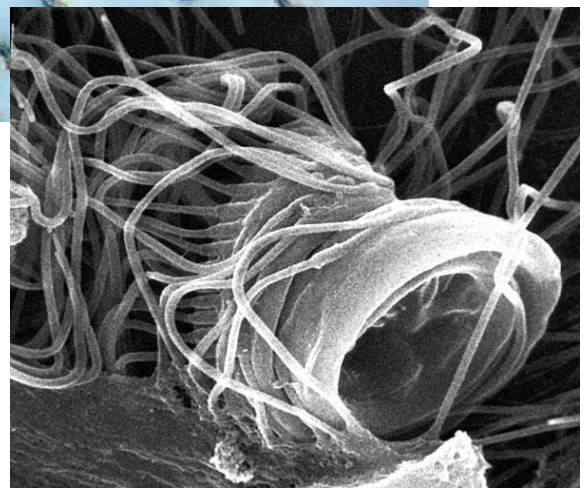


Bryophytes

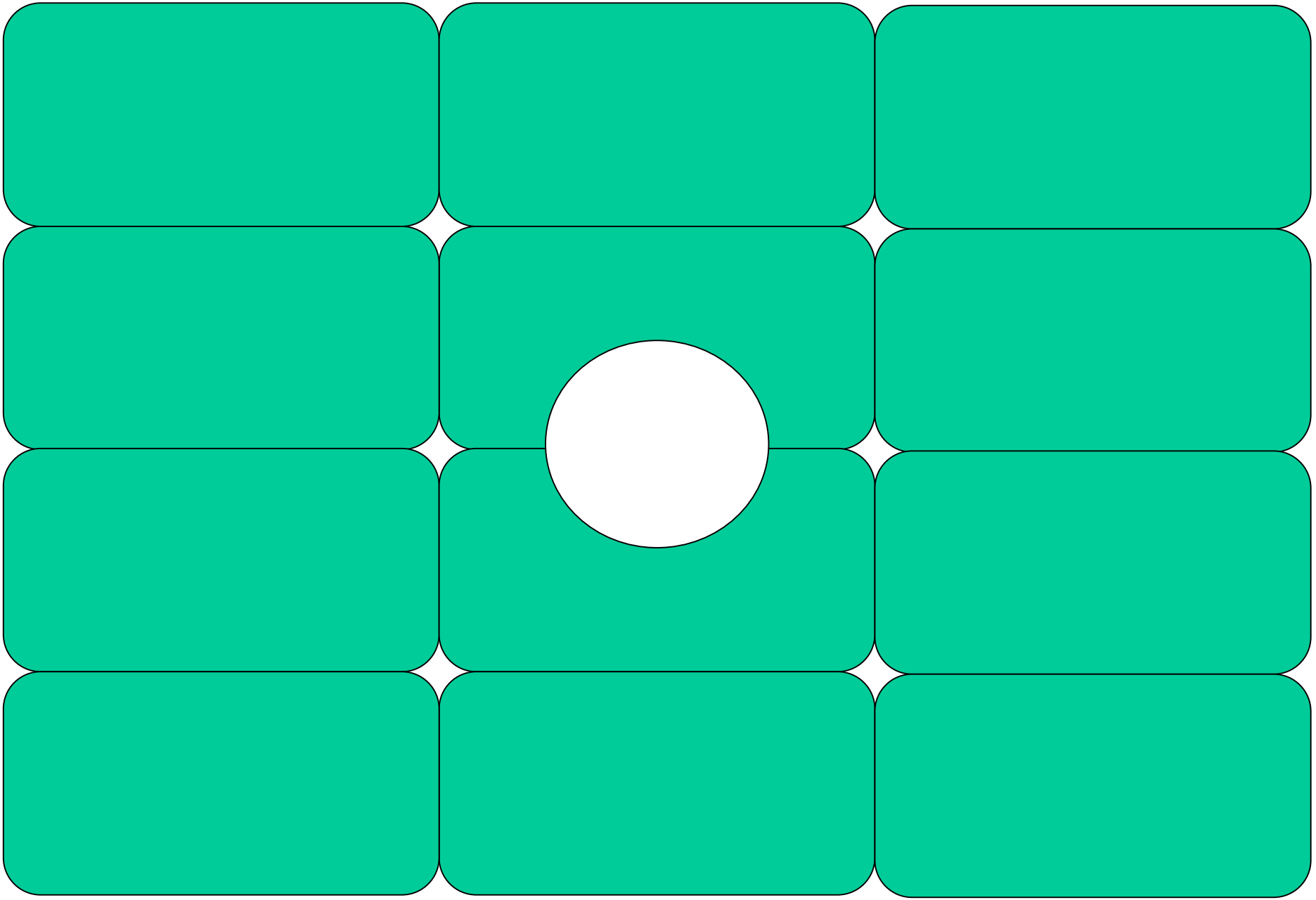


(Ferns *Pteridium aquilinum*).

