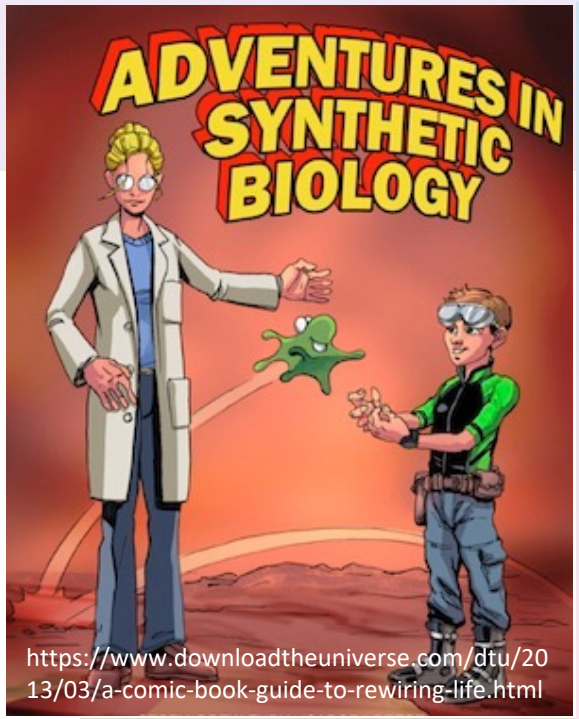

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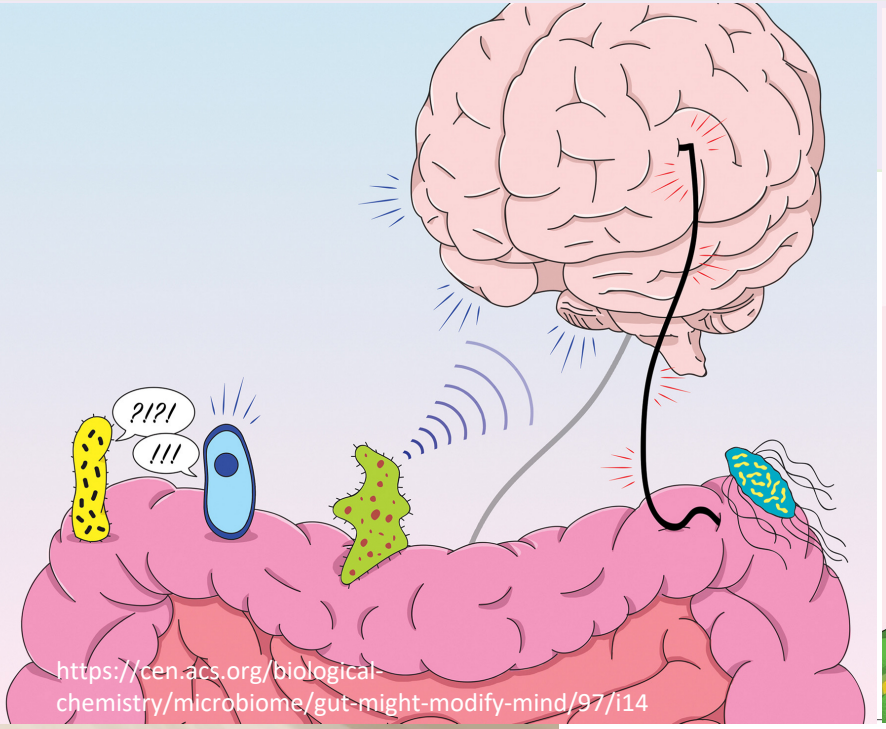

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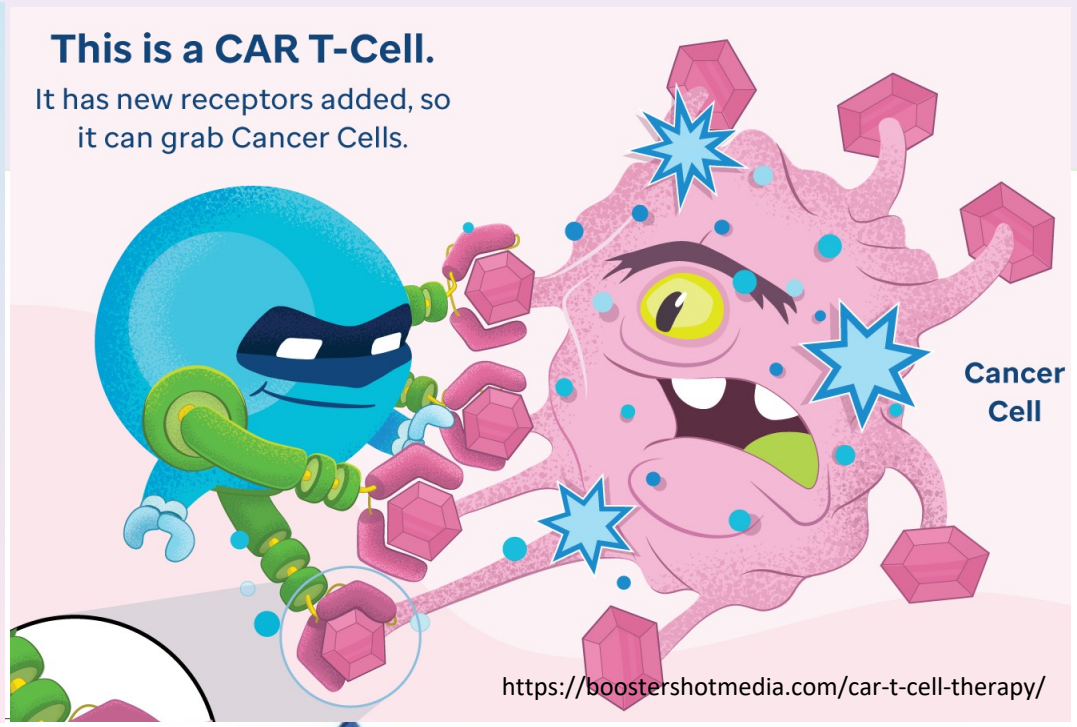

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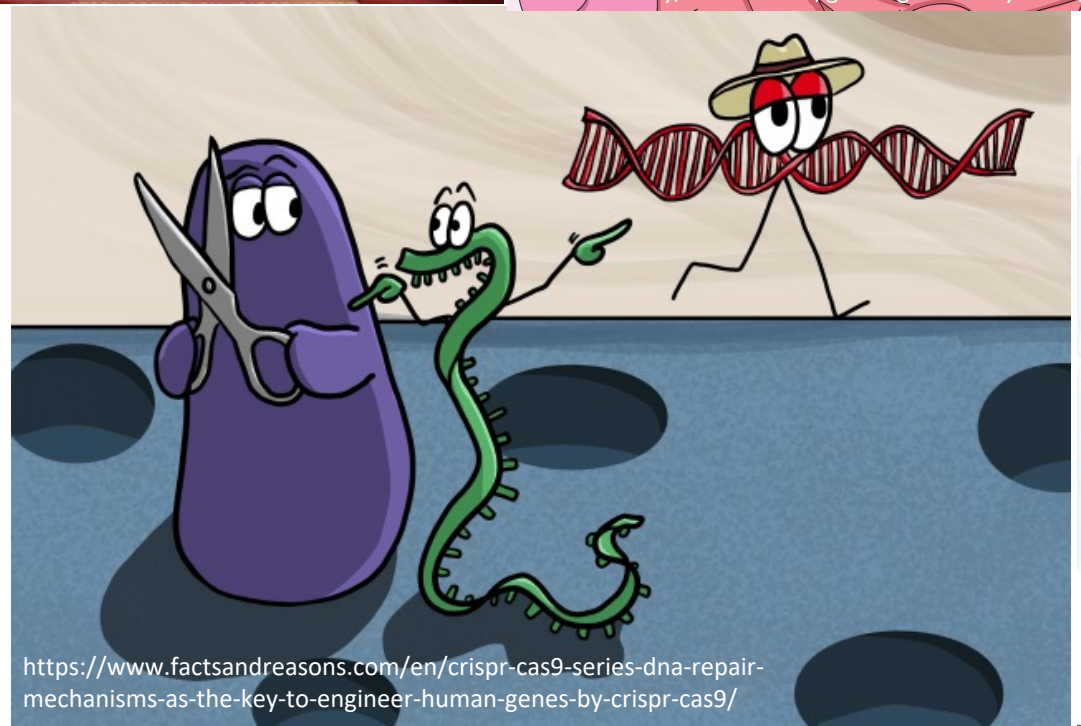

