Educational Conference: *Schools Unlimited*

USING TECHNOLOGY IN BIOLOGY CLASSROOMS, DESPITE LIMITED RESOURCES

The Imperative of Technology in Modern Biology Education

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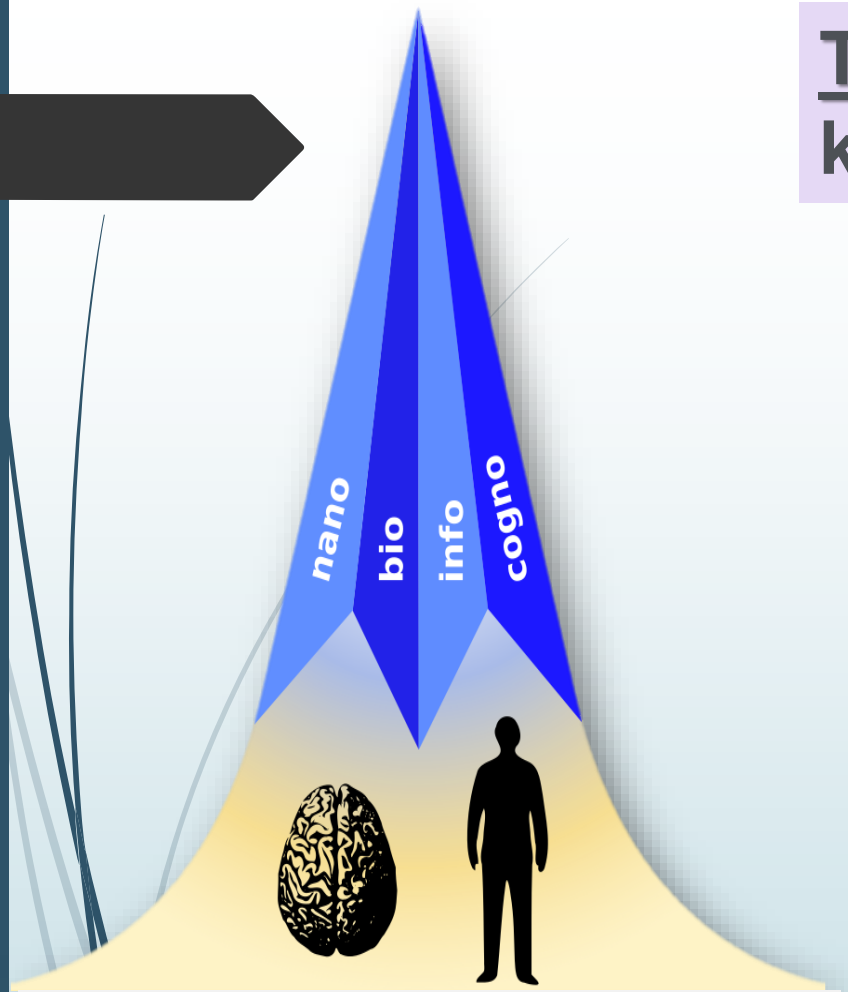
Biology education is facing a paradigm shift.