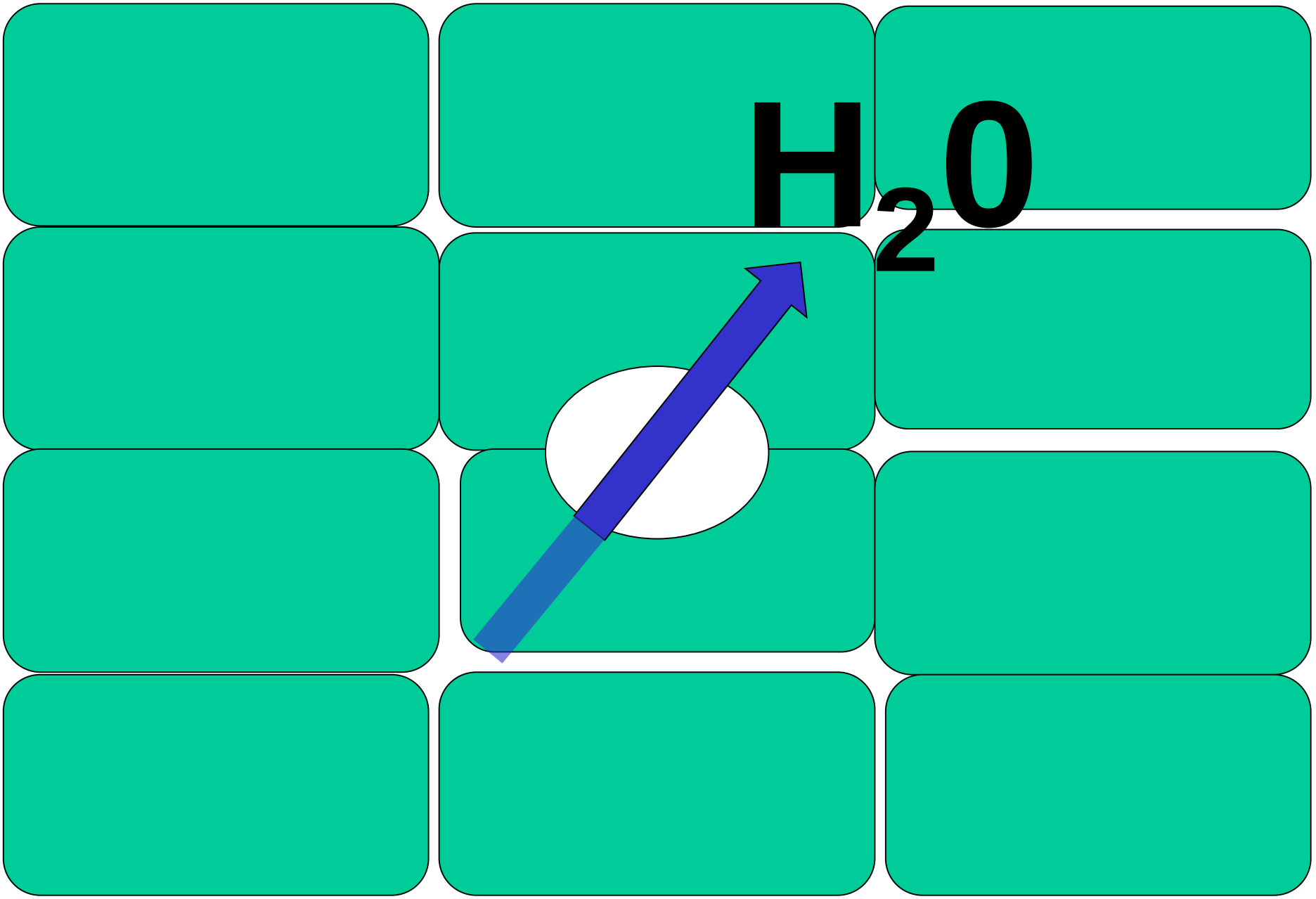




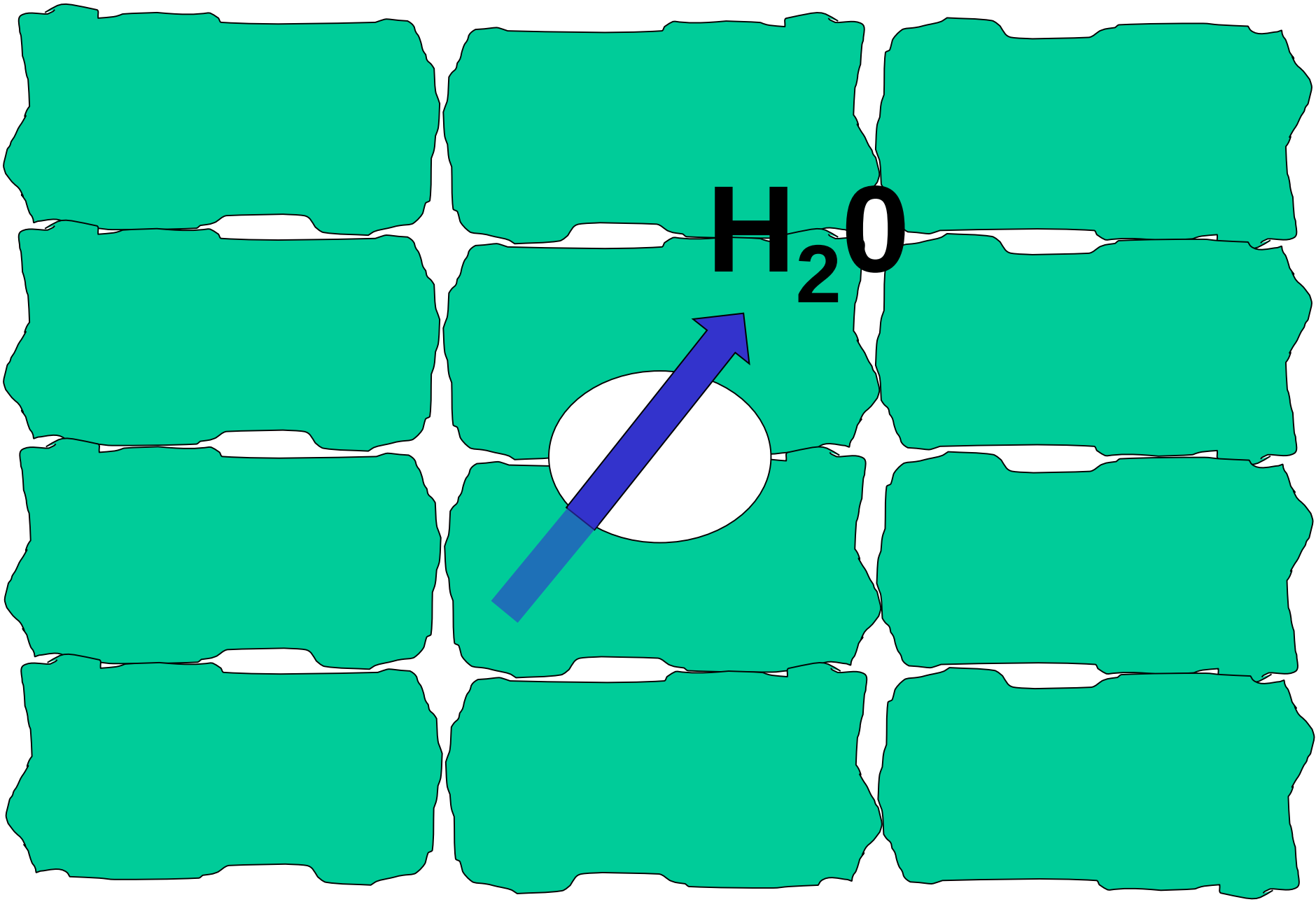
Ferns



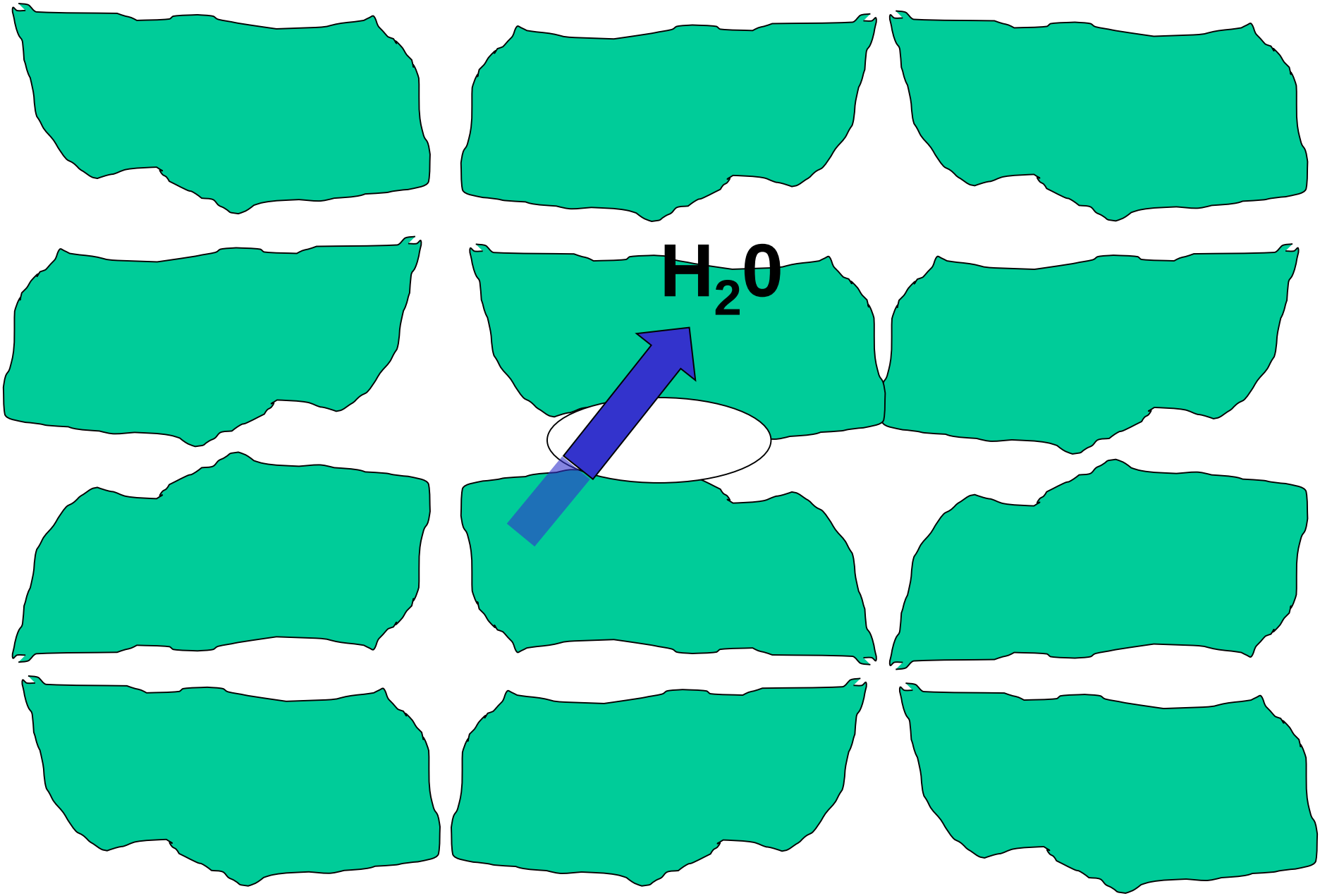
Ferns



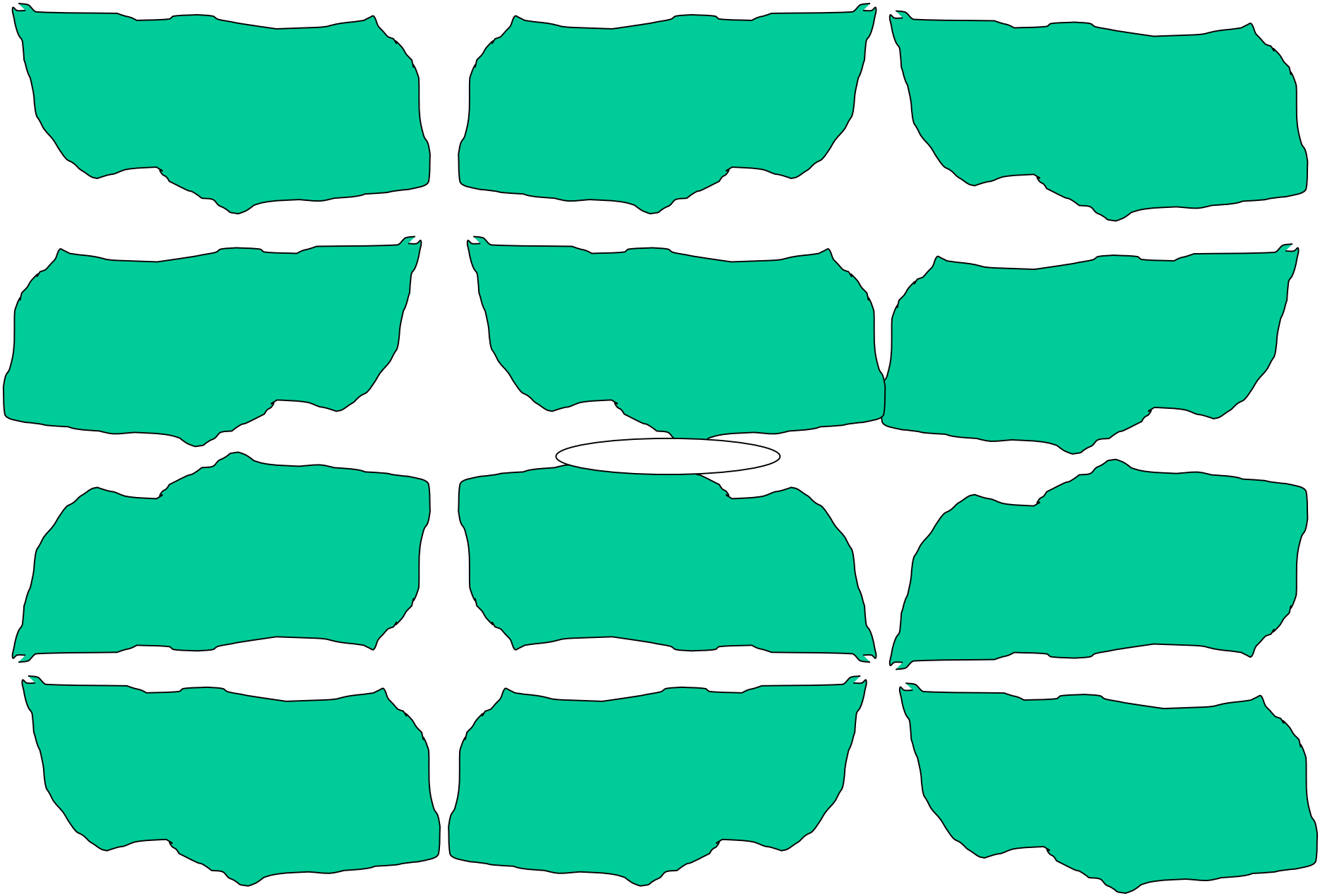
Ferns



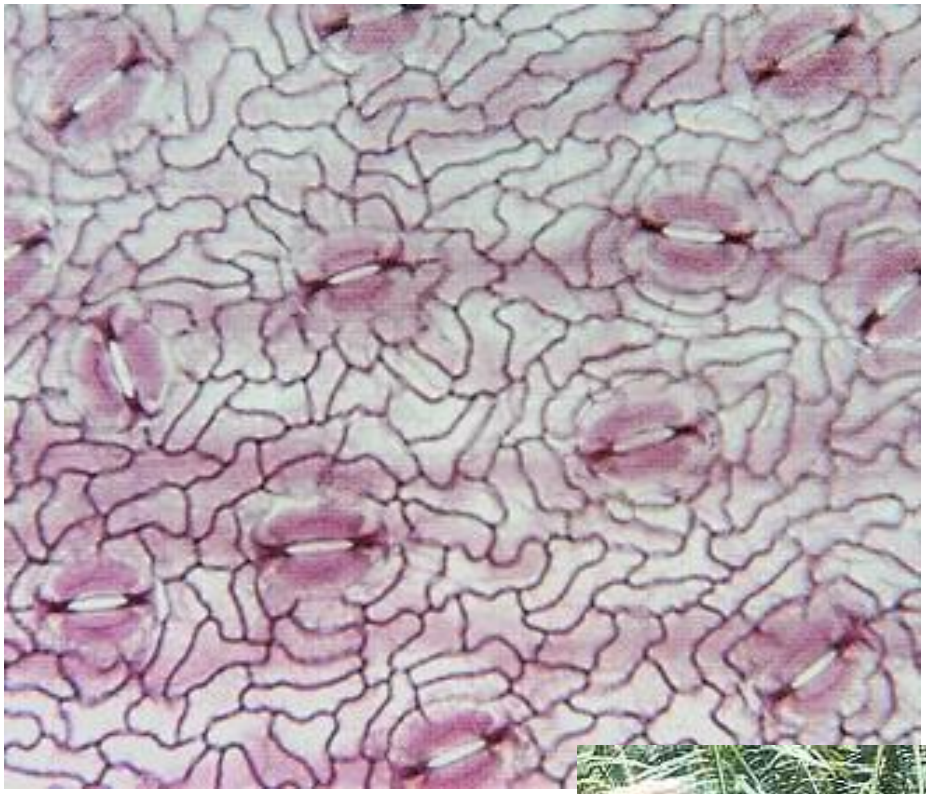
Ferns



Ferns



Cycads



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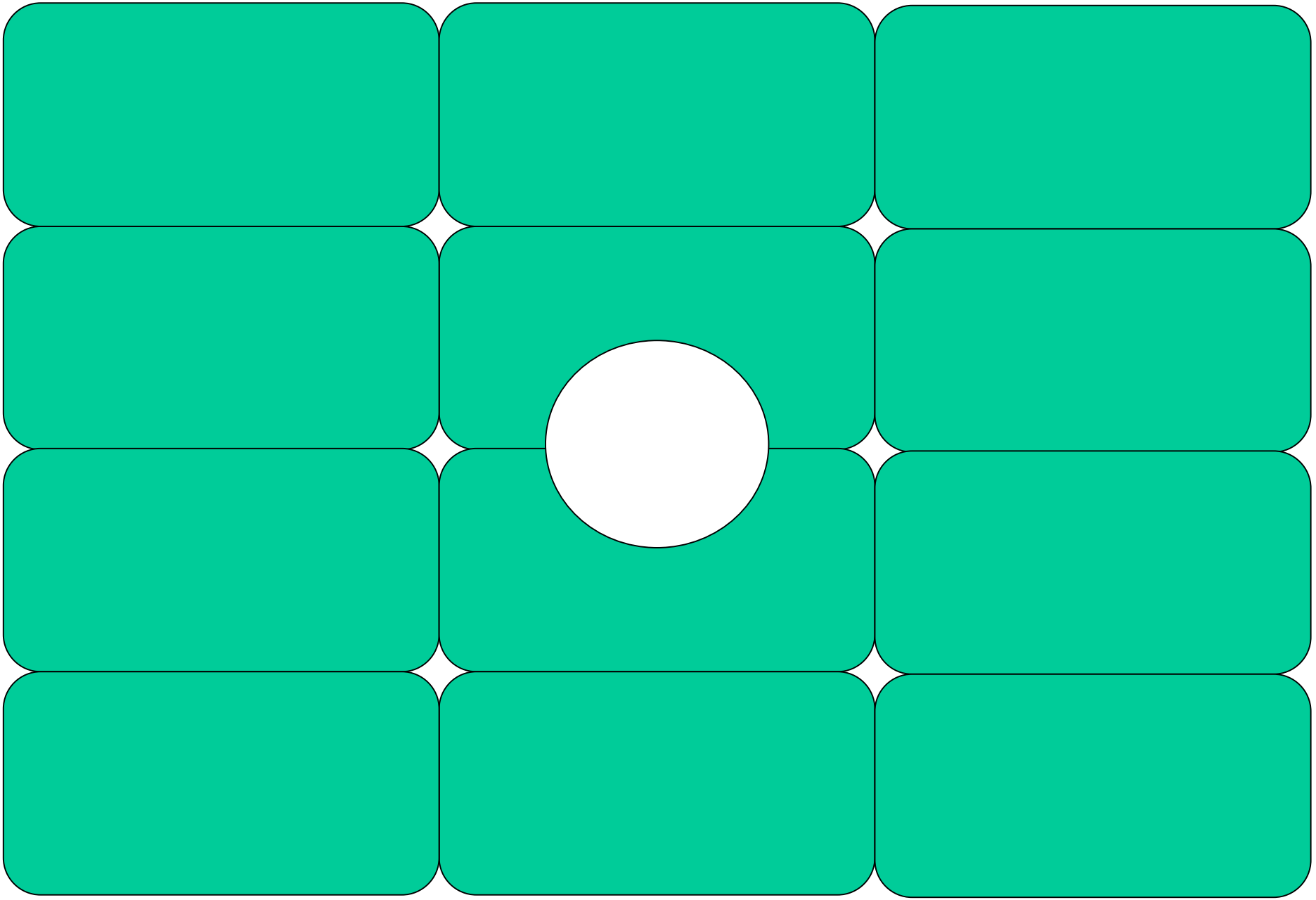