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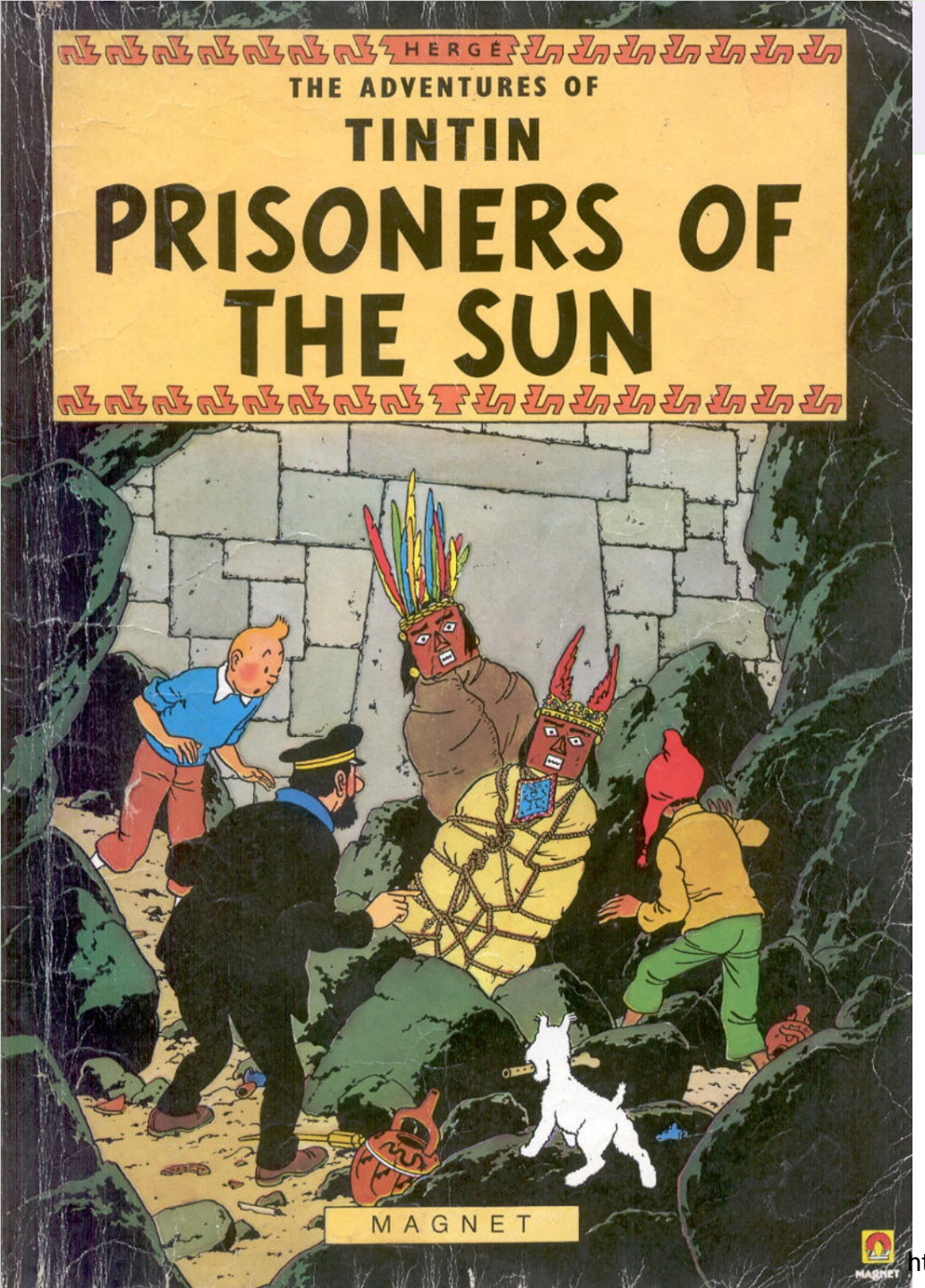
https://i.ytimg.com/vi/Ts4b7B8mHL0/sddefault.jpg

Introduction



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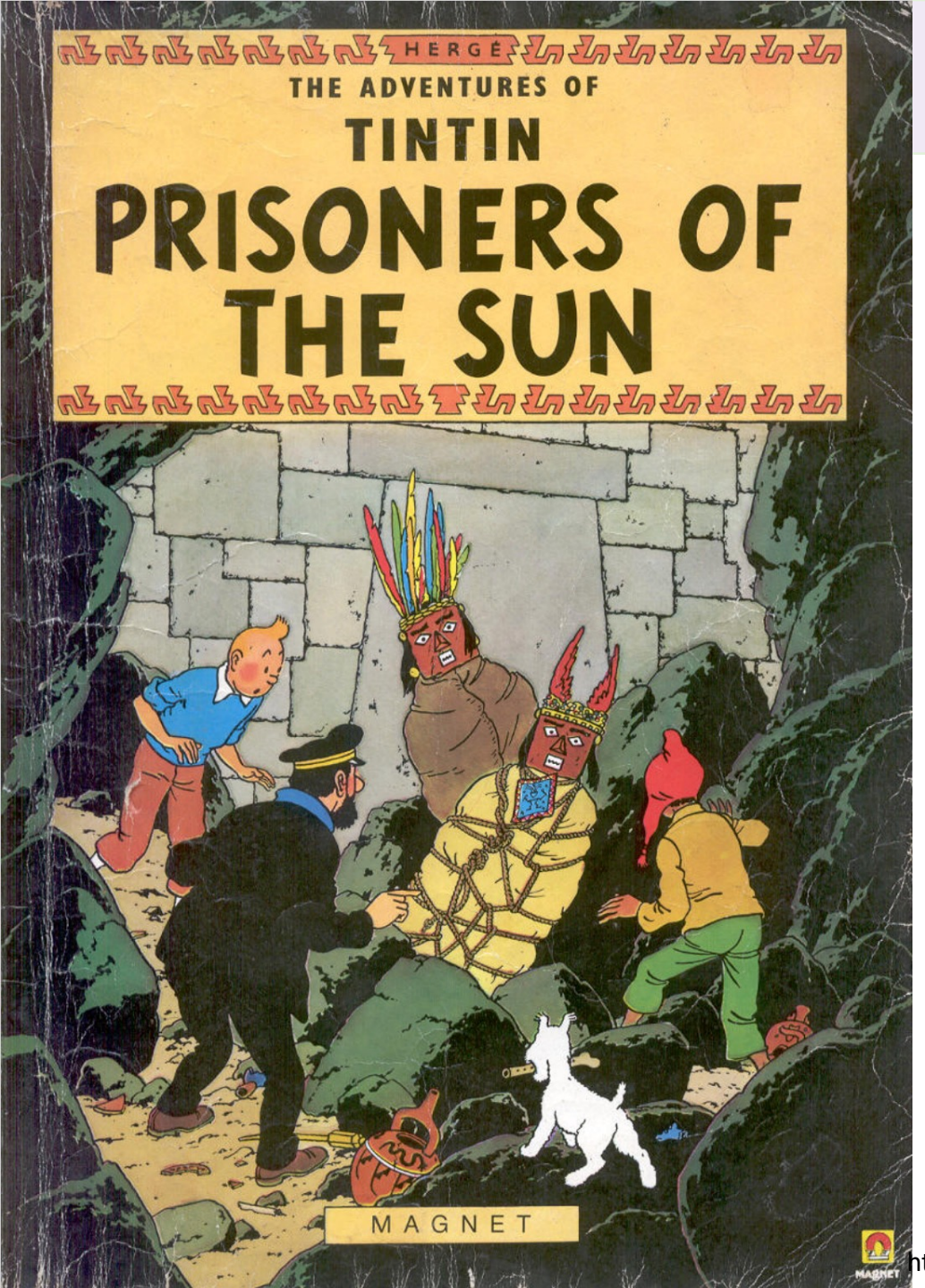
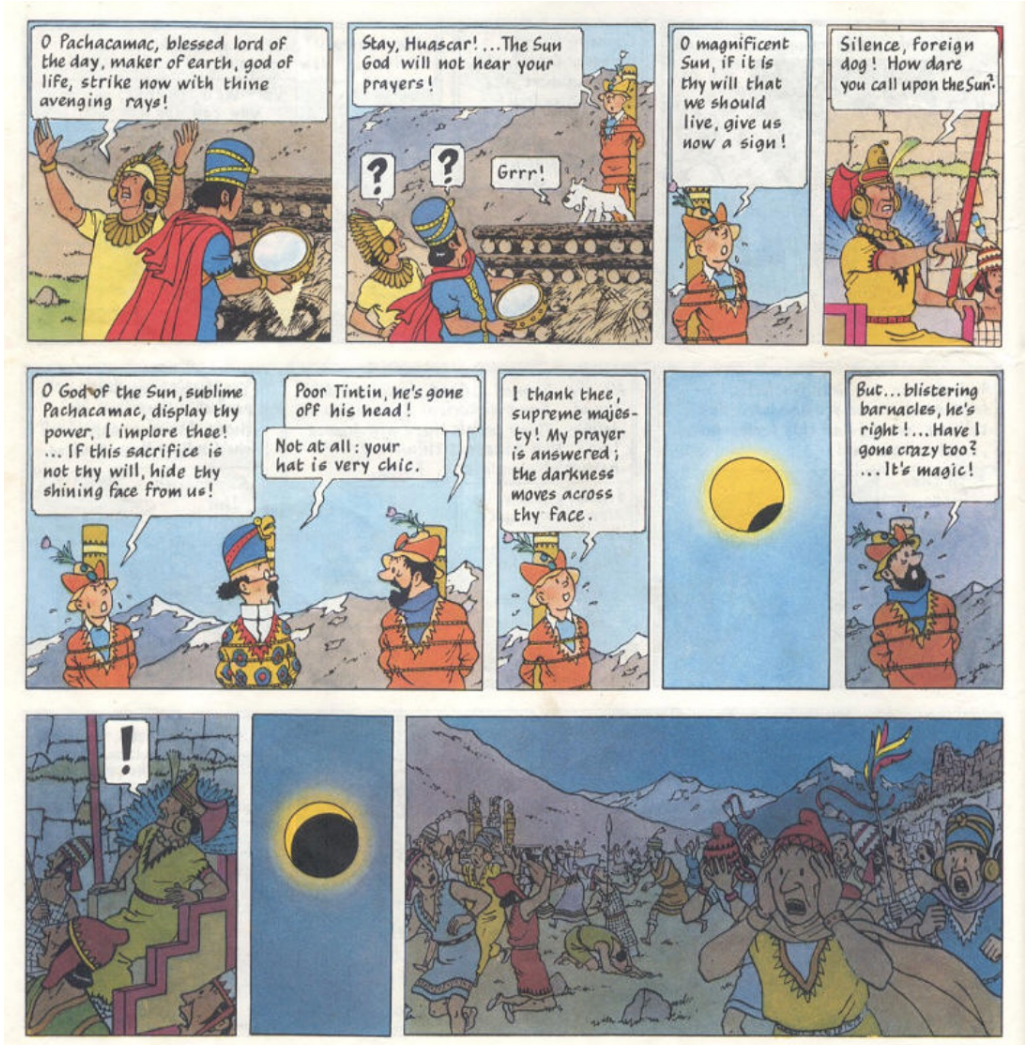


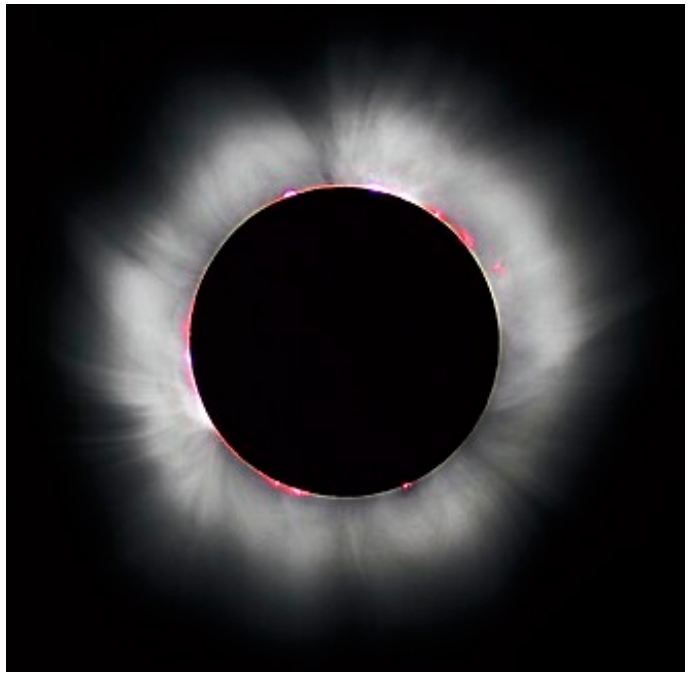
Lack of awareness…



leads to misconceptions

https://ia601304.us.archive.org/25/items/01TintinInTheLandOfTheSoviets/14_Tintin_and_the_Prisonres_of_Sun.pdf