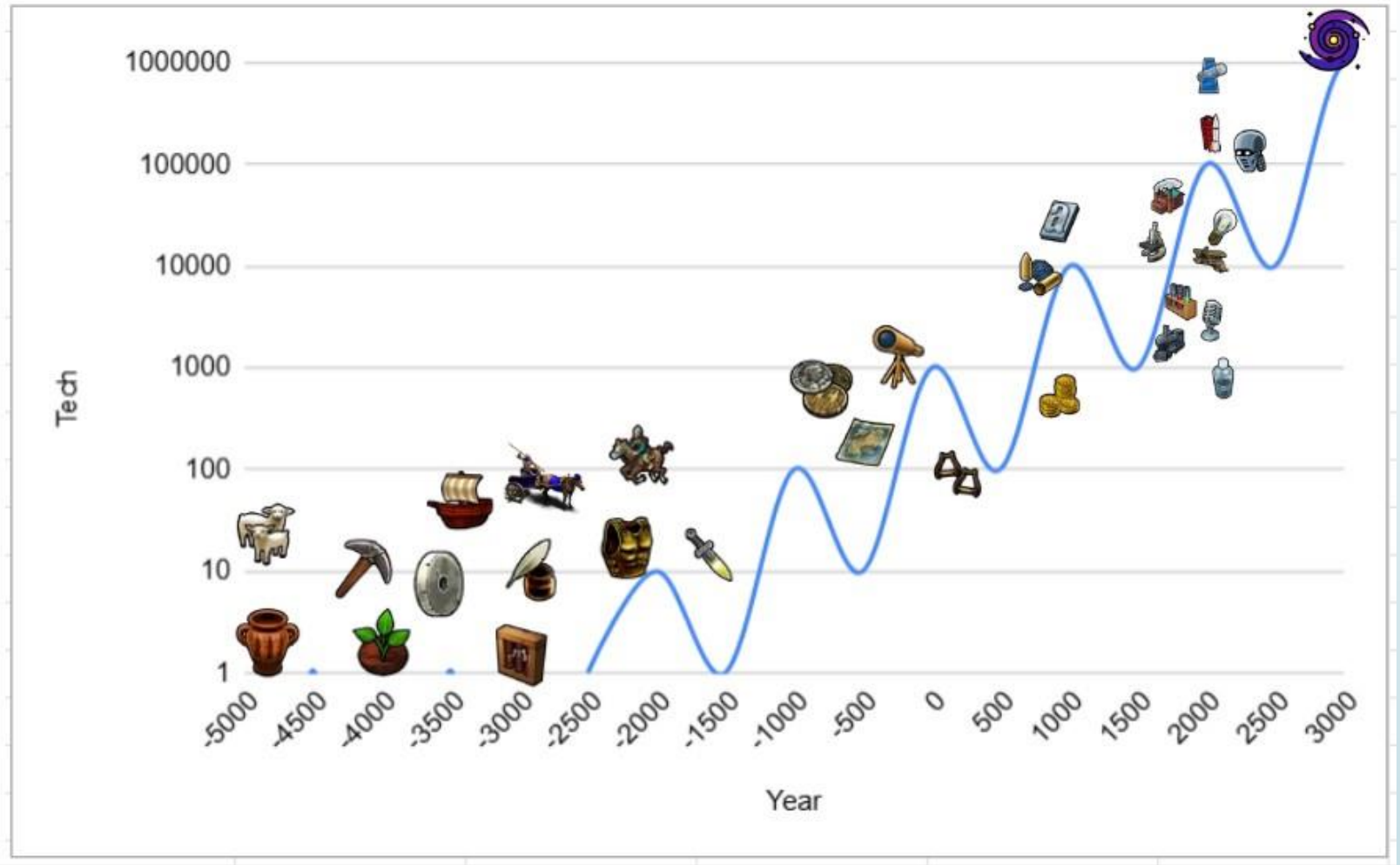
Traditional methods based on textbooks and lectures are no longer sufficient for understanding increasingly complex and dynamic biological concepts.

Technology is emerging as a fundamental tool to support learning processes.

Technology is the application of conceptual knowledge to achieve practical goals.



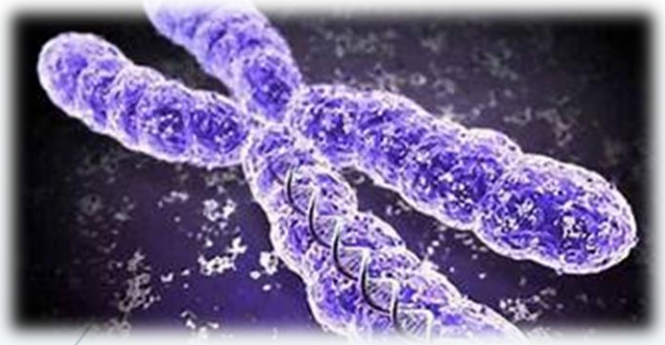
Cover of *Converging Technologies*, a report exploring the potential of synergies between nanotechnology, biotechnology, information technology, and cognitive science (NBIC).