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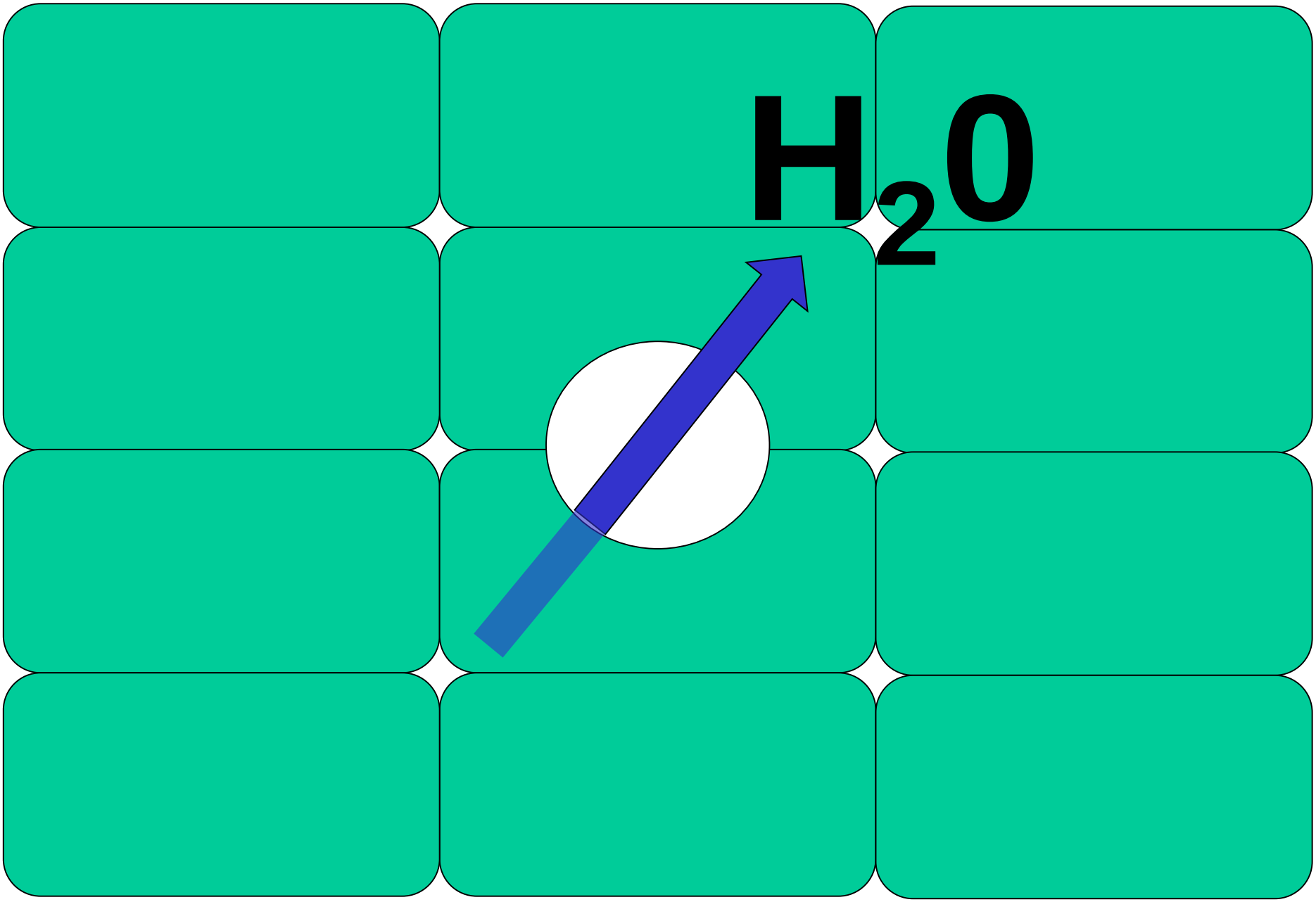

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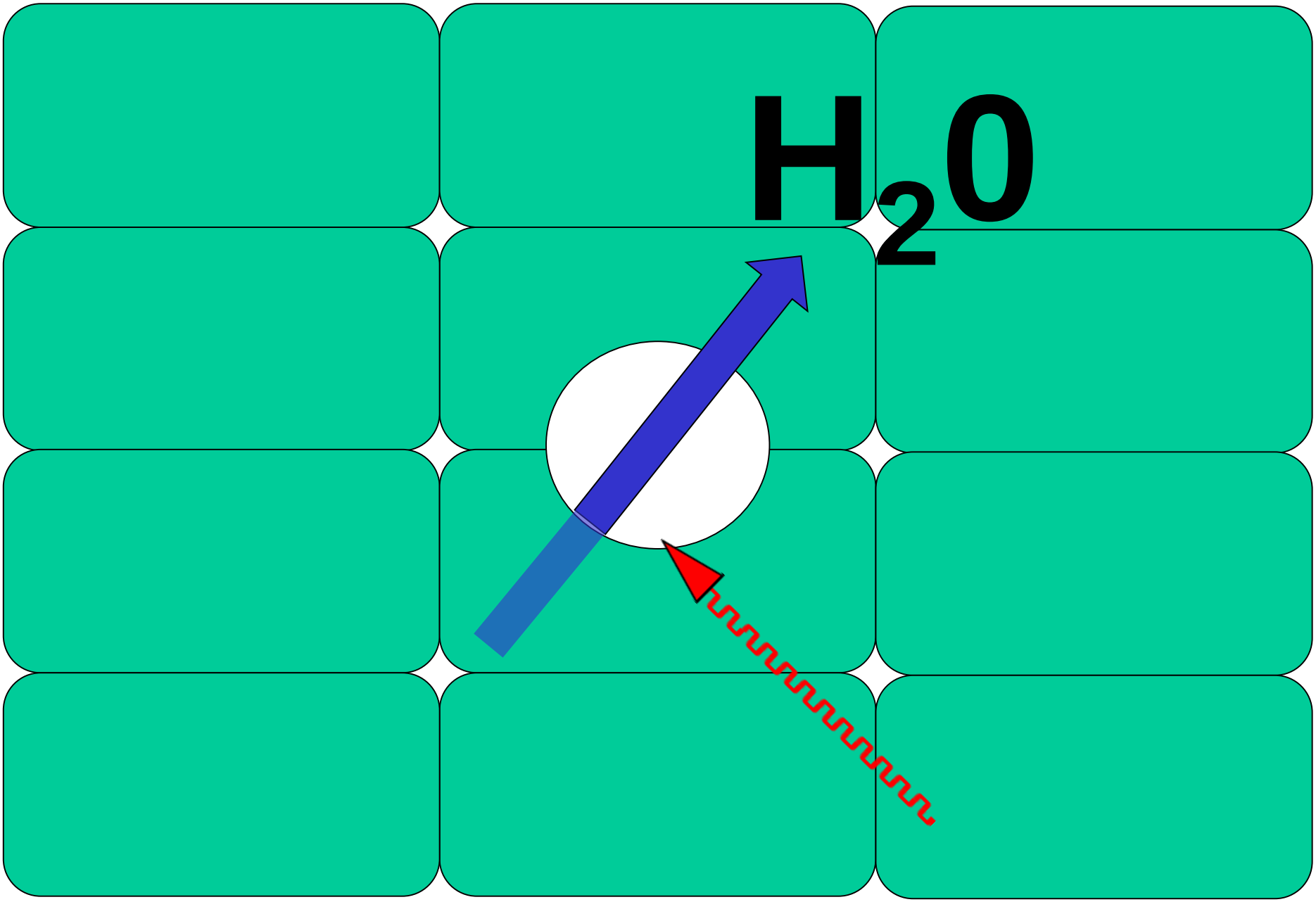

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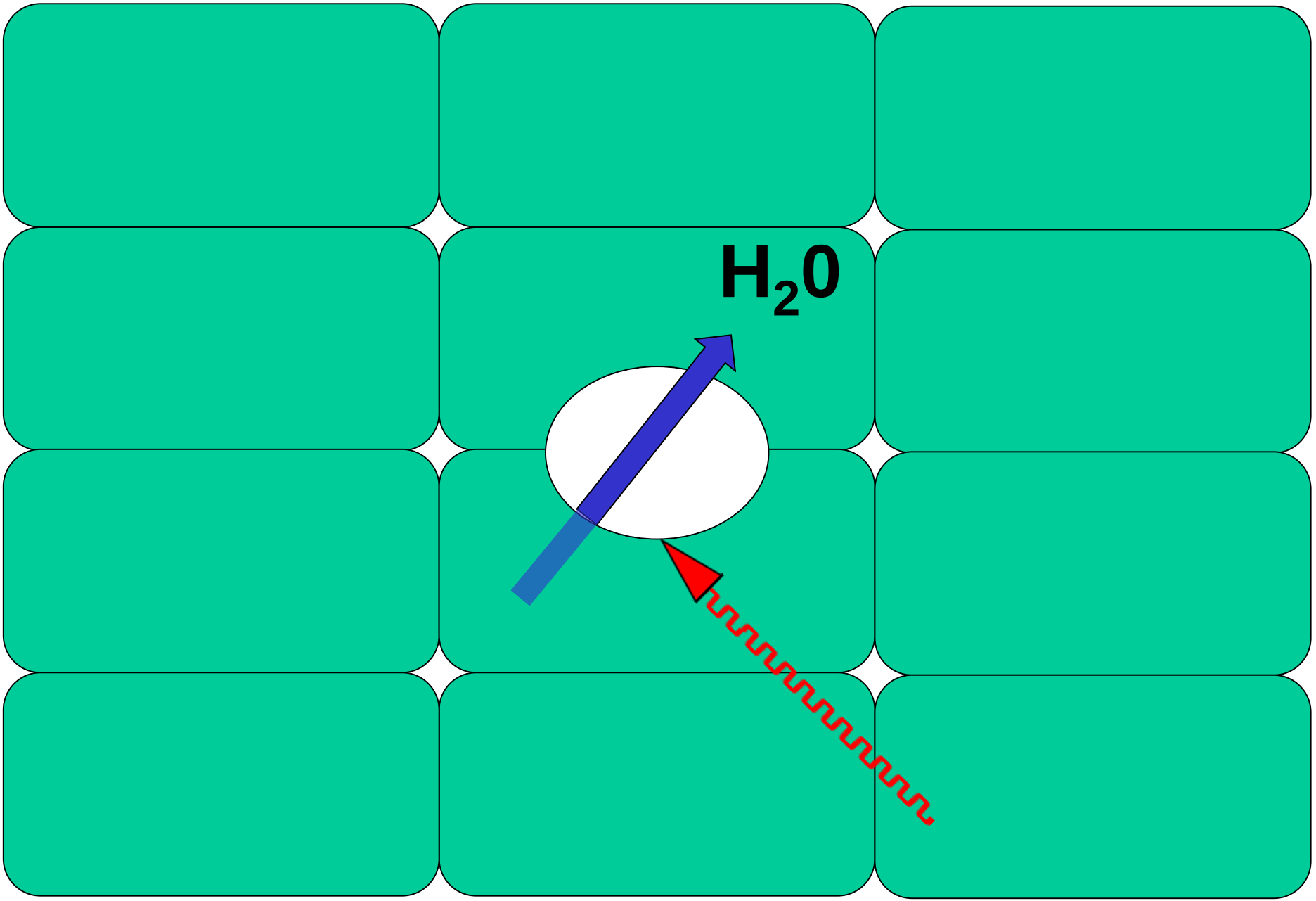