Eclipses and myths



Lack of awareness of natural phenomena led to myths

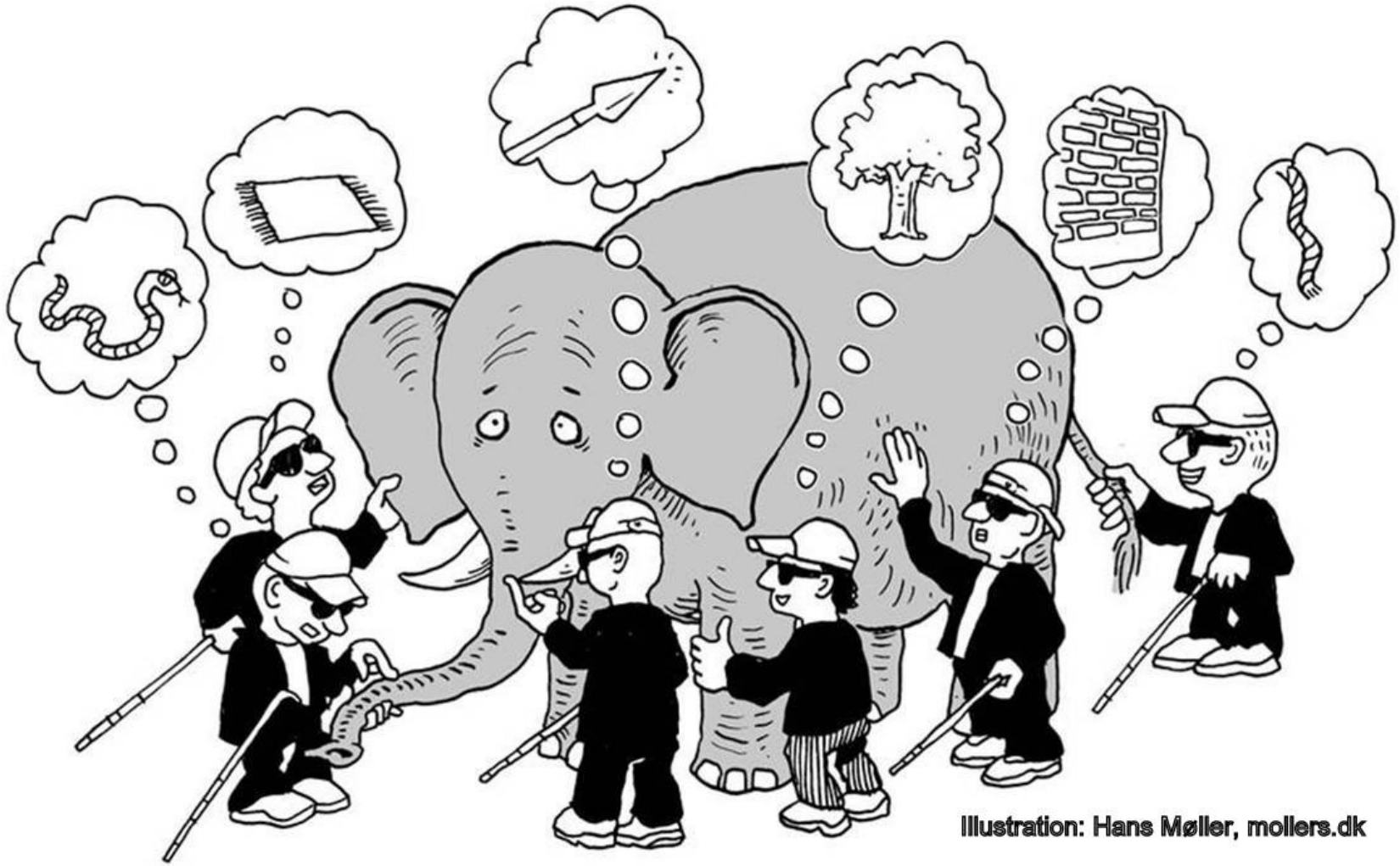
Images of total solar and total lunar eclipses are from the respective Wikipedia pages

ESA Just Faked a Solar Eclipse – And Caught the Sun's Hidden Halo

BY EUROPEAN SPACE AGENCY (ESA) — JUNE 19, 2025 NO COMMENTS 11 MINS READ

https://scitechdaily.com/esa-just-faked-a-solar-eclipse-and-caught-the-suns-hidden-halo/

Perception and reality



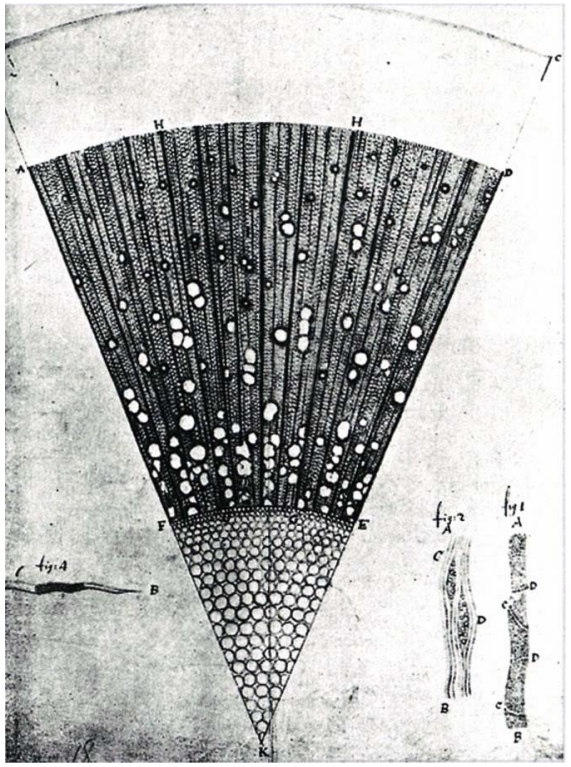
Originally copied from https://www.engagementaustralia.org.au/blog/blind-men-elephant

Biology: perceptions and reality

Perception	Reality
Biology requires good drawing skills	
Large vocabulary is unique to Biology	
Study of Biology requires memorization	

Recording observations: then...

A replica of a microscope by Antonie van Leeuwenhoek



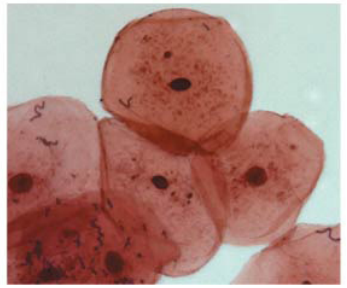
A microscopic section of an ash tree (Fraxinus) wood

Antonie van Leeuwenhoek

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

Recording observations: now...

Brightfield (unstained specimen)

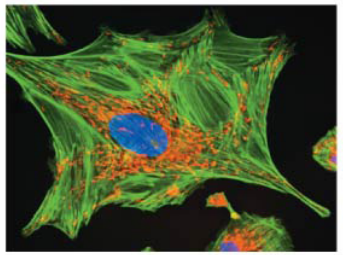


Brightfield (stained specimen)

Phase-contrast

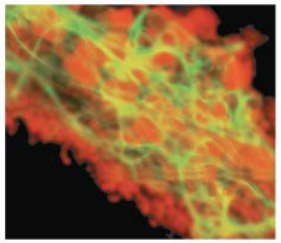
Differential-interference-contrast (Nomarski)

50 µm

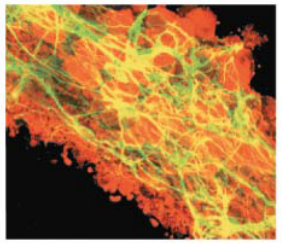


Fluorescence

10 µm

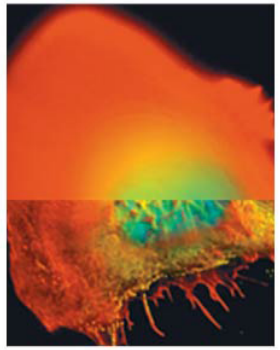


Confocal (without)



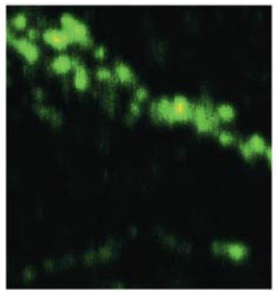
Confocal (with)

50 µm

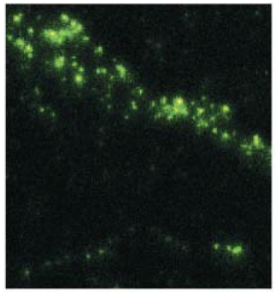


Deconvolution

10 µm

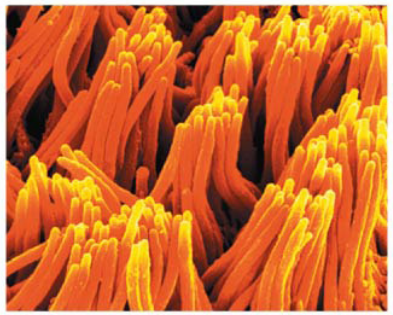


Super-resolution (without)



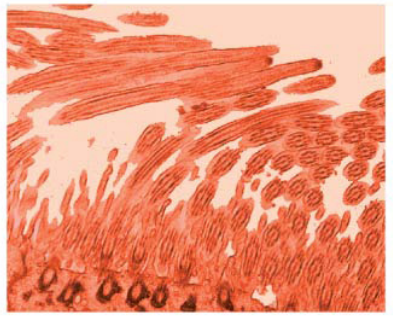
Super-resolution (with)