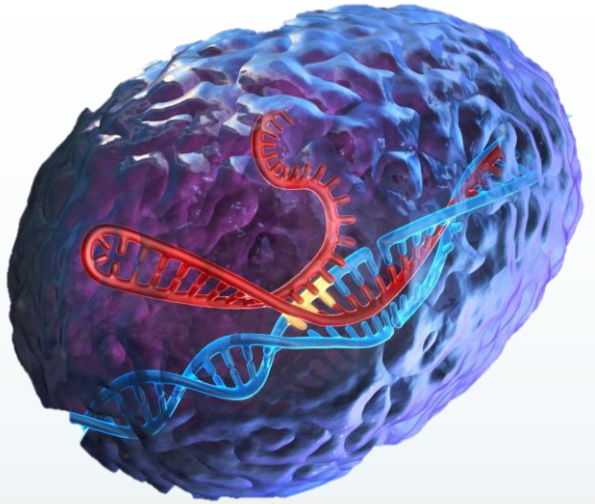


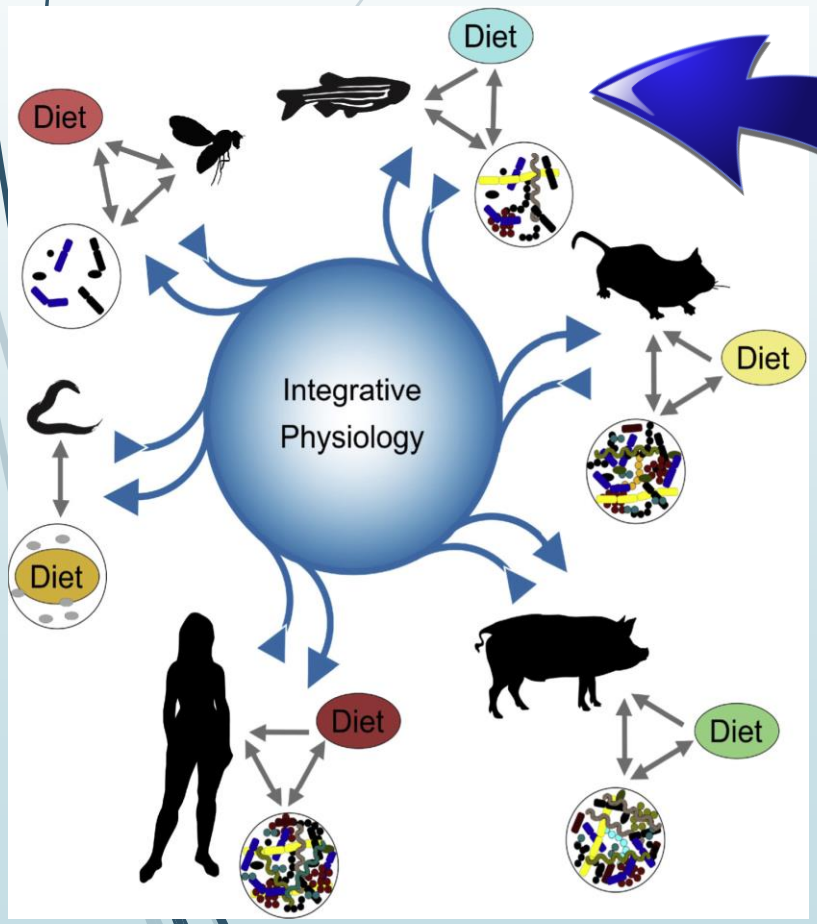
Timeline history of Technology

Technology has given us numerous developments that have improved our lives throughout history.

Nowadays, technology not only helps us travel, use resources, and develop tools, but it can also help us **improve our teaching-learning processes**.







Modern biology encompasses complex topics such as molecular genetics, cell biology, and integrative physiology, which require advanced visualization and interactive experimentation. Technology enables deeper and more meaningful teaching, making invisible processes tangible and facilitating the development of scientific thinking.