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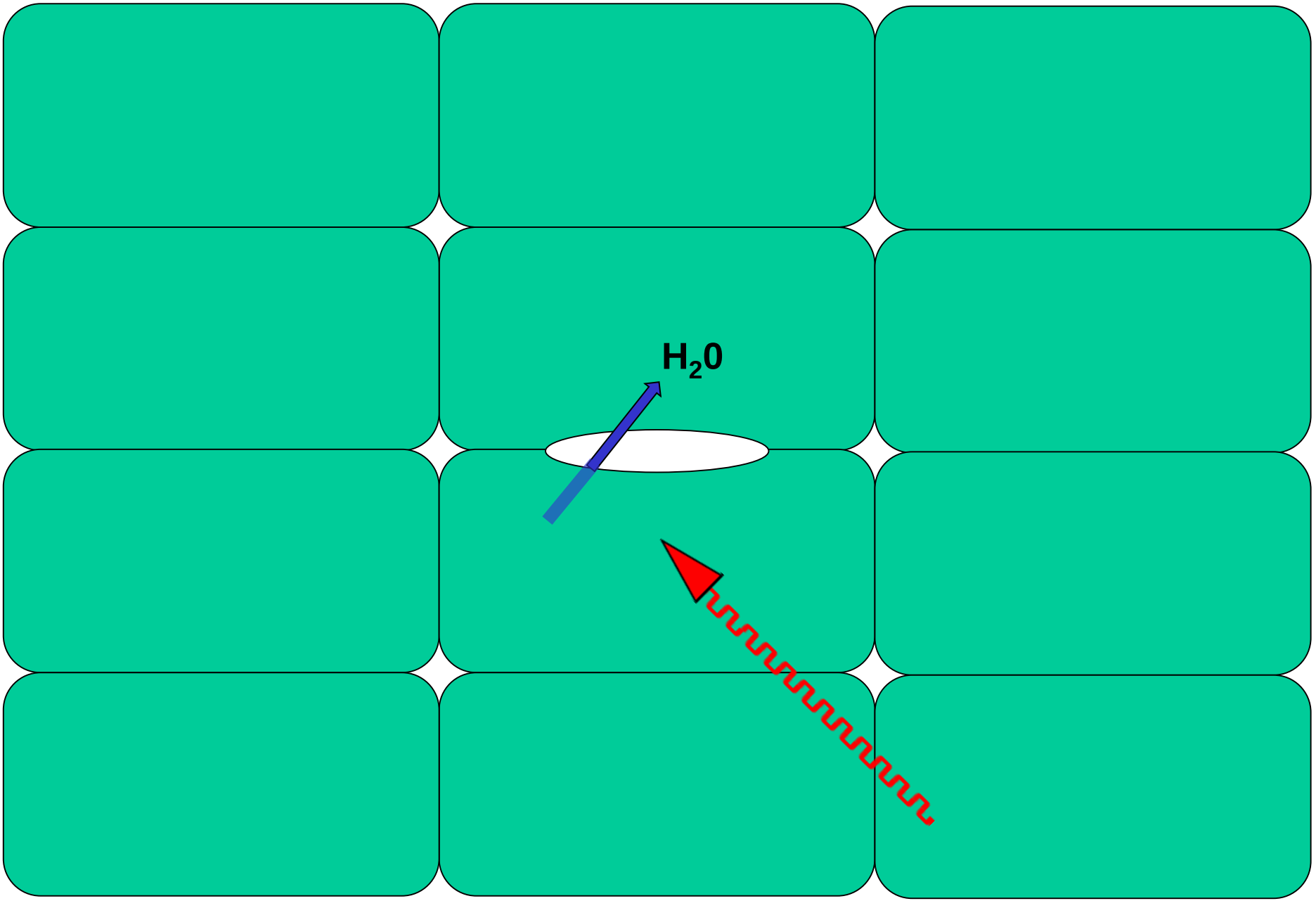

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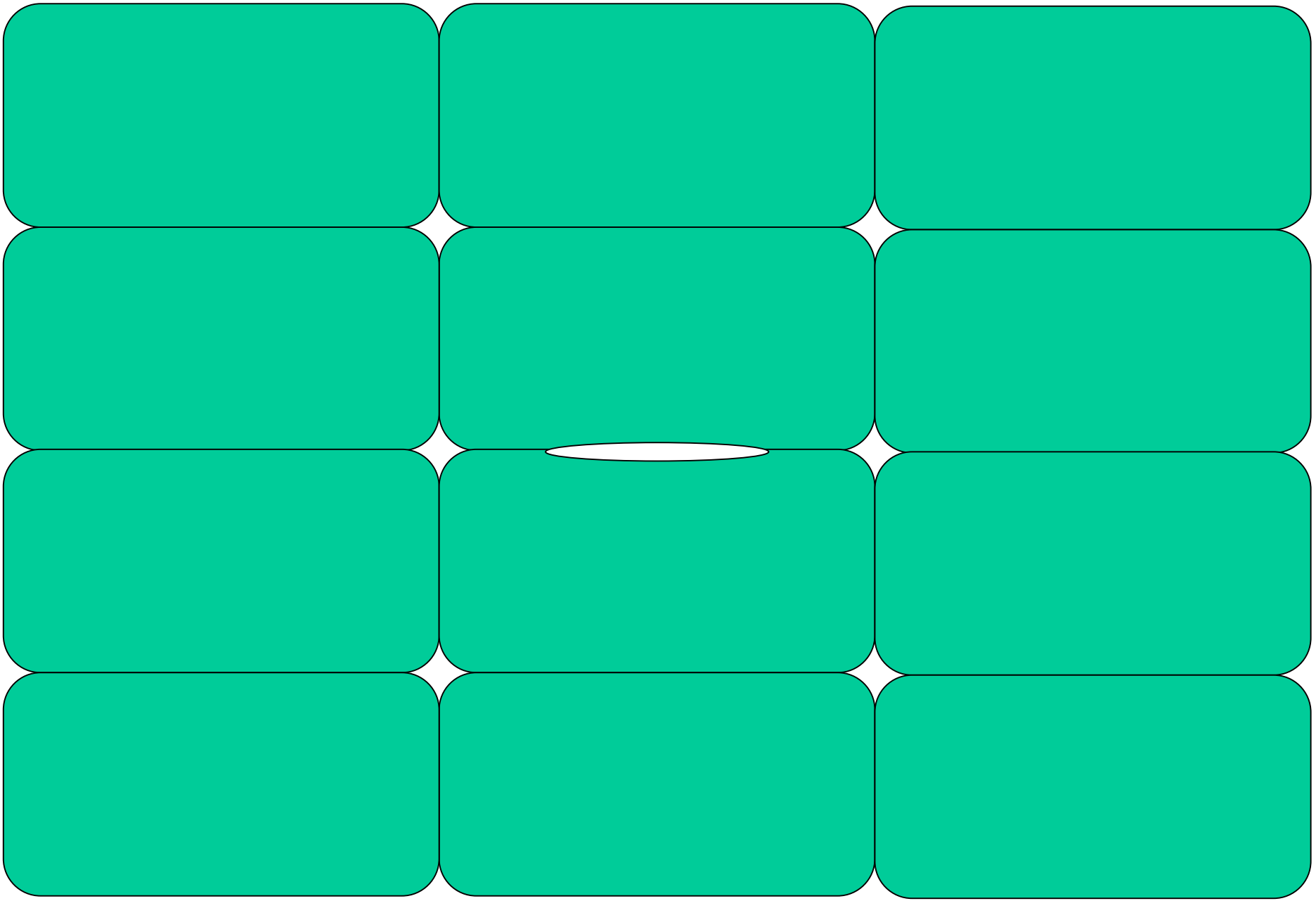
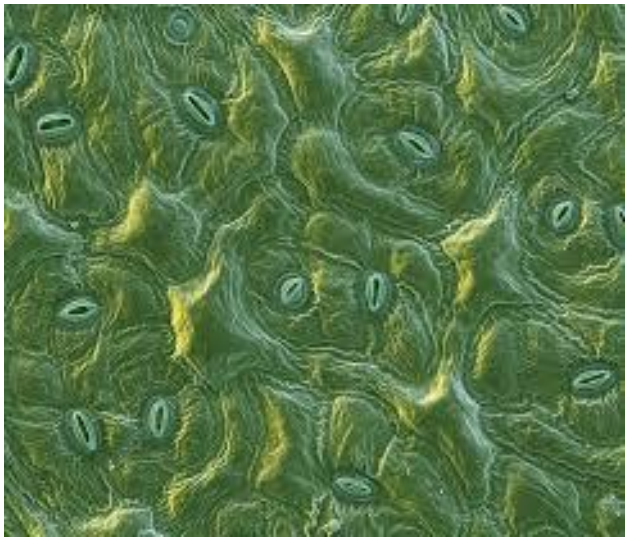
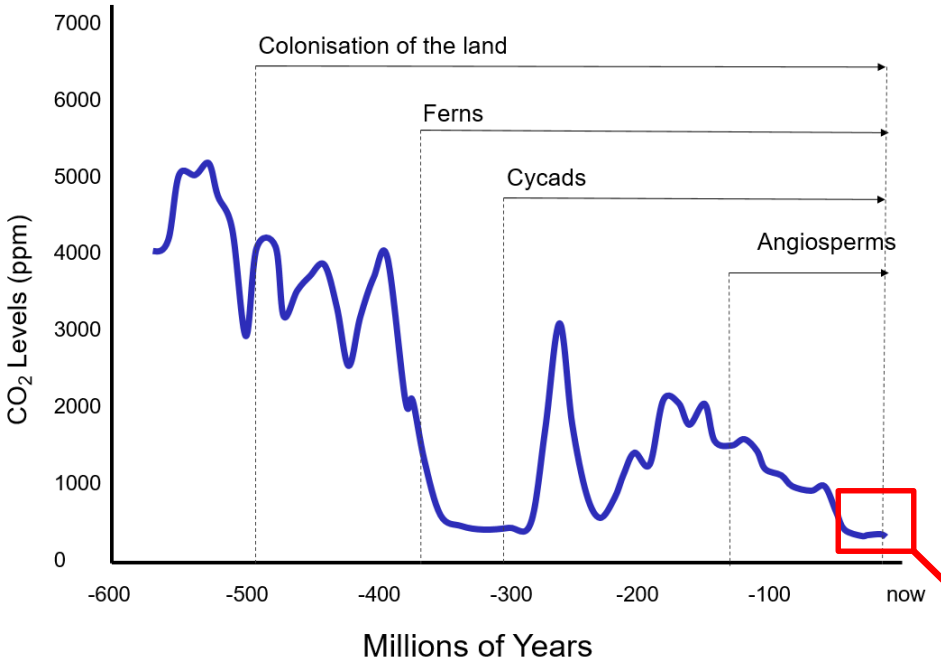
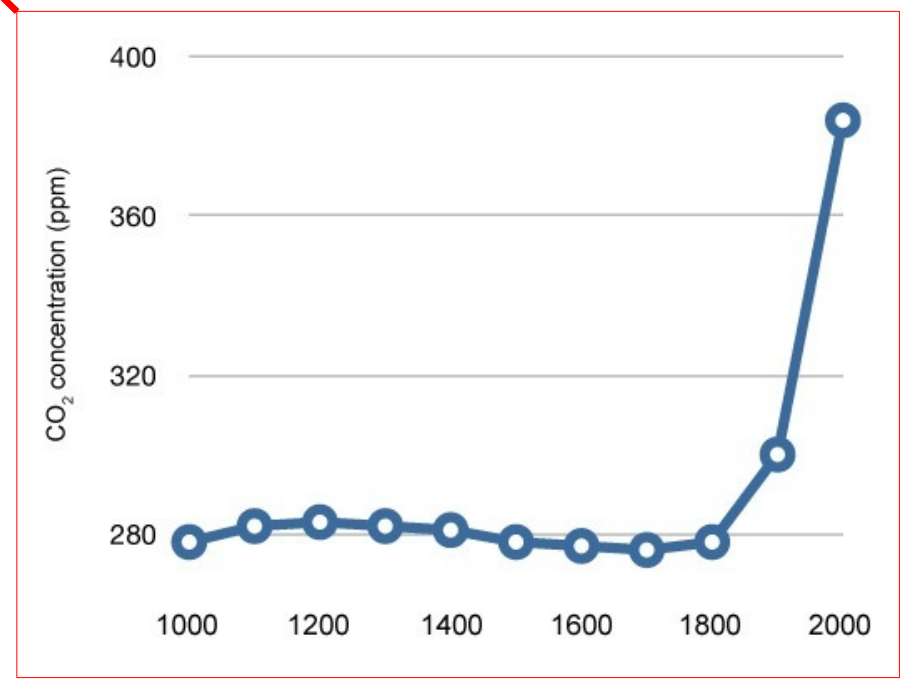