1 µm



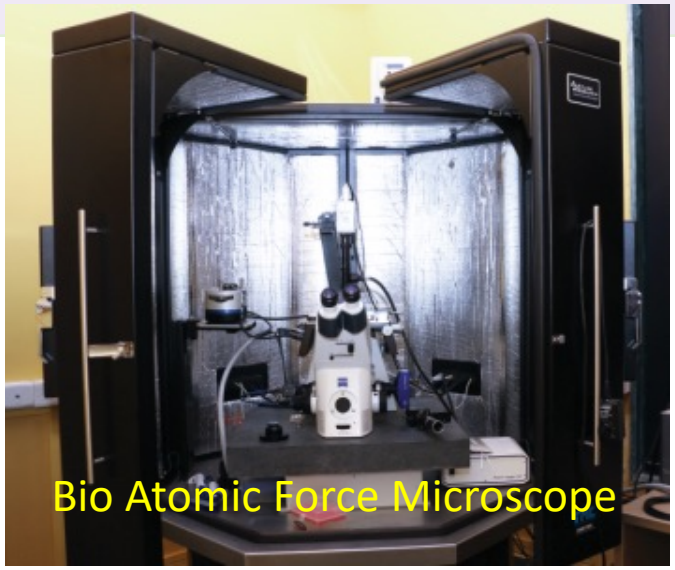
Scanning electron microscopy (SEM)

2 µm



Transmission electron microscopy (TEM)

2 µm



Bio Atomic Force Microscope

Laser scanning confocal microscope

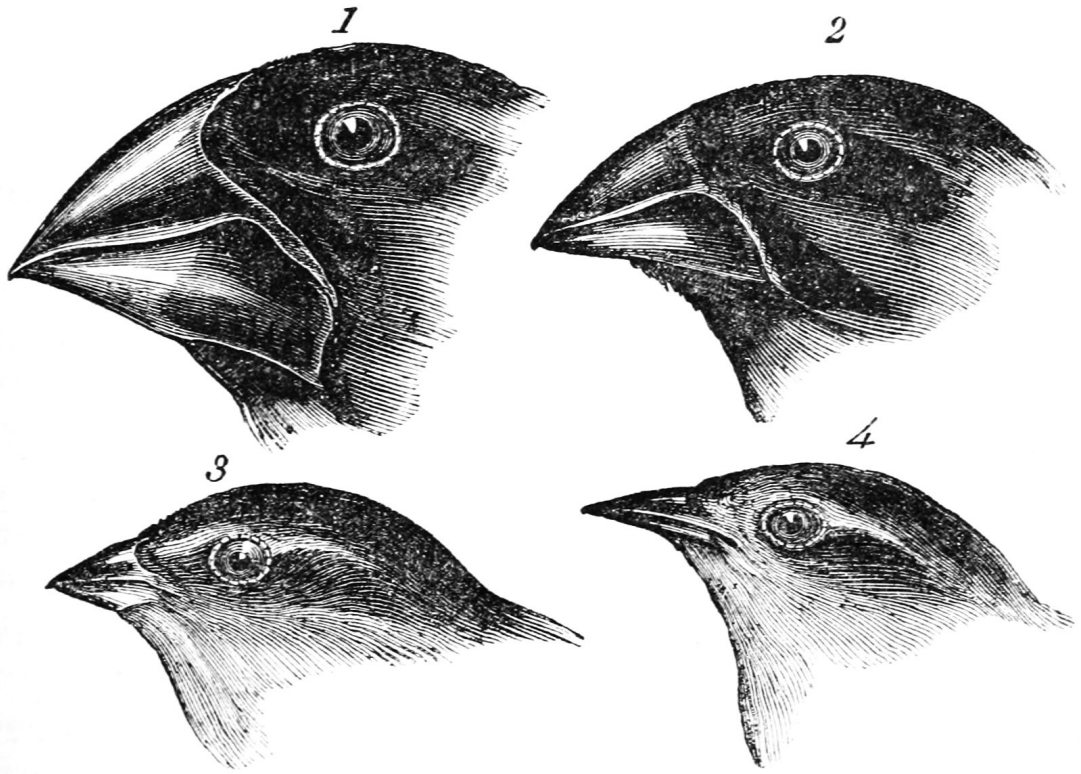
Figure 6.3 from Campbell's Biology

About images in the previous slide

- All are variants of light microscopy except SEM and TEM
- Light microscopy allows imaging of a live cell
- Scanning Electron Microscopy (SEM) and

  Transmission Electron Microscopy (TEM) use dead cells
- Note: artifacts are introduced while preparing specimens

Recording observations: then...



1. Geospiza magnirostris.
2. Geospiza fortis.
3. Geospiza parvula.
4. Certhidea olivacea.

What is NOT sketched is perhaps equally important

Coloration, texture, location, surroundings, …

https://en.wikipedia.org/wiki/Darwin%27s_finches#/media/File:Darwin's_finches_by_Gould.jpg

Recording observations: now...

Biology: perceptions and myths

Perception	Reality
Biology requires good drawing skills	Actually, a disadvantage (contextual)
Large vocabulary is unique to Biology	
Study of Biology requires memorization	

How many components?

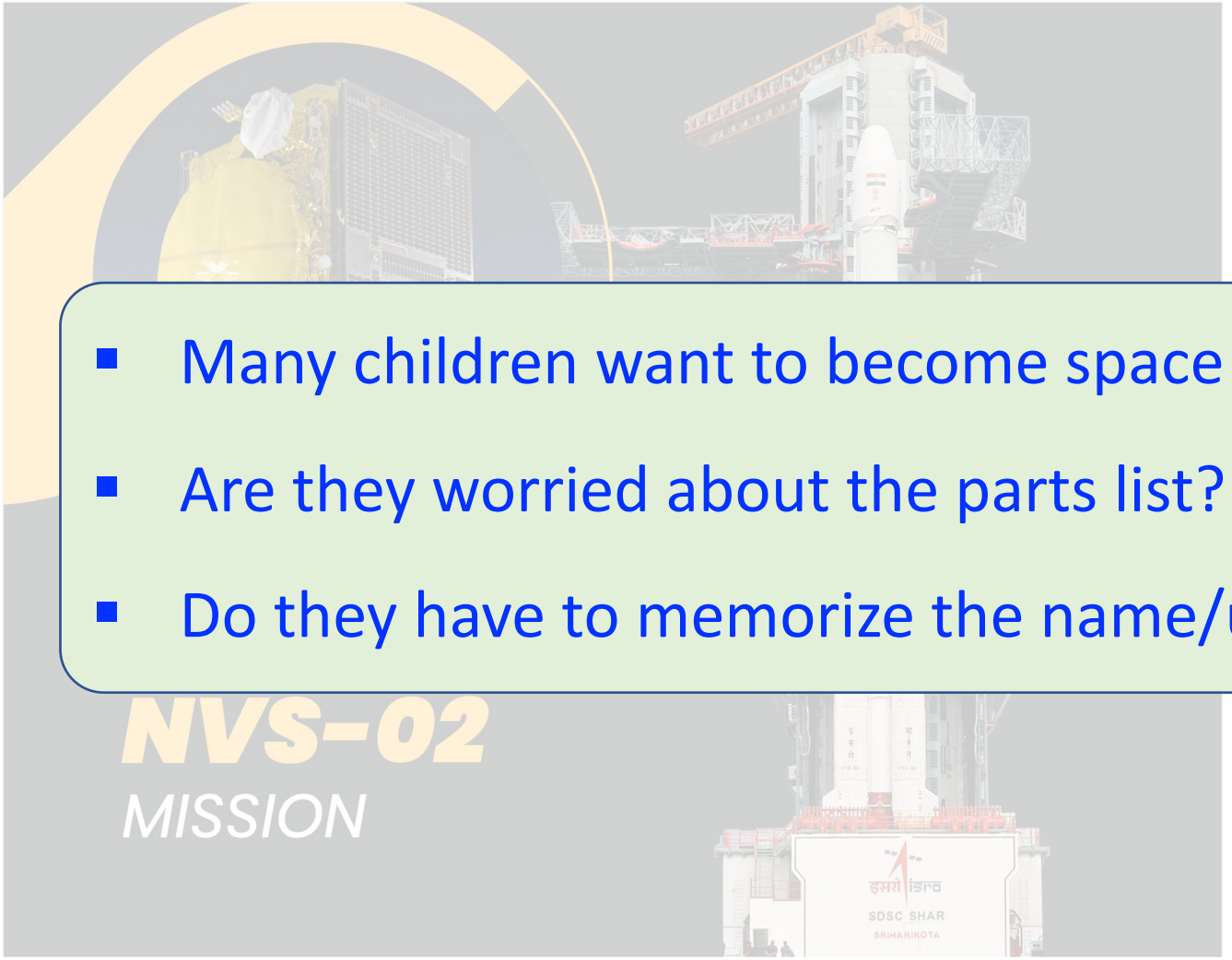
Launch of NavIC-2 (29 January 2025)

1. Propulsion system
2. Navigation system
3. Telemetry
4. Thermal systems
5. Electrical systems
6. Safety and abort systems
7. Payload

Hardware
Software

https://www.isro.gov.in/media_isro/pdf/GSLVF15/GSLV-F15_NVS-02_EngBrochure240125.pdf

How many components?



- Many children want to become space scientists…
- Are they worried about the parts list?
- Do they have to memorize the name/use of each and every component?