MECHANICAL TECHNOLOGY

MEDICAL TECHNOLOGY

INDUSTRIAL AND MANUFACTURING TECHNOLOGIES

Teaching-learning process

ELECTRONIC TECHNOLOGY

COMMUNICATIONS TECHNOLOGY

Benefits of Integrating Technology into Teaching-Learning Processes

- ✓ Facilitates active and experiential learning.
- ✓ Enables virtual simulations that replicate real laboratories.
- ✓ Adapts to different learning styles.
- ✓ Fosters student motivation and interest in science.

General context

Biology education faces a paradigm shift as technology becomes integral to understanding complex concepts. Tools such as virtual laboratories, interactive simulations, and adaptive learning platforms offer immersive experiences that transcend traditional textbook learning.

These tools offer immersive experiences that transcend traditional textbook learning

Limitations

Global disparities in resource access, particularly in low-income and rural areas, create inequities in educational outcomes.

Background

Reality of Educational Institutions with Scarce Technological Resources

➔ Limited access to internet connectivity:

Many schools rely on shared devices or outdated equipment.

➔ Inadequate teacher training

Educators often lack professional development opportunities to integrate technology effectively.

➔ Curriculum misalignment:

Technological tools are not frequently included in pedagogical goals, reducing their impact.

Some studies revealed that almost 70% of biology teachers had no access to virtual labs, and 80% reported insufficient training to use digital tools.

Proposed Actions and Activities

- Take advantage of offline simulations and mobile devices.
- Train and support teachers in the use of educational technology.
- Integrate technology into curriculum objectives and teaching planning.

Proposed Actions and Activities

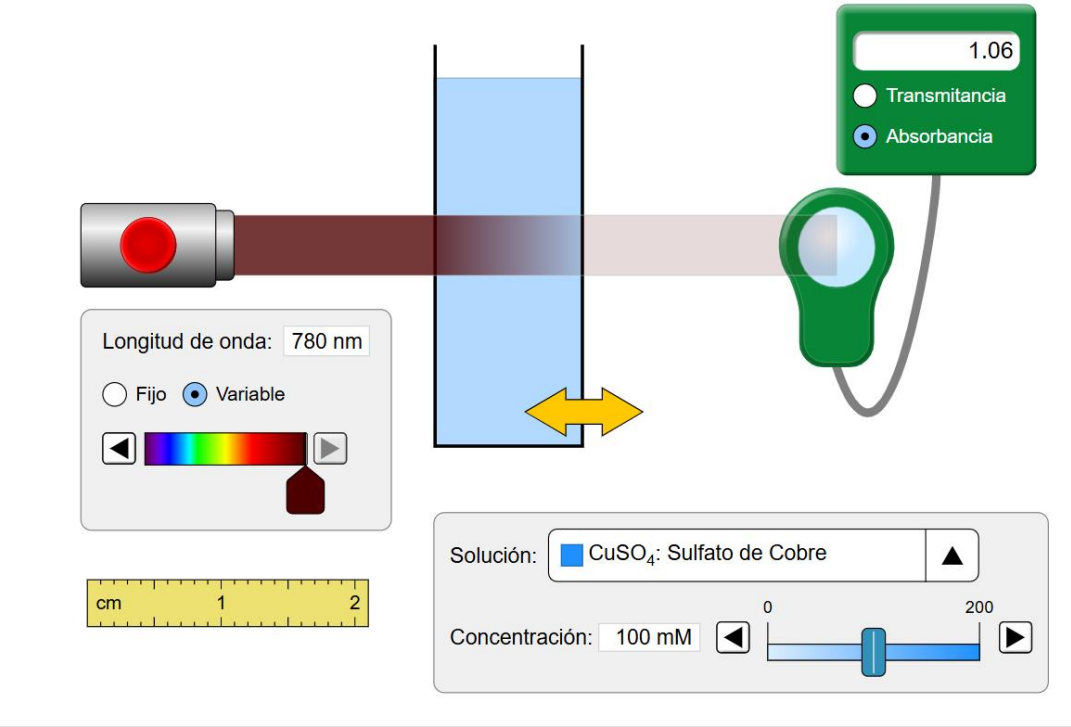
I) *Maximizing Low-Cost and Offline Technologies*

- Adopt offline simulations: Use tools like *PhET Simulations*, which function without internet and are compatible with low-spec devices.
- Leverage mobile technology: Design lessons around cellphone apps (e.g. TechXR for augmented reality or *Anatomy 4D* for physiology) to capitalize on widespread mobile access.