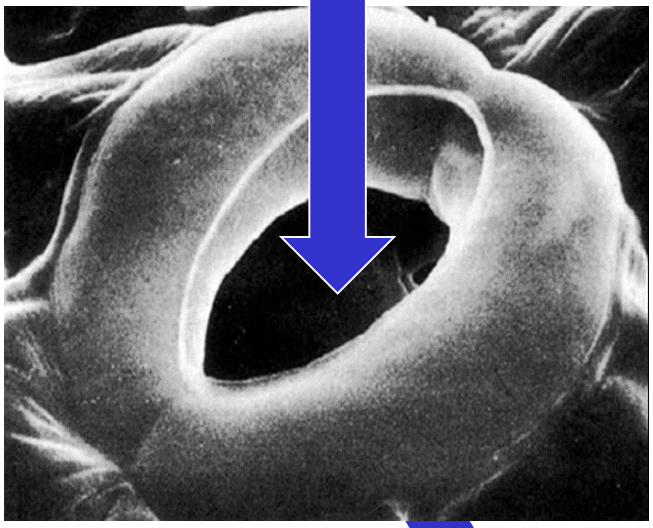
Flowering plants

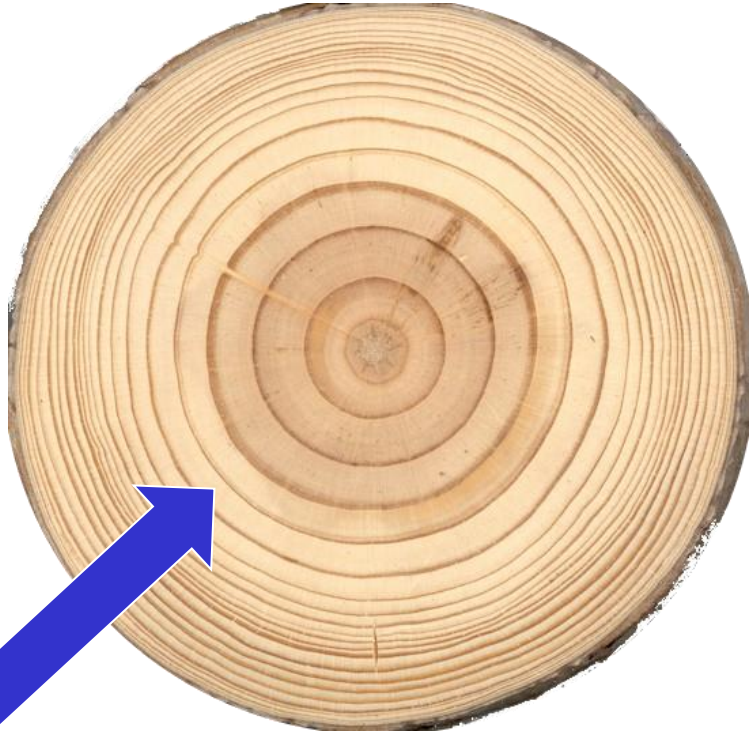



7000
6000
5000
4000
3000
2000
1000
0
CO_2 Levels (ppm)
Colonisation of the land
Ferns
Cycads
Angiosperms
-600
-500
-400
-300
-200
-100
now
Millions of Years


400
360
320
280
CO_2 concentration (ppm)
1000
1200
1400
1600
1800
2000

CO_2

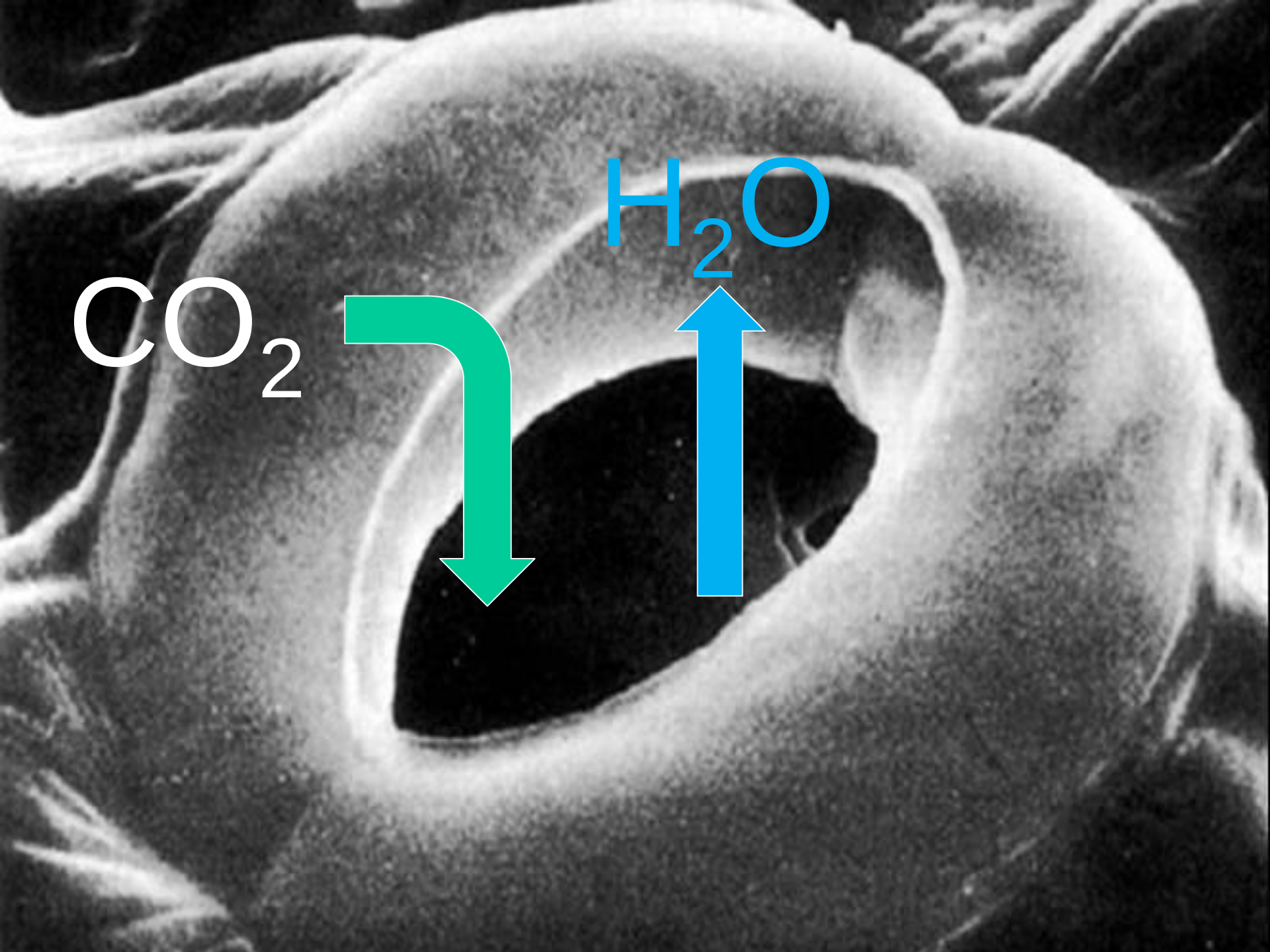




Sugar

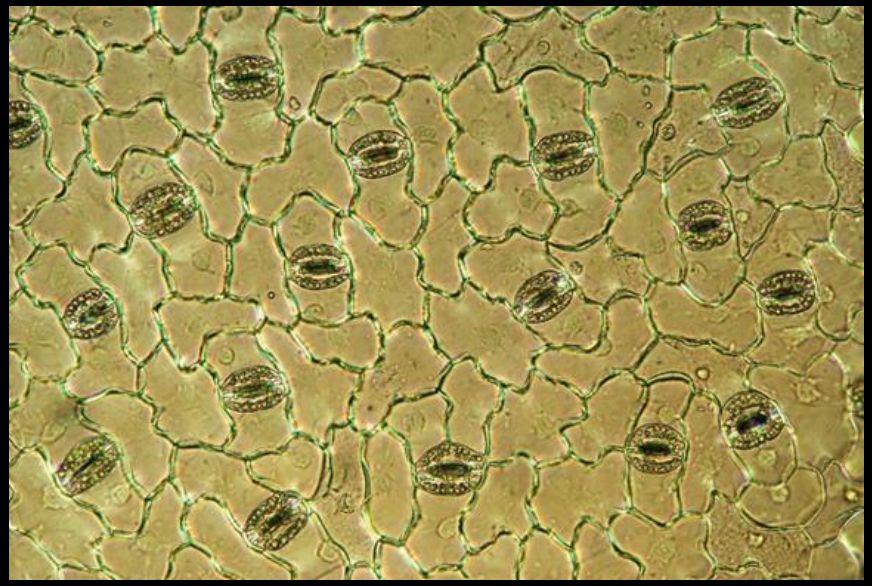
CO_2 can be good for plants


CANE sugar
BY APPOINTMENT TO HER MAJESTY THE QUEEN
TATE & LYLE PLC LONDON SUGAR REFINERS
TATE & LYLE
CANE sugar
GRANULATED
Each 4g teaspoon contains
Calories 16 1%
Sugars 4g 4%
Fat 0g 0%
Saturates 0g 0%
Salt 0g 0%
of an adult's guideline daily amount
1kg e