Launch of NavIC-2 (29 January 2025)

https://www.isro.gov.in/media_isro/pdf/GSLVF15/GSLV-F15_NVS-02_EngBrochure240125.pdf

Vocabulary-rich science

Biology is a vocabulary-rich science

it has to be, like the study of any other complex and self-regulated system

Across the globe, Biology teaching has moved towards bringing out

(i) the beauty of life,

(ii) the benefits of understanding how they work,

(iii) Intellectual challenges associated with the study, and

(iv) exploiting such a knowledge for a better living

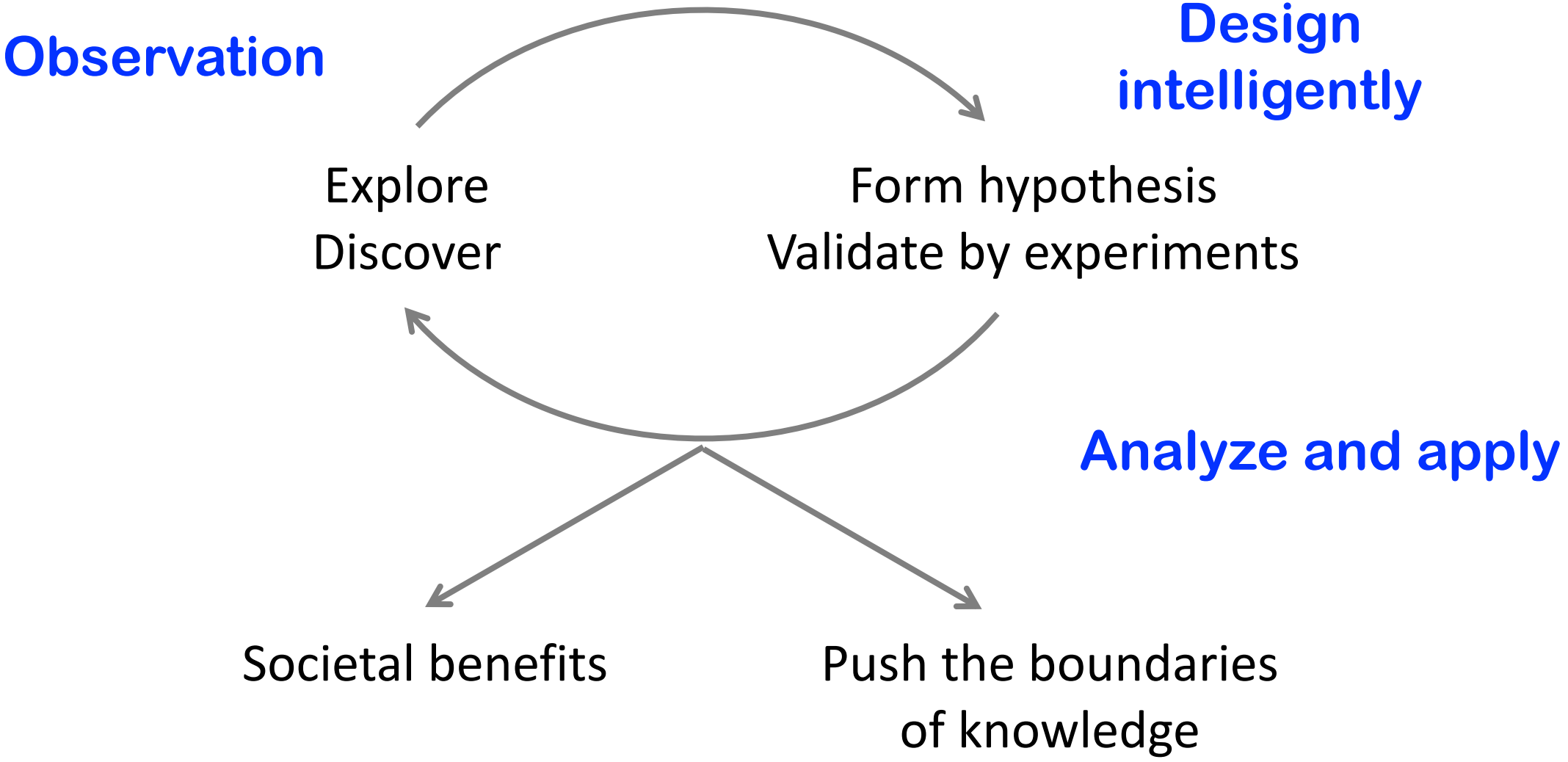
Biology: perceptions and myths

Perception	Reality
Biology requires good drawing skills	Actually, a disadvantage (contextual)
Large vocabulary is unique to Biology	As much as for any multi-component complex system
Study of Biology requires memorization	

Traditional biology

- Emphasis on anatomy and taxonomy
- Importance, utility, intellectual challenges were known
- Field was not developed enough
  - Instrumentation and other tools were yet to be developed

Current Biology



Biology: perceptions and myths

Perception	Reality
Biology requires good drawing skills	Actually, a disadvantage (contextual)
Large vocabulary is unique to Biology	As much as for any multi-component complex system
Study of Biology requires memorization	No more than required for the study of any other discipline

Summary so far...

- Lack of awareness creates myths
  - Myths widely associated with Biology are just that: myths!

What is Biology?

Biology is the study of life and living organisms!

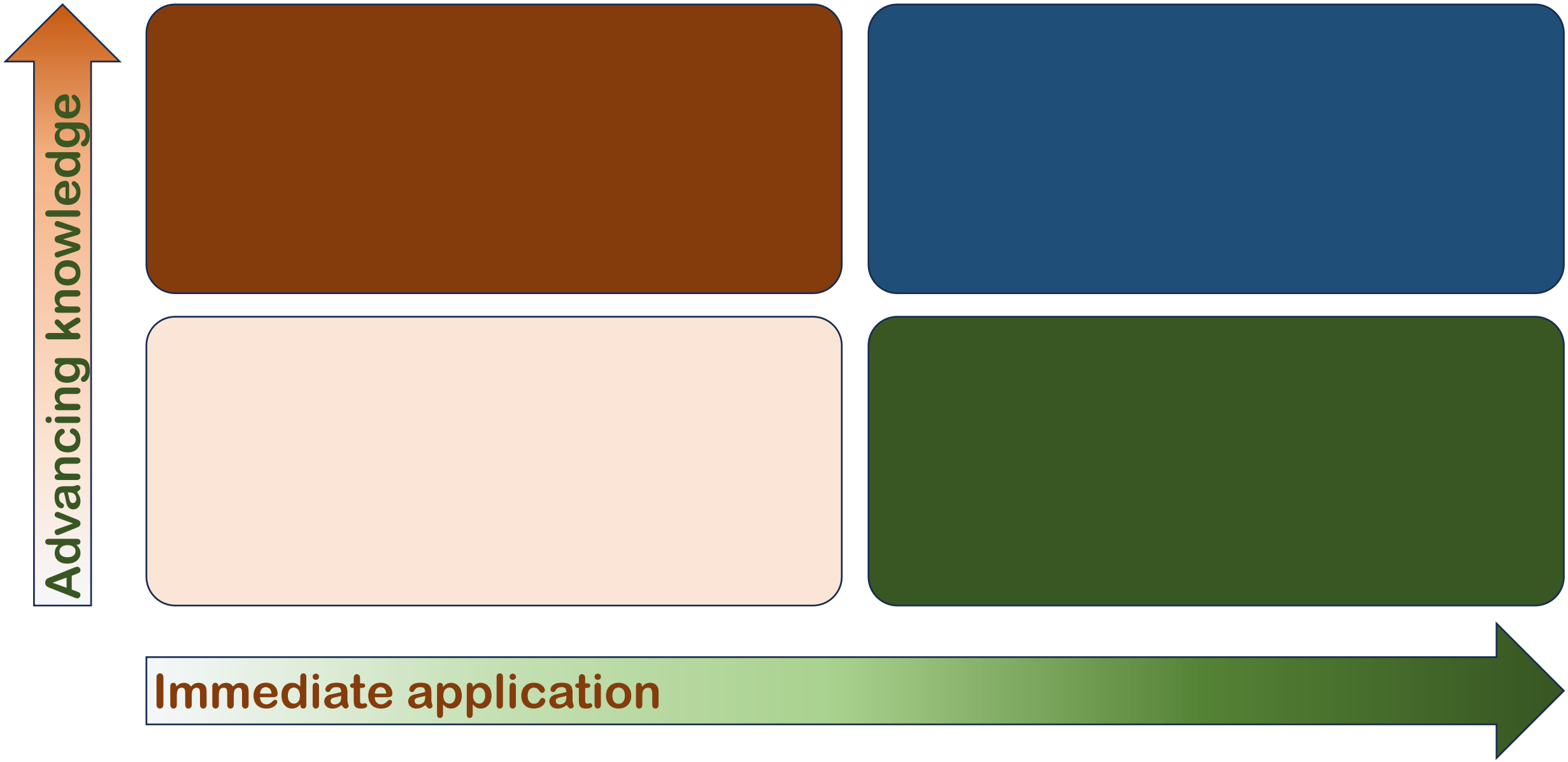
Biology: invention or discovery?

Discovery versus invention

Representative discoveries
Circulatory system
Continental drift
Electrical impulses in the nervous system
Inverse square law of gravity
Moons of Jupiter
Newton’s laws of motion
Periodicity of elements
Radioactivity

Representative inventions
Automobile
Electric bulb
Internet
Printing press
Radio
Telephone
Television
Wheel

Inventions and discoveries



Study of biology: invention or discovery?

Advancing knowledge

Curie quadrant
Pure basic research
No relevance to practical issues

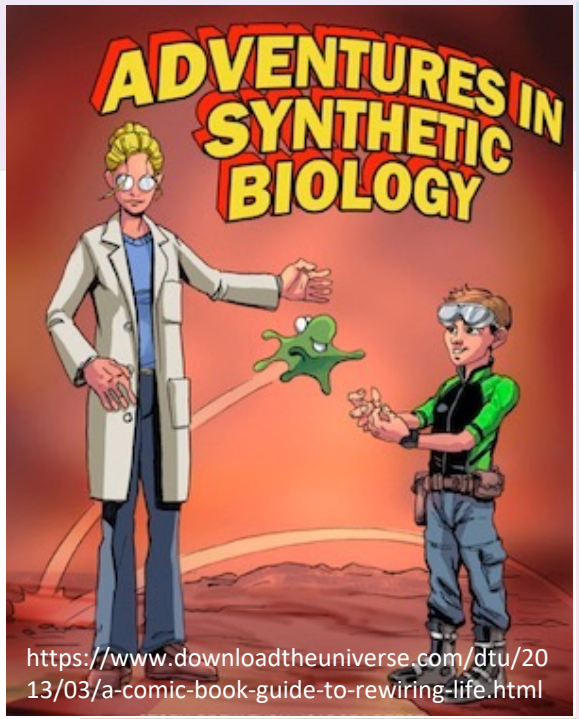
Biology

Pasteur quadrant
Use-inspired basic research
High relevance to practical issues

Curiosity quadrant
Exploratory quadrant
Waste quadrant?