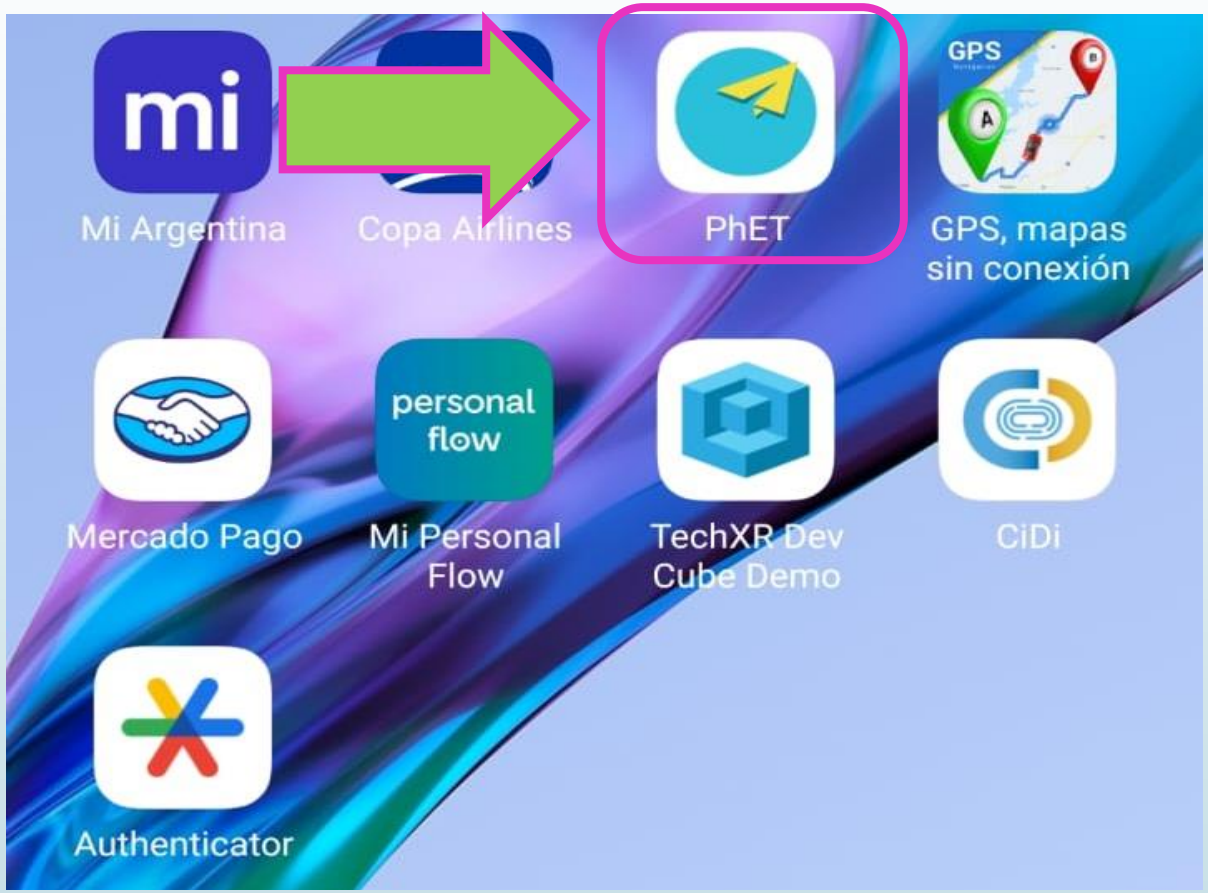
- Repurpose everyday tech: Use social media platforms (e.g., WhatsApp groups) for collaborative problem-solving and resource sharing.
- Open Educational Resources (OERs): Platforms like *Khan Academy* and *CK-12, Crush Course Biology.*