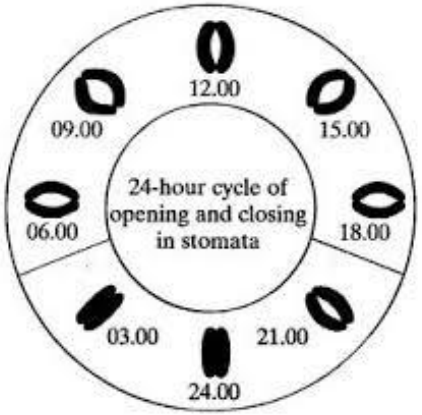

H_2O
CO_2

Minutes

Millennia

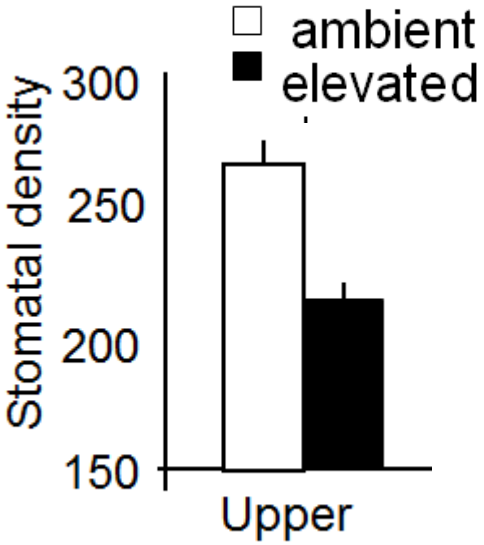


Hours



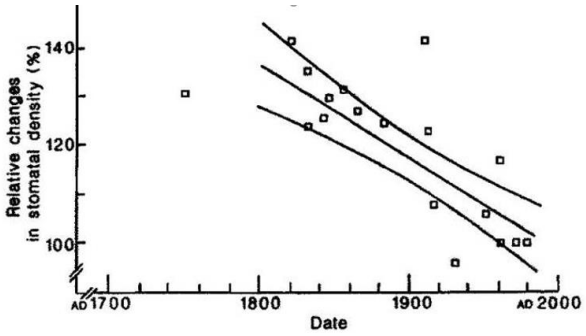
Stomata close at night

Weeks

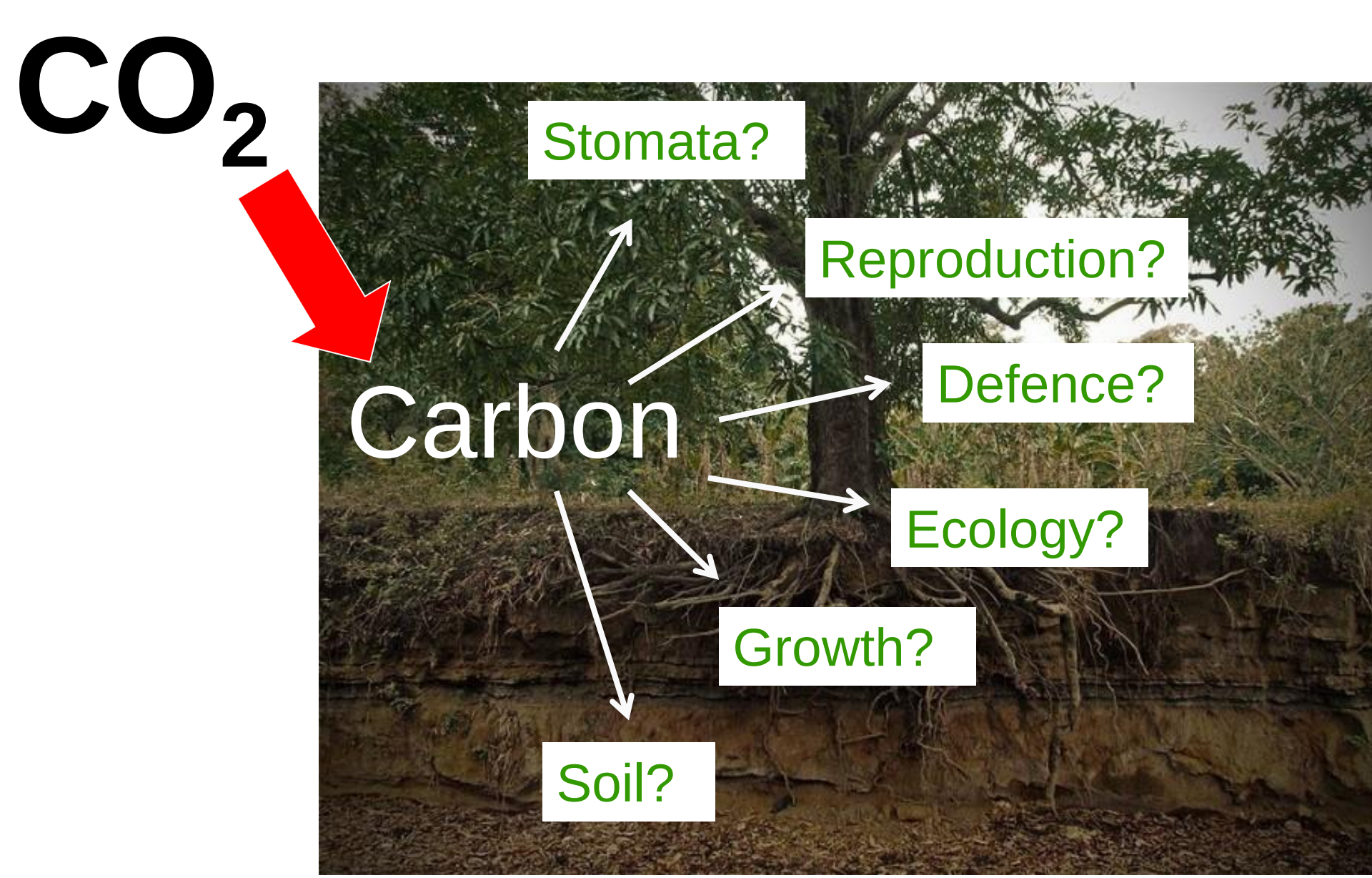


Stomatal density decreases under elevated CO_2

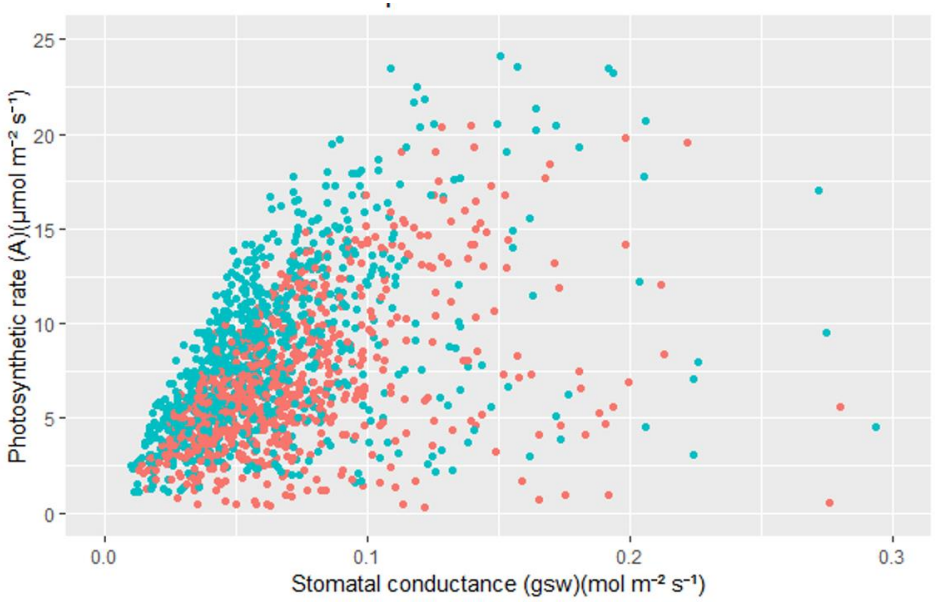
Centuries



Stomatal density has decreased over climate change

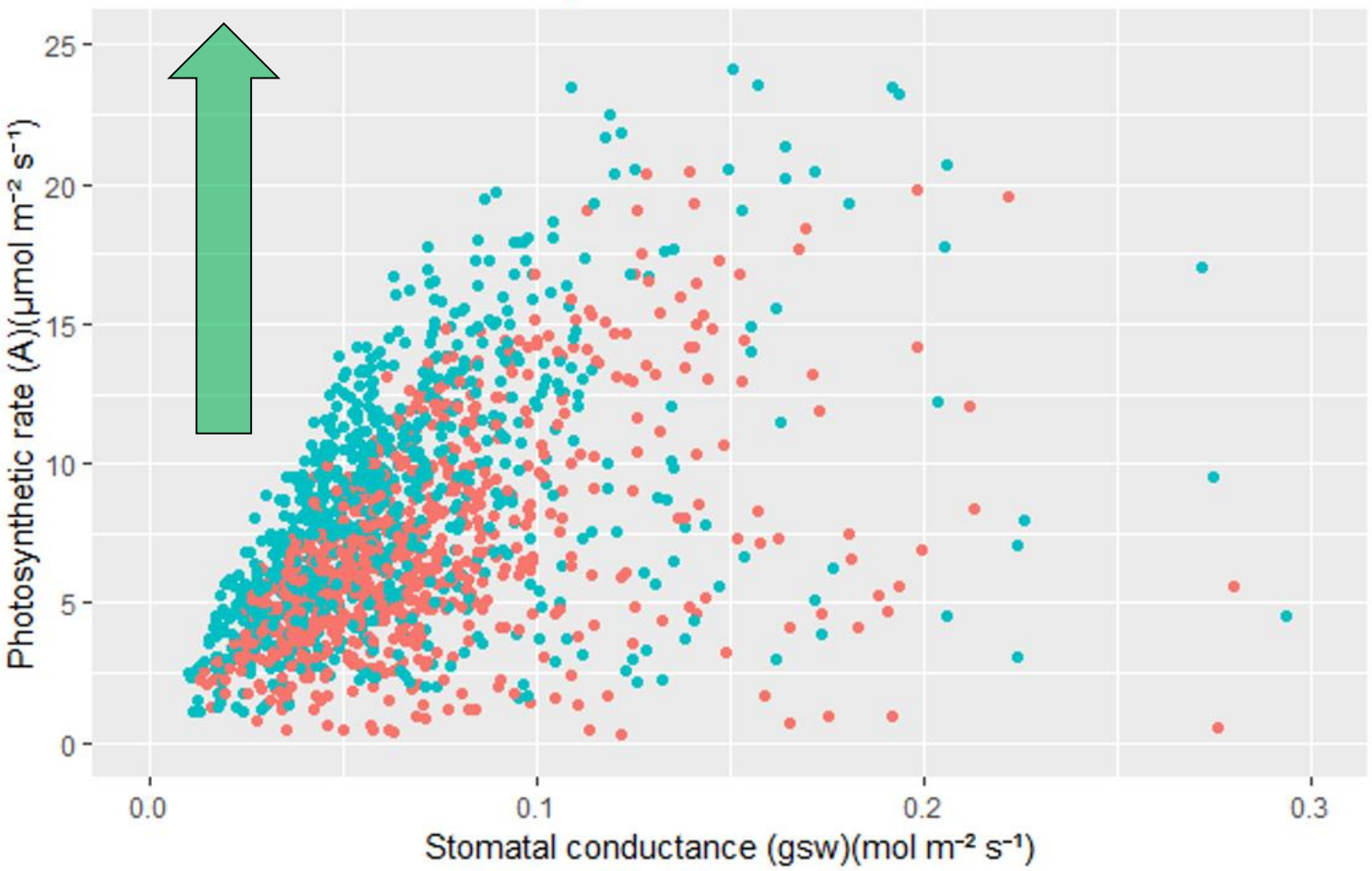

CO_2
Stomata?
Reproduction?
Defence?
Carbon
Ecology?
Growth?
Soil?