Edison quadrant
Pure applied research
Address practical issues

Immediate application



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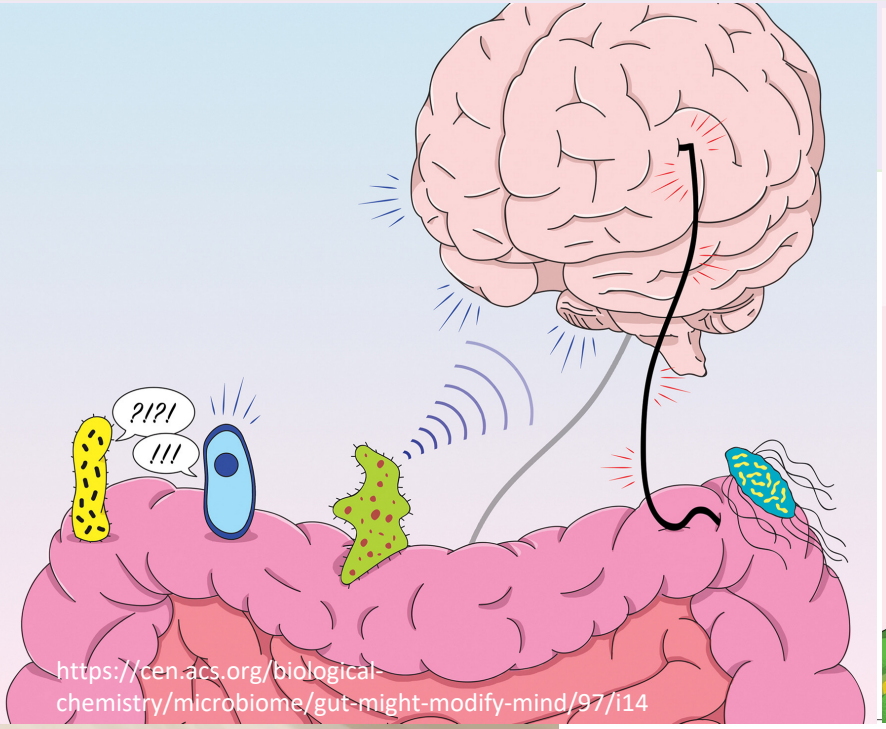

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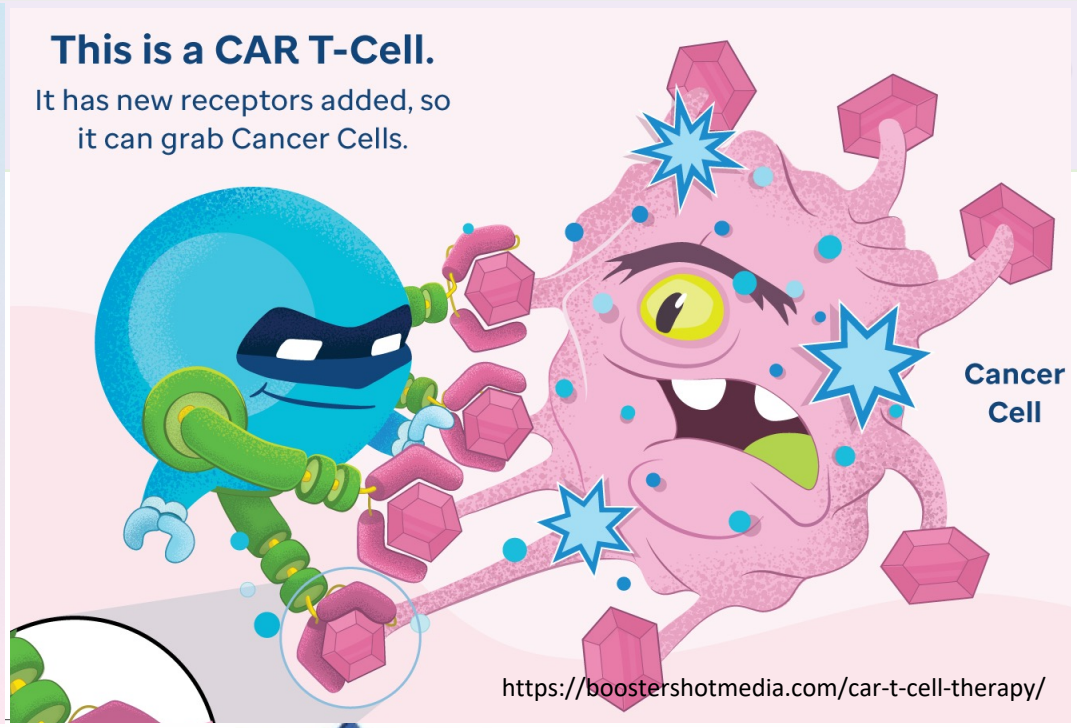

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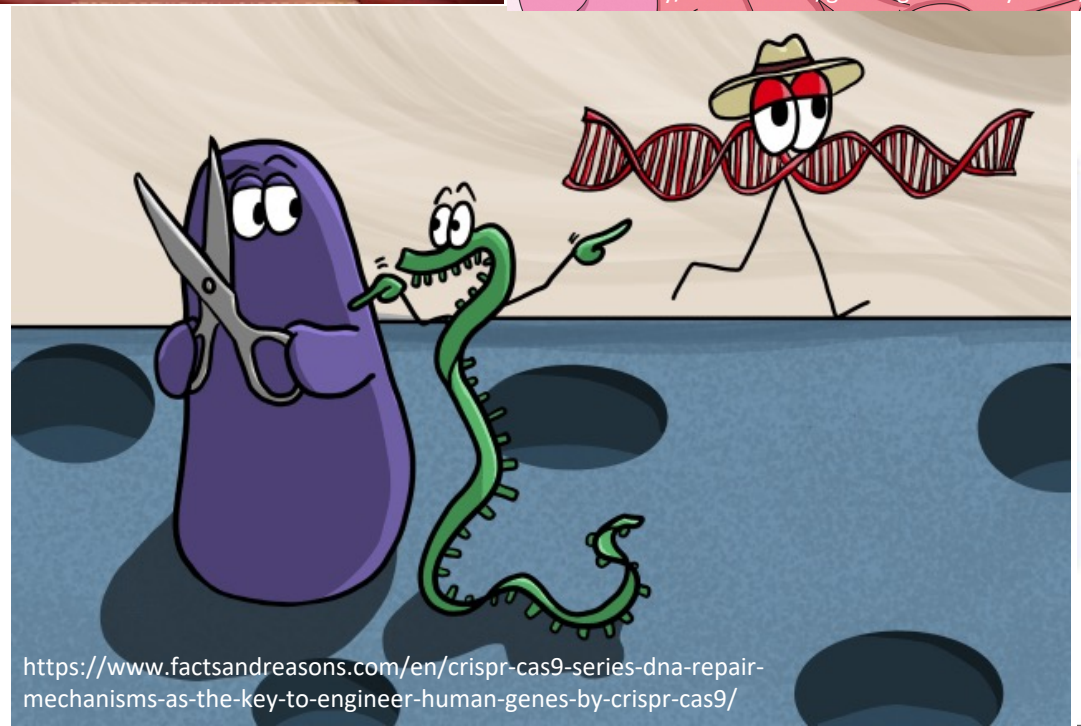

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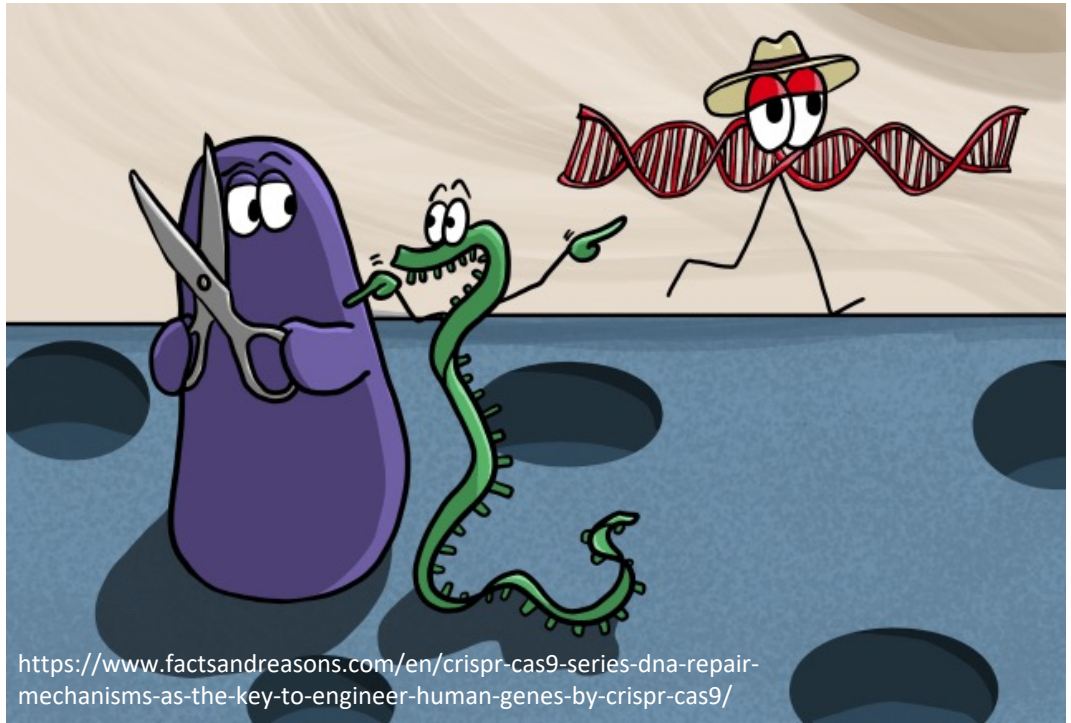
https://i.ytimg.com/vi/Ts4b7B8mHL0/sddefault.jpg

That Dont Evolve

Editing genes

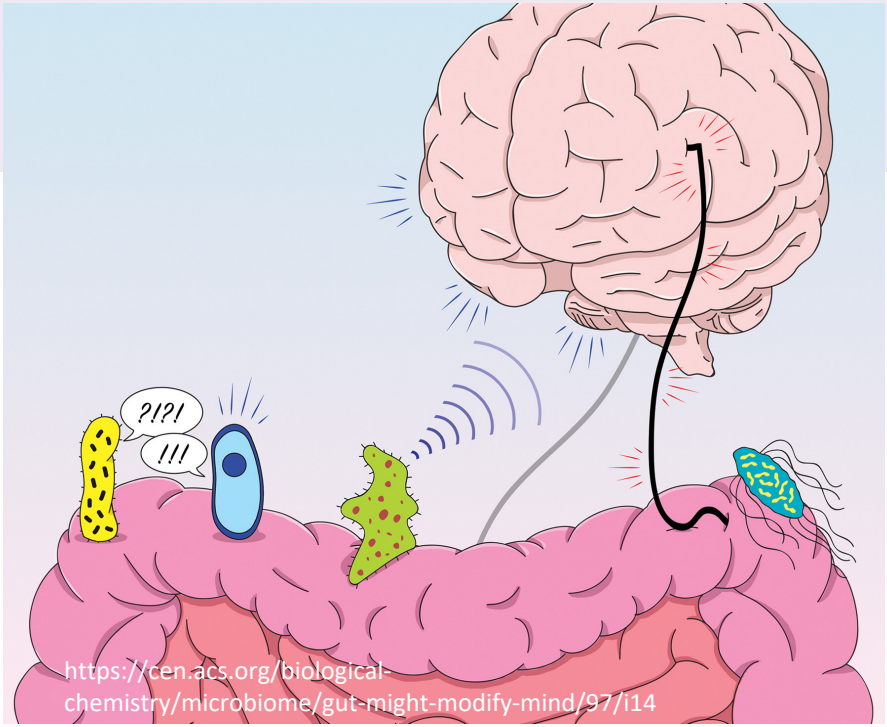
- Several diseases are caused by “a defective gene”
- We can now “edit” the defect

CRISPR-Cas systems



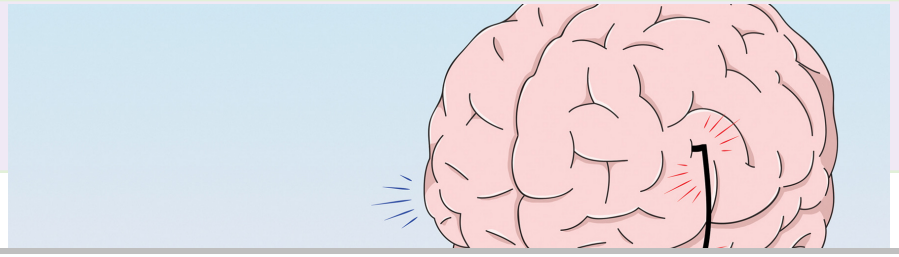
https://www.factsandreasons.com/en/crispr-cas9-series-dna-repair-mechanisms-as-the-key-to-engineer-human-genes-by-crispr-cas9/

Gut – brain axis



https://cen.acs.org/biological-chemistry/microbiome/gut-might-modify-mind/97/i14

- Microbes inhabit human gut
- These microbes communicate with the brain



Gut – brain axis

Google

gut feeling

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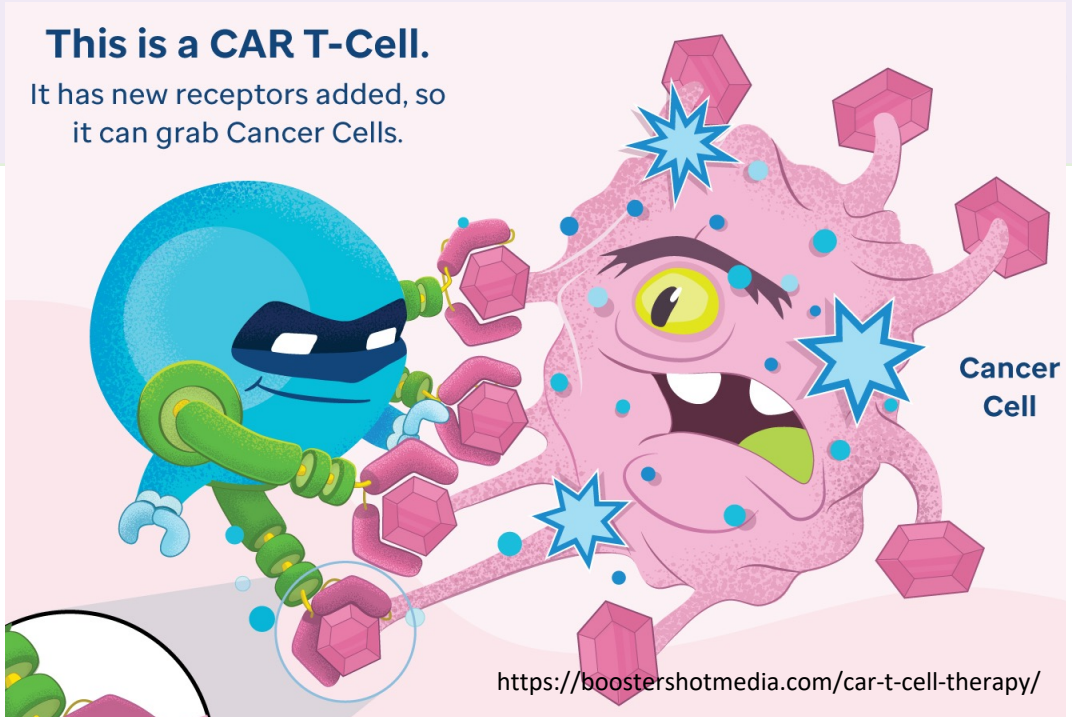
AI Overview

म En Listen

A "gut feeling" is **an intuitive judgment or instinctive feeling that arises without conscious reasoning**. It's often described as a strong, often physical, sensation that suggests a certain course of action or belief about a situation or person. Gut feelings can be powerful, but their accuracy can vary, and it's often wise to consider them alongside other information and analysis.

BB 101 Biology
2025-26
Lecture 1

CAR-T cell therapy



Ms. Ishwari Bhagirav from Nashik (around 11 years of age)

Cancer-free since receiving this therapy about 2 years ago

First in India to receive this treatment

For treating relapsed or refractory B-cell lymphomas and leukemia

Refractory: stubborn, resistant, etc., leukemia: a type of blood cancer; lymphoma: a type of cancer that affects the lymphatic system; it is a part of our immune system

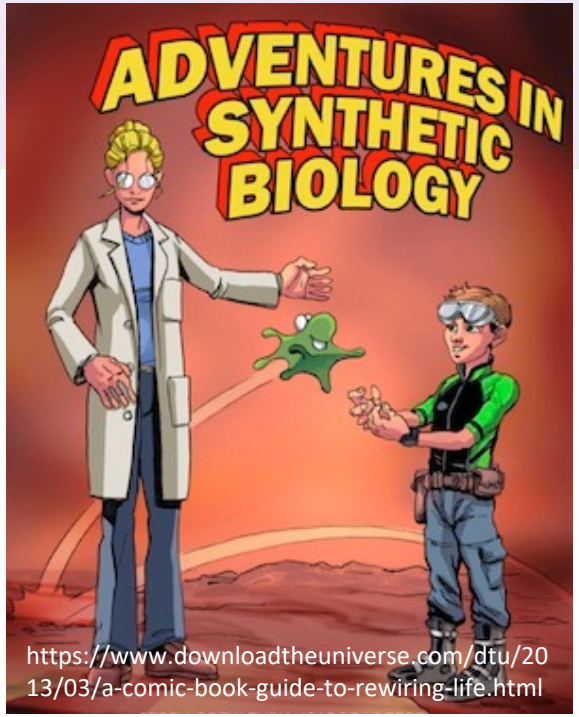
CAR-T cell therapy

Dedication of the first indigenously developed therapy for relapsed-refractory B-cell lymphomas and leukemia

4 April 2024 @ IIT Bombay

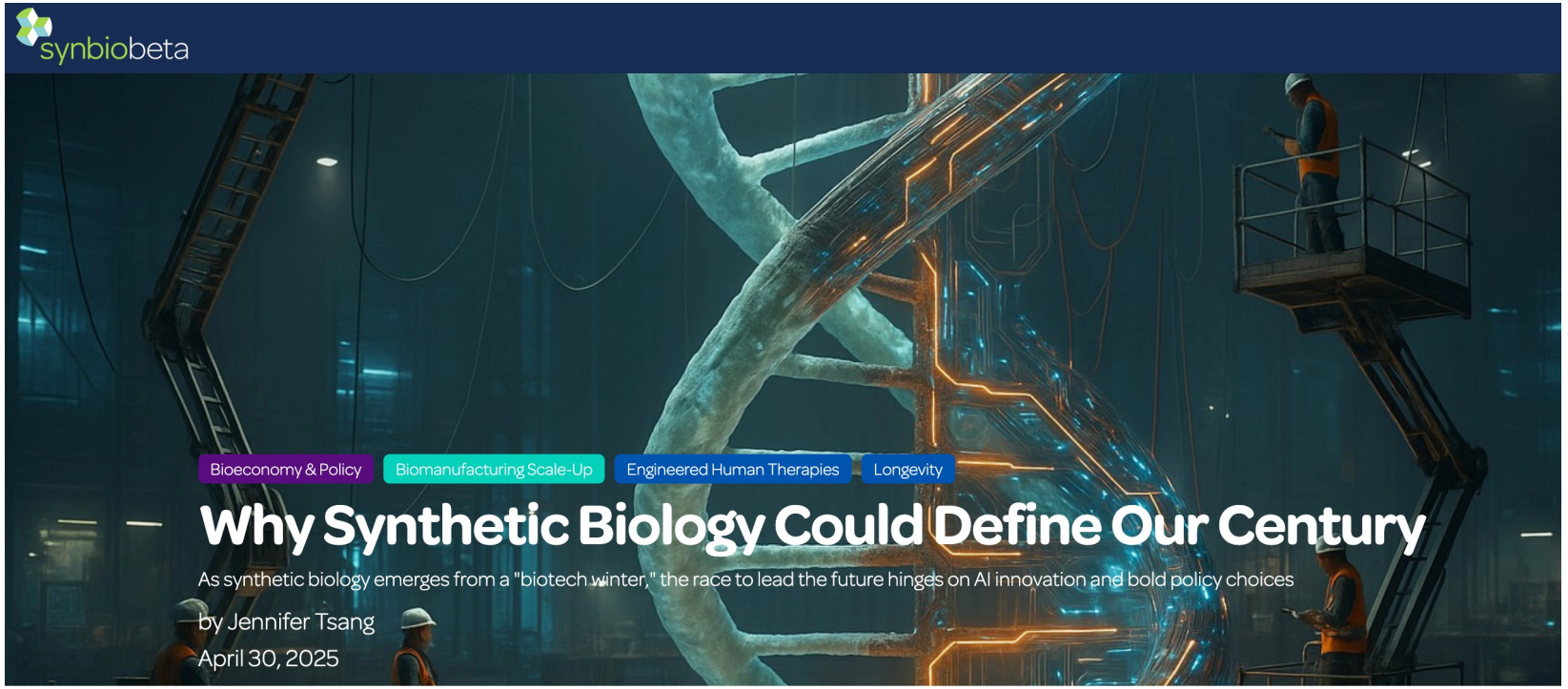
Hon'ble President of India
Ms. Draupadi Murmu

Synthetic biology

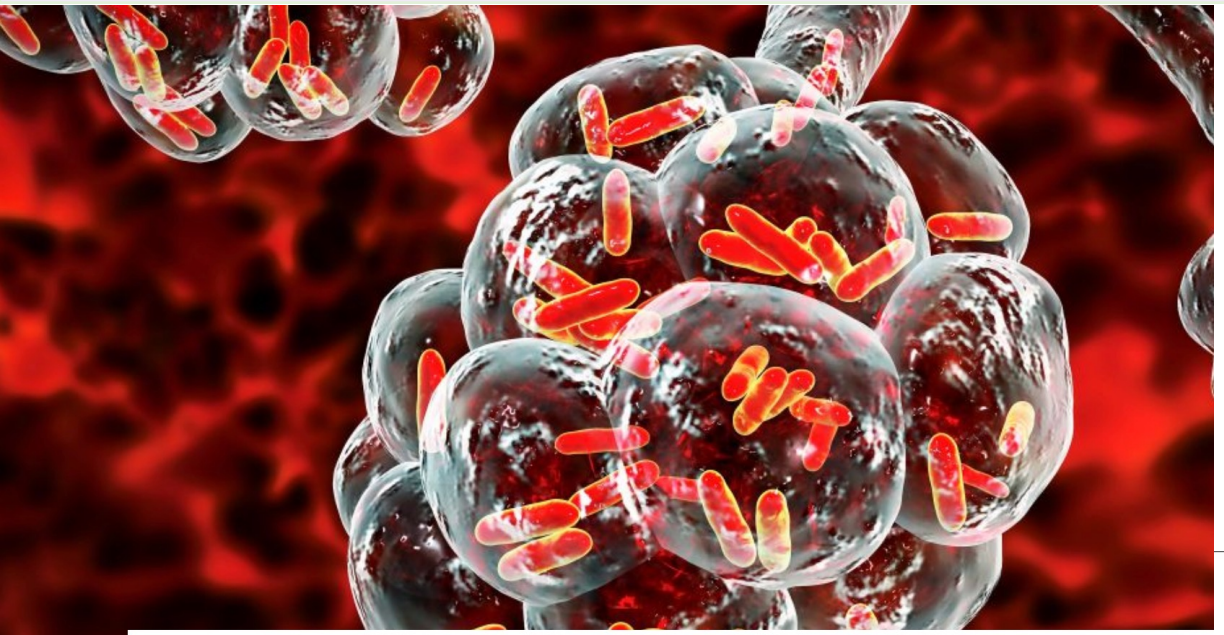


https://www.downloadtheuniverse.com/dtu/2013/03/a-comic-book-guide-to-rewiring-life.html

Design and synthesis of NEW biological systems



Evolution: still relevant?



Home 〉 News 〉 Study reveals new mechanism for rapid evolution of multi-drug resistant infections in patients

Study reveals new mechanism for rapid evolution of multi-drug resistant infections in patients

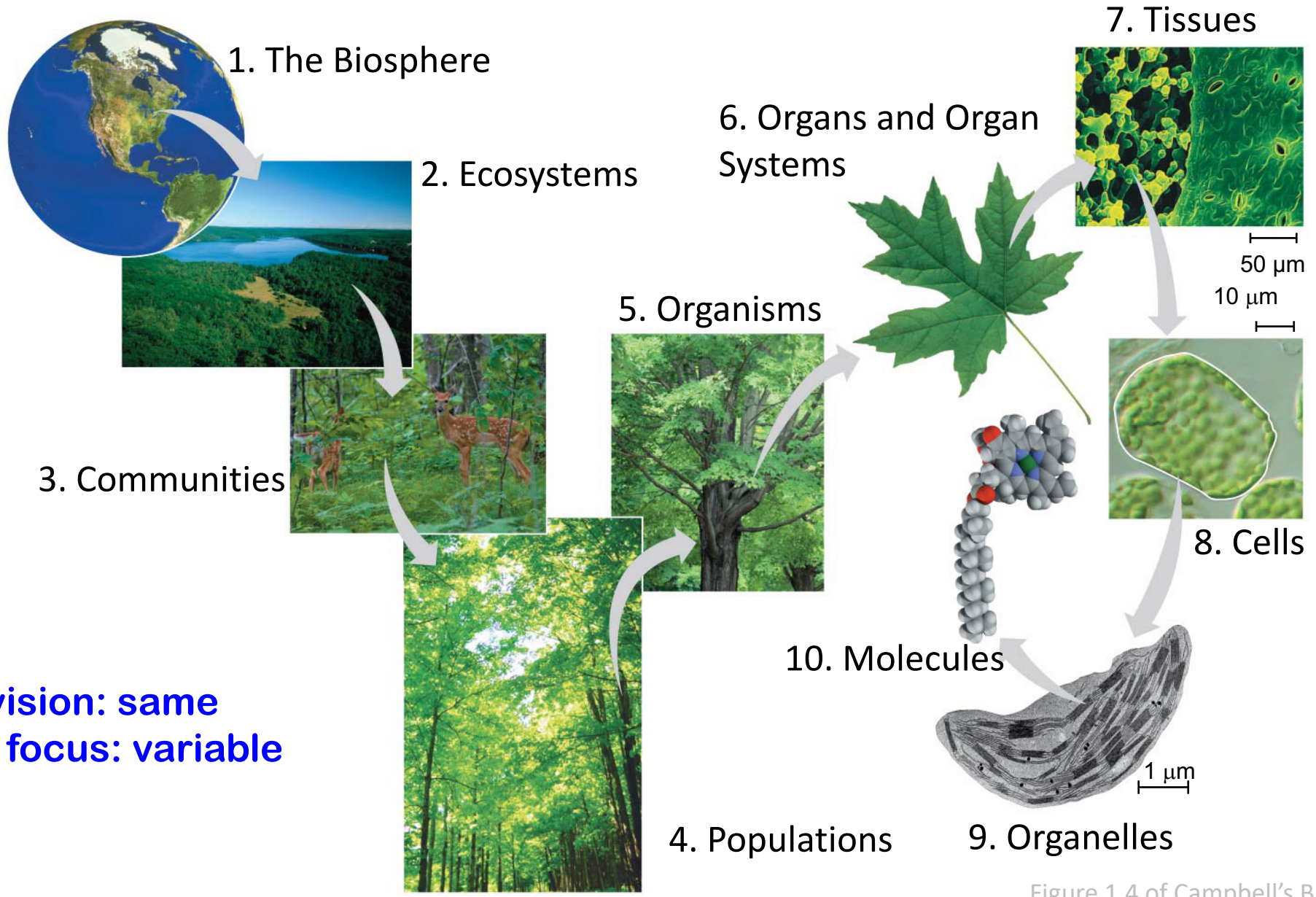
PUBLISHED
12 JUL 2023

https://i.ytimg.com/vi/Ts4b7B8mHL0/sddefault.jpg

Summary so far...

- Lack of awareness creates myths
  - Myths widely associated with Biology are just that: myths!
- Biology in the 21st century is critical for understanding / resolving issues
  - Directly affecting human beings
    - Healthcare and agriculture
  - Indirectly benefitting human beings
    - Sustainability, smart materials, space (= ISRO and such), …

Study of Biology



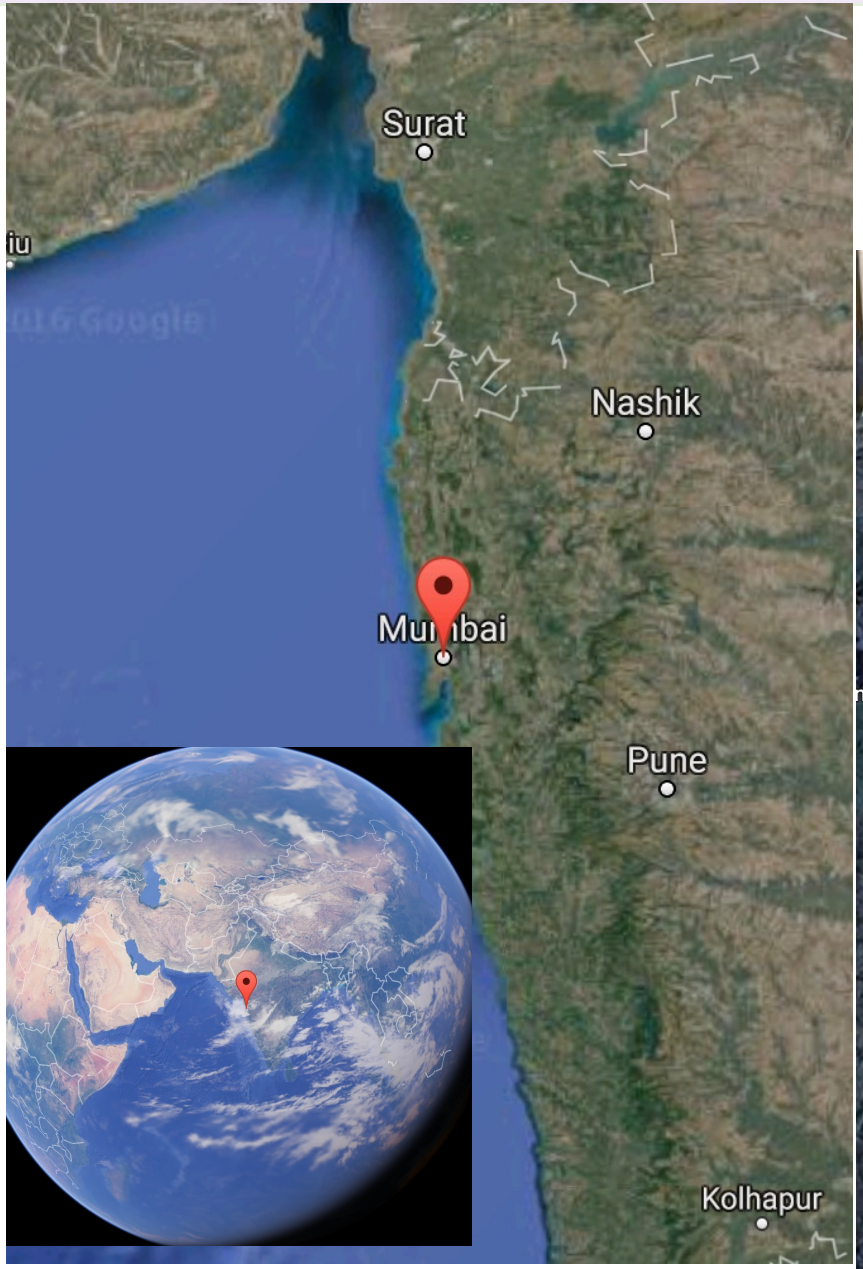
Field of vision: same
Depth of focus: variable

Figure 1.4 of Campbell's Biology: a global approach