Low-Cost and Offline Technologies

INTERACTIVE SIMULATIONS



*https://phet.colorado.edu/sims/html/beers-law-lab/latest/beers-law-lab_all.html?locale=es



AUGMENTED REALITY

Tech XR Cube

Virtual laboratories

* Espectrofotómetro UV-VIS

Simulation of protein electrophoresis in SDS-polyacrylamide gel

Parameters | Graph | Simulation | Protein info

ELECTROPHORESIS PARAMETERS

Animation speed

○ Slow ◉ Average ○ Fast

Problem proteins	% Acrylamide
Problem #1 ▼	7.5% ▼

Patterns

- ☐ ß-gal.
- ☐ ovalb.
- ☐ anh. carb.
- ☐ TIM
- ☐ Mioglob.
- ☐ Lisoz.
- ☐ BPTI

Voltage

○ 50V ◉ 100V ○ 150V ○ 200V

Add pattern | Add sample

Begin | Arrest

PROTEIN DATA

Identifier

Protein name

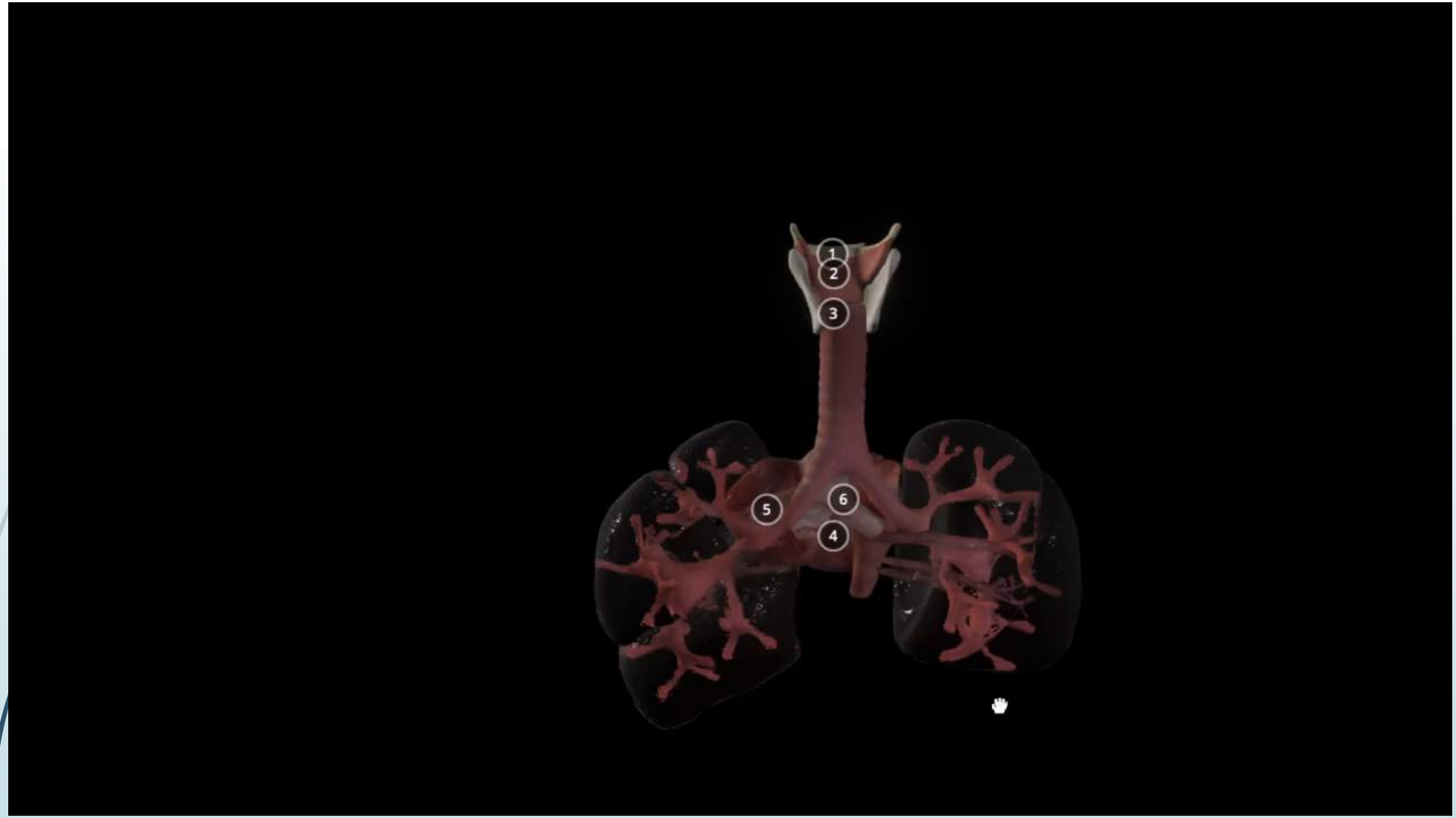
Abbreviation

Molecular mass

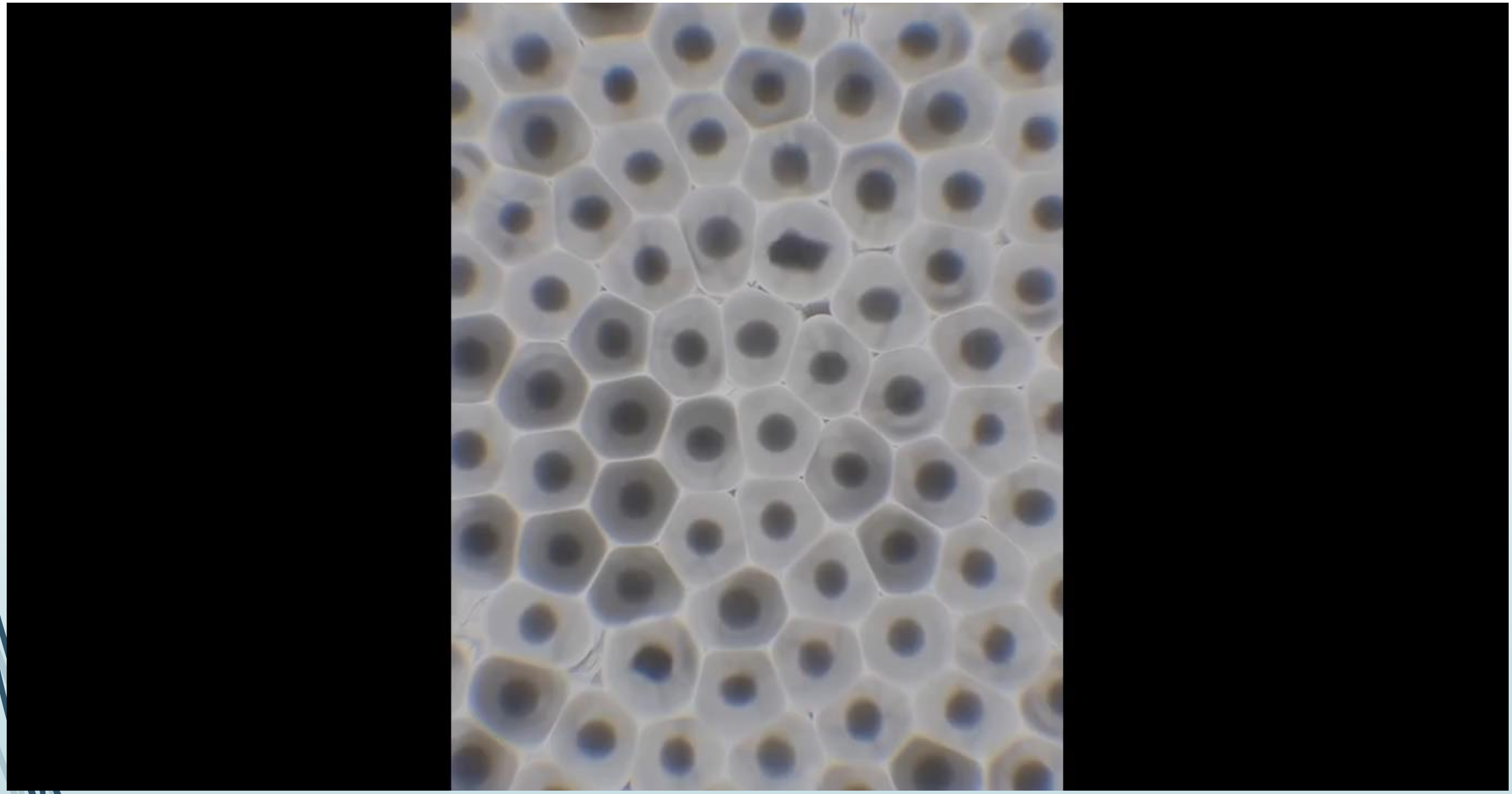
log (Mr)