Breaking news: Early data



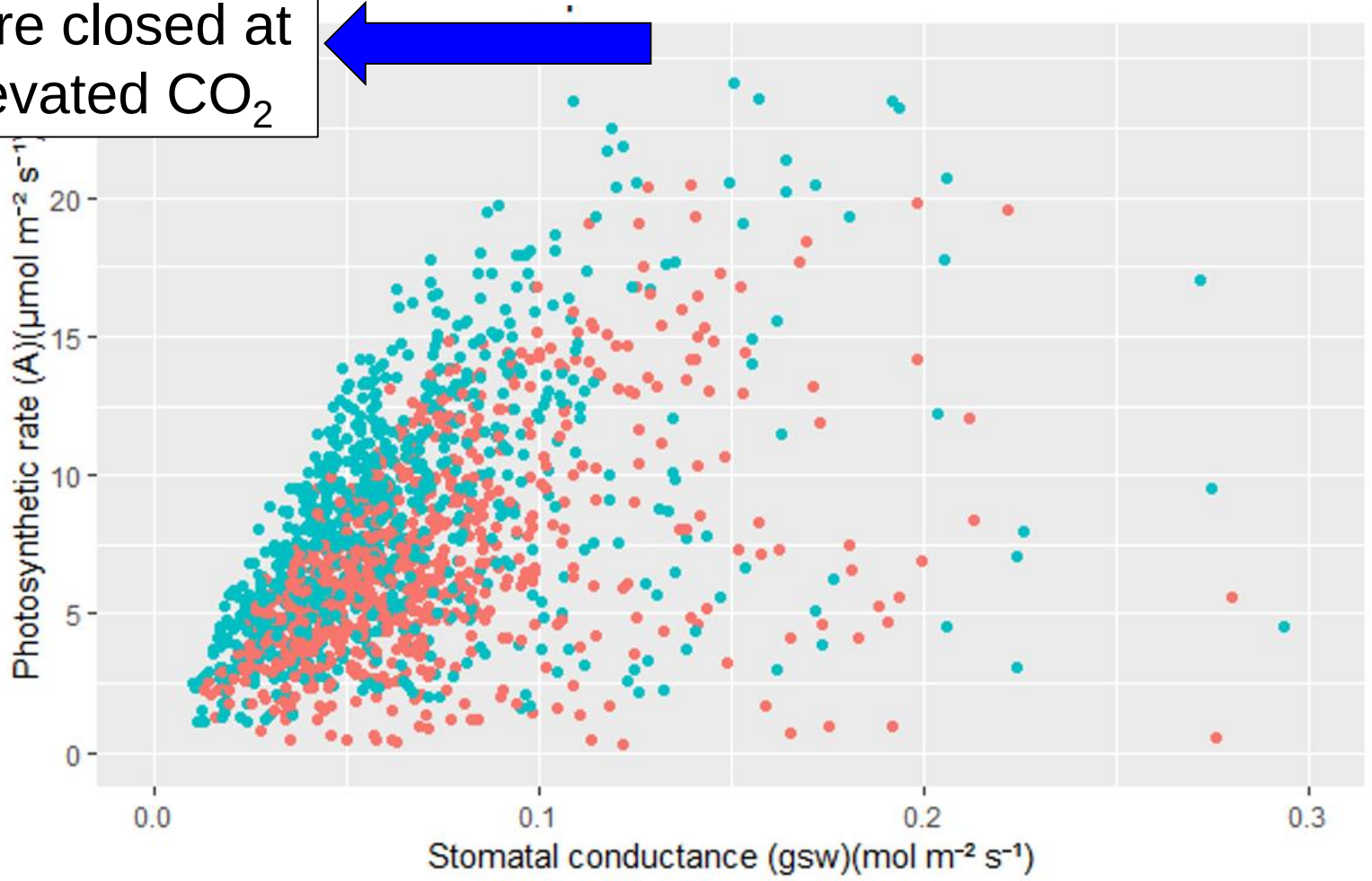
Anna Gardner BiFor PhD

Photosynthesis is higher at elevated CO_2



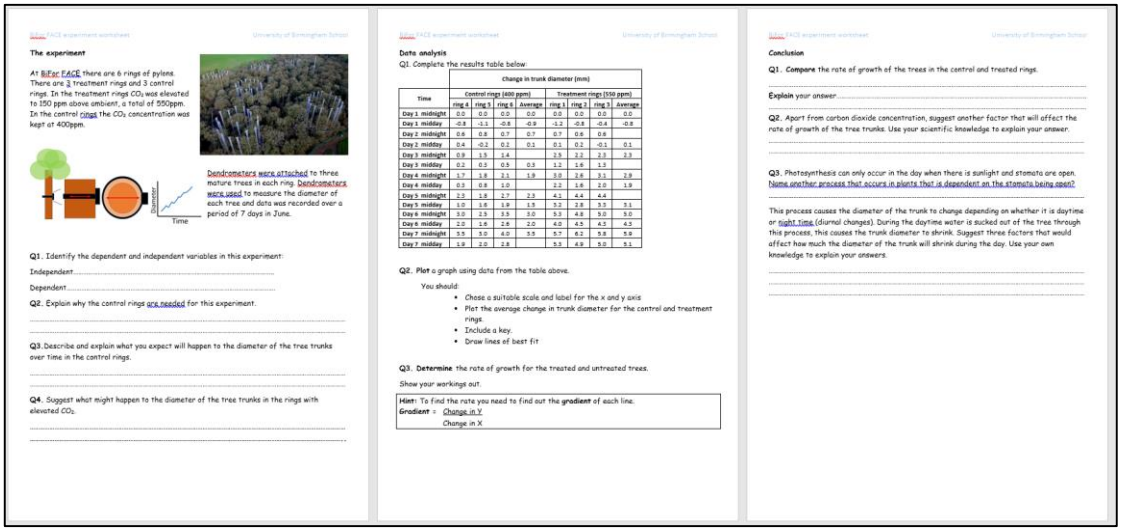
Anna Gardner BiFor PhD

Stomata are more closed at elevated CO_2



Anna Gardner BiFor PhD

Education links – UoB school. Computer science



The experiment

At BiFor FACE there are 6 rings of pylons. There are 3 treatment rings and 3 control rings. In the treatment rings CO_2 was elevated to 150 ppm above ambient, a total of 550ppm. In the control rings the CO_2 concentration was kept at 400ppm.

Dendrometers were attached to three mature trees in each ring. Dendrometers were used to measure the diameter of each tree and data was recorded over a period of 7 days in June.

Q1. Identify the dependent and independent variables in this experiment:

Independent.....

Dependent.....

Q2. Explain why the control rings are needed for this experiment.

Q3. Describe and explain what you expect will happen to the diameter of the tree trunks over time in the control rings.

Q4. Suggest what might happen to the diameter of the tree trunks in the rings with elevated CO_2.

Data analysis

Q1. Complete the results table below:

Time	Change in trunk diameter (mm)							
	Control rings (400 ppm)				Treatment rings (550 ppm)			
	ring 4	ring 5	ring 6	Average	ring 1	ring 2	ring 3	Average
Day 1 midnight	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Day 1 midday	-0.8	-1.1	-0.8	-0.9	-1.2	-0.8	-0.4	-0.8
Day 2 midnight	0.8	0.8	0.7	0.7	0.7	0.6	0.6	
Day 2 midday	0.4	-0.2	0.2	0.1	0.1	0.2	-0.1	0.1
Day 3 midnight	0.9	1.5	1.4		2.5	2.2	2.3	2.3
Day 3 midday	0.2	0.3	0.5	0.3	1.2	1.6	1.3	
Day 4 midnight	1.7	1.8	2.1	1.9	3.0	2.6	3.1	2.9
Day 4 midday	0.3	0.8	1.0		2.2	1.6	2.0	1.9
Day 5 midnight	2.3	1.8	2.7	2.3	4.1	4.4	4.4	
Day 5 midday	1.0	1.6	1.9	1.5	3.2	2.8	3.3	3.1
Day 6 midnight	3.0	2.5	3.5	3.0	5.0	4.8	5.0	5.0
Day 6 midday	2.0	1.6	2.8	2.0	4.0	4.5	4.5	4.3
Day 7 midnight	3.5	3.0	4.0	3.5	5.7	6.2	5.8	5.9
Day 7 midday	1.8	2.0	2.8		5.3	4.9	5.0	5.1

Q2. Plot a graph using data from the table above.

You should

- Chose a suitable scale and label for the x and y axis
- Plot the average change in trunk diameter for the control and treatment rings.
- Include a key.
- Draw lines of best fit

Q3. Determine the rate of growth for the treated and untreated trees.

Show your workings out.

Hint: To find the rate you need to find out the gradient of each line.

Gradient = Change in Y / Change in X

Conclusion

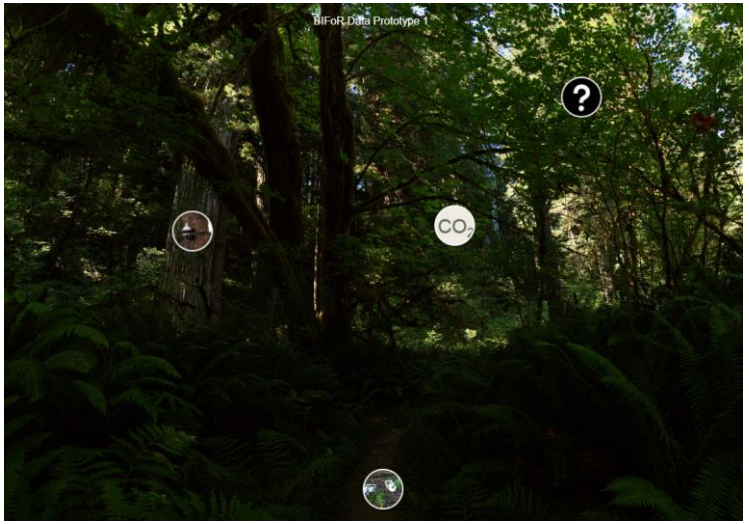
Q1. Compare the rate of growth of the trees in the control and treated rings.

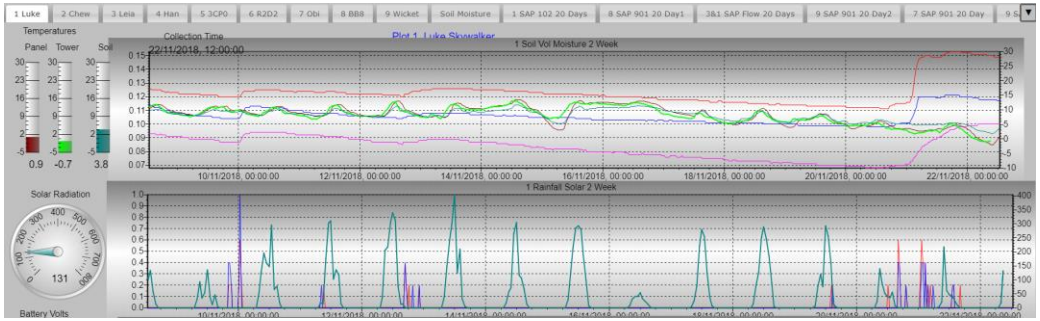
Explain your answer.....

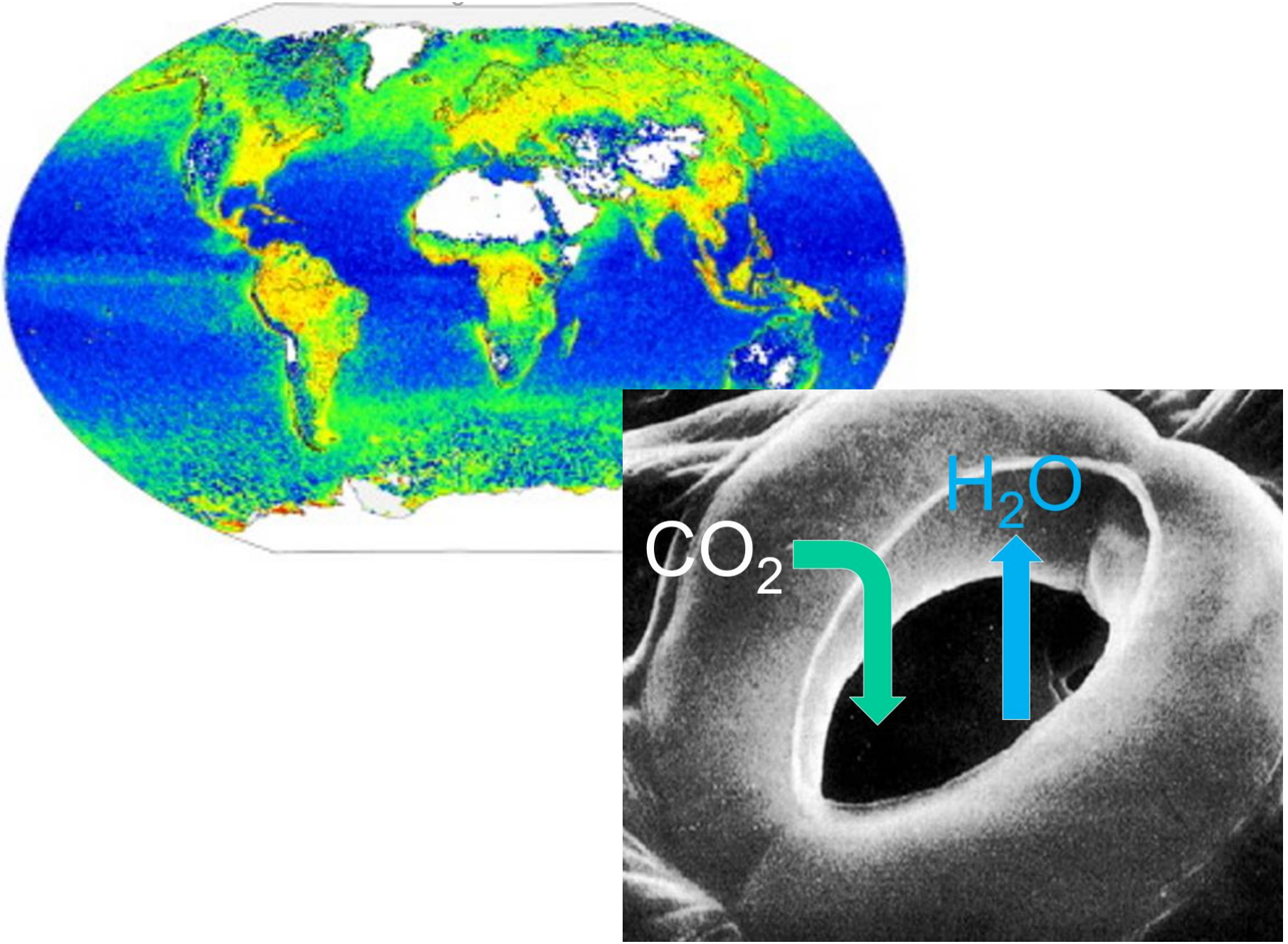
Q2. Apart from carbon dioxide concentration, suggest another factor that will affect the rate of growth of the tree trunks. Use your scientific knowledge to explain your answer.

Q3. Photosynthesis can only occur in the day when there is sunlight and stomata are open. Name another process that occurs in plants that is dependent on the stomata being open?

This process causes the diameter of the trunk to change depending on whether it is daytime or night time (diurnal changes). During the daytime water is sucked out of the tree through this process, this causes the trunk diameter to shrink. Suggest three factors that would affect how much the diameter of the trunk will shrink during the day. Use your own knowledge to explain your answers.






H_2O
CO_2

- Plants have breathable waterproofs
- More CO_2 doesn't always mean better plants
- FACE gives us new data to predict climate change

Professor Jeremy Pritchard
@DrJPritchard

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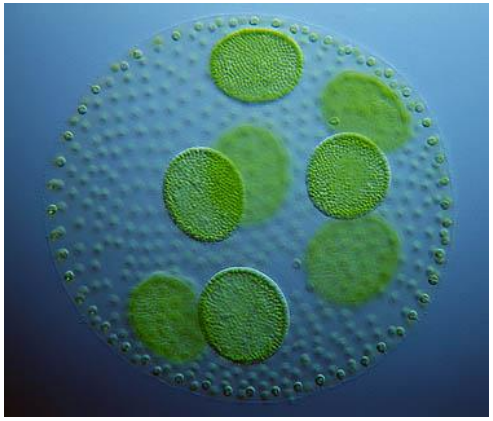
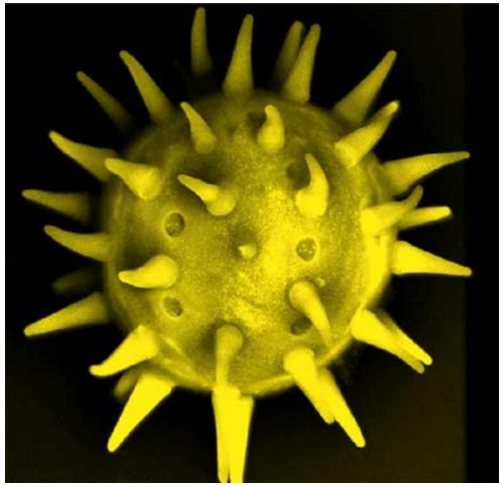
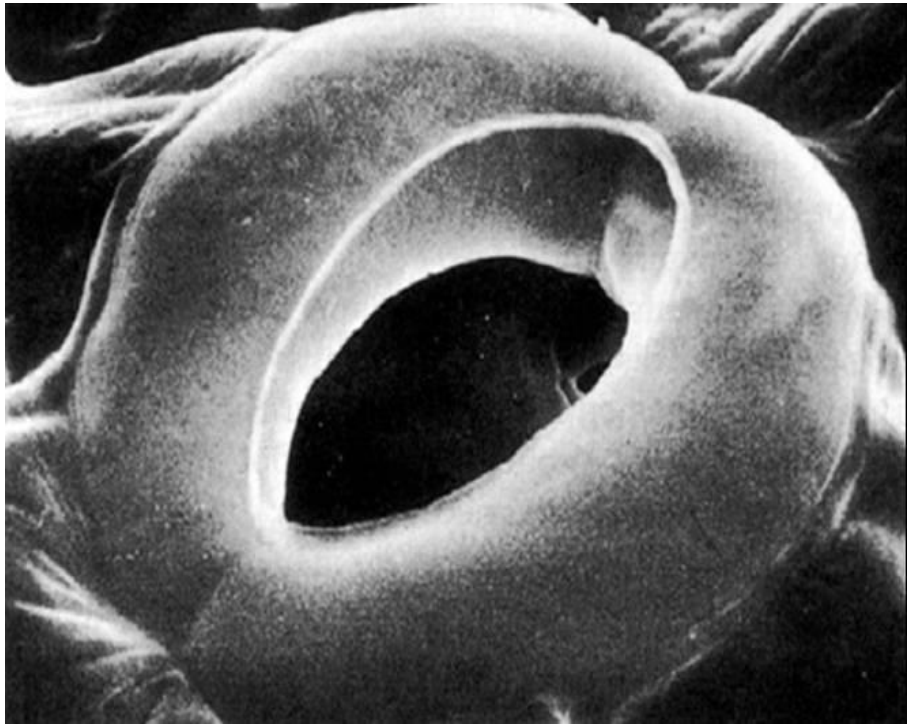
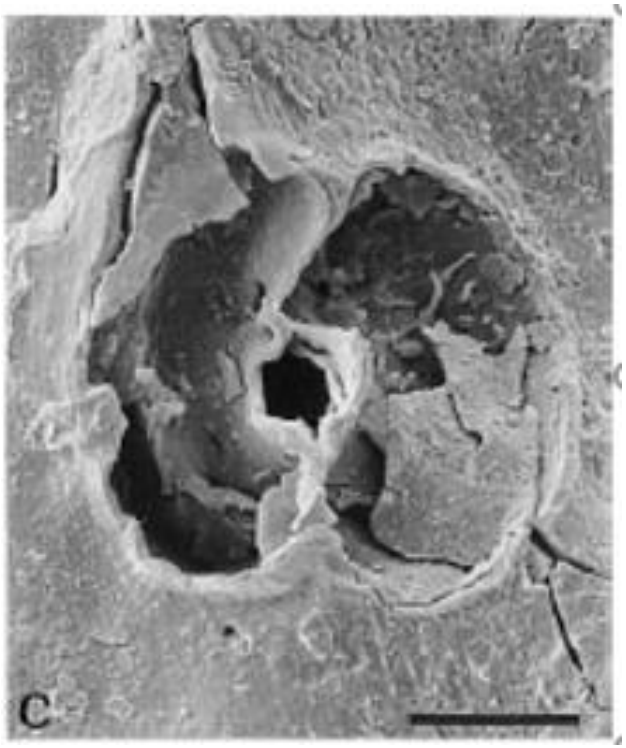
Thank you….





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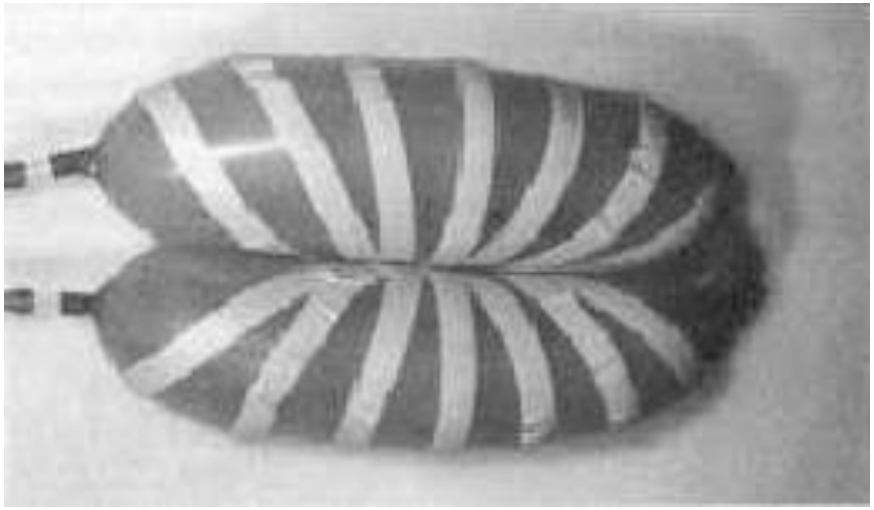

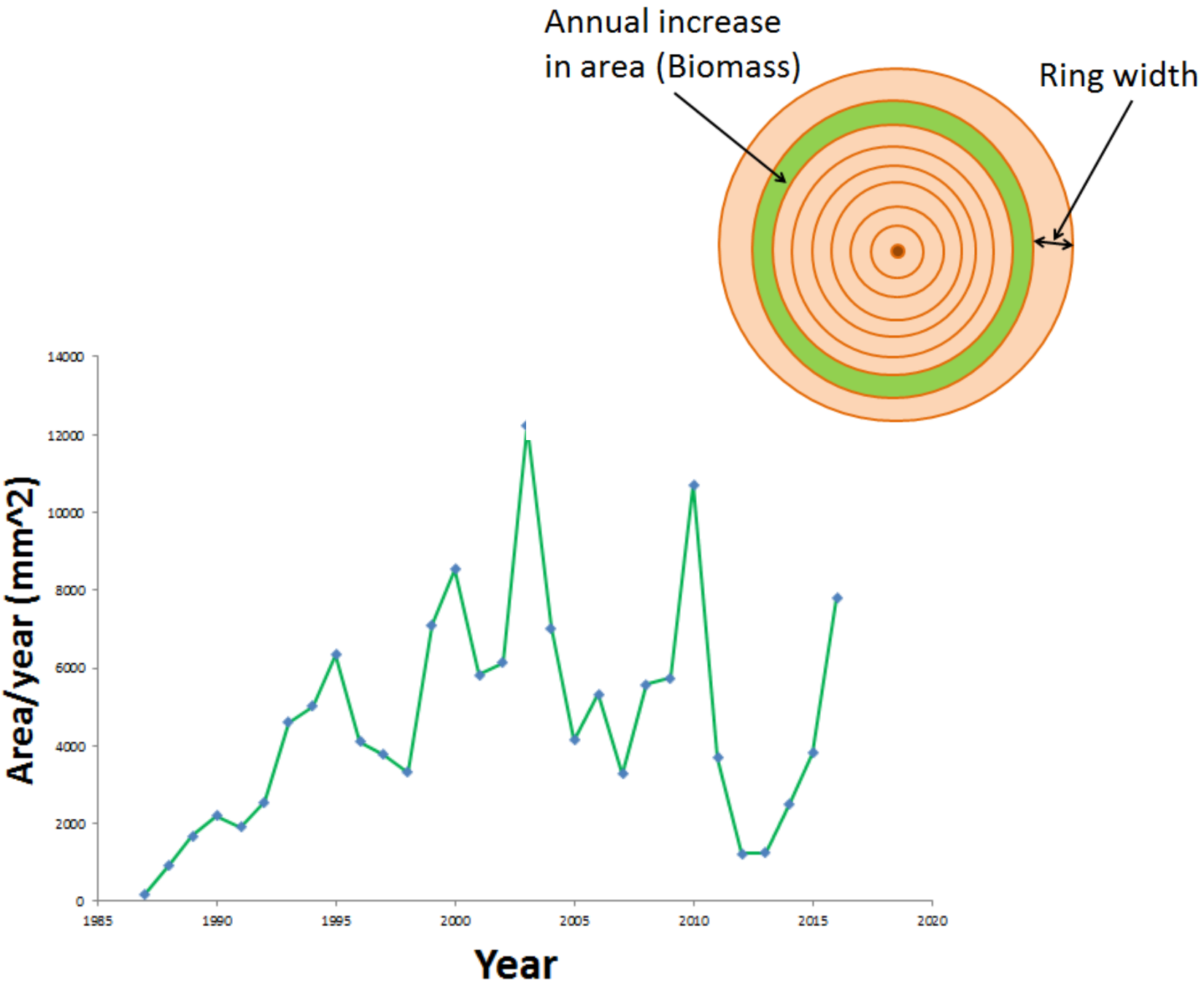
Annual increase
in area (Biomass)
Ring width
Area/year (mm^2)
14000
12000
10000
8000
6000
4000
2000
0
1985
1990
1995
2000
2005
2010
2015
2020
Year