This simulation was originally developed as a Java applet by David Mix under the supervision of Dr. Paul Craig (Rochester Institute of Technology, Rochester, NY, USA). Its conversion to this HTML5 version (which does not require Java) was performed by Dr. Robert M. Hanson (St. Olaf College, Northfield, MN, USA) using the SwingJS tool. Duplicated, translated, and converted with permission of Dr. Craig.

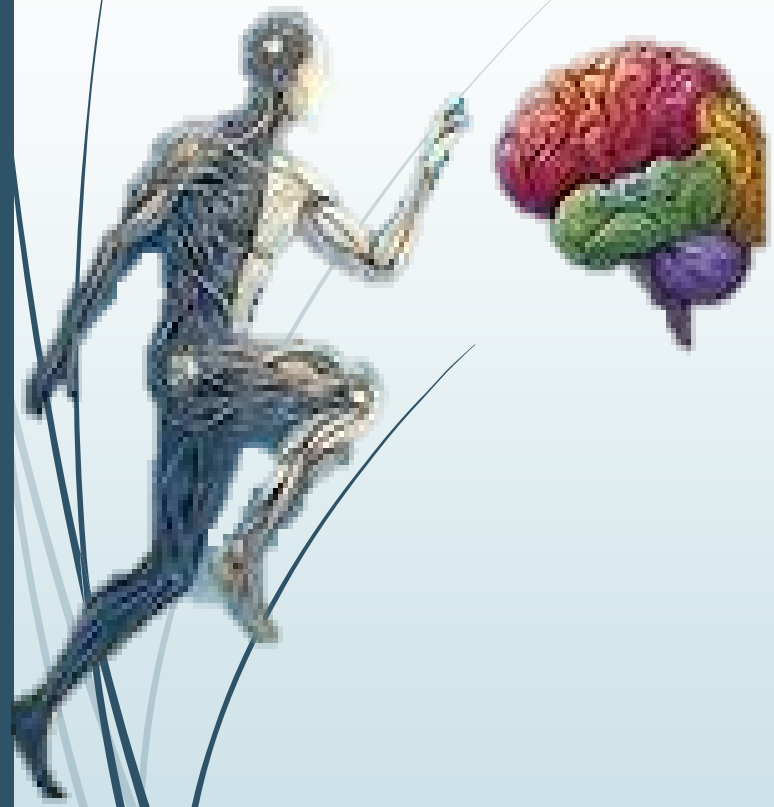
3D models and animations



*https://sketchfab.com/benben-miao/collections/science-7b505bf6bfb141f88b17b6b4a7152727



Embodied cognition in science learning: our thinking is deeply connected with our physical interactions and experiences in the world (Danish *et al*., 2020).



When I interact with a concept or theory through the use of technological tools, I have greater and better chances to learn…

Importance of Collaboration and Networks

Global communities and networks of biology teachers can share resources, experiences, and training, generating a multiplier effect that helps reduce access gaps and strengthen educational practices with technology.

Long-Term Vision

- A global network of biology teachers using technology could soon emerge in which schools share resources, training and innovations.
- This requires coordinated efforts among politics, education and technology to promote equity in digital education.

Thank you very much for your attention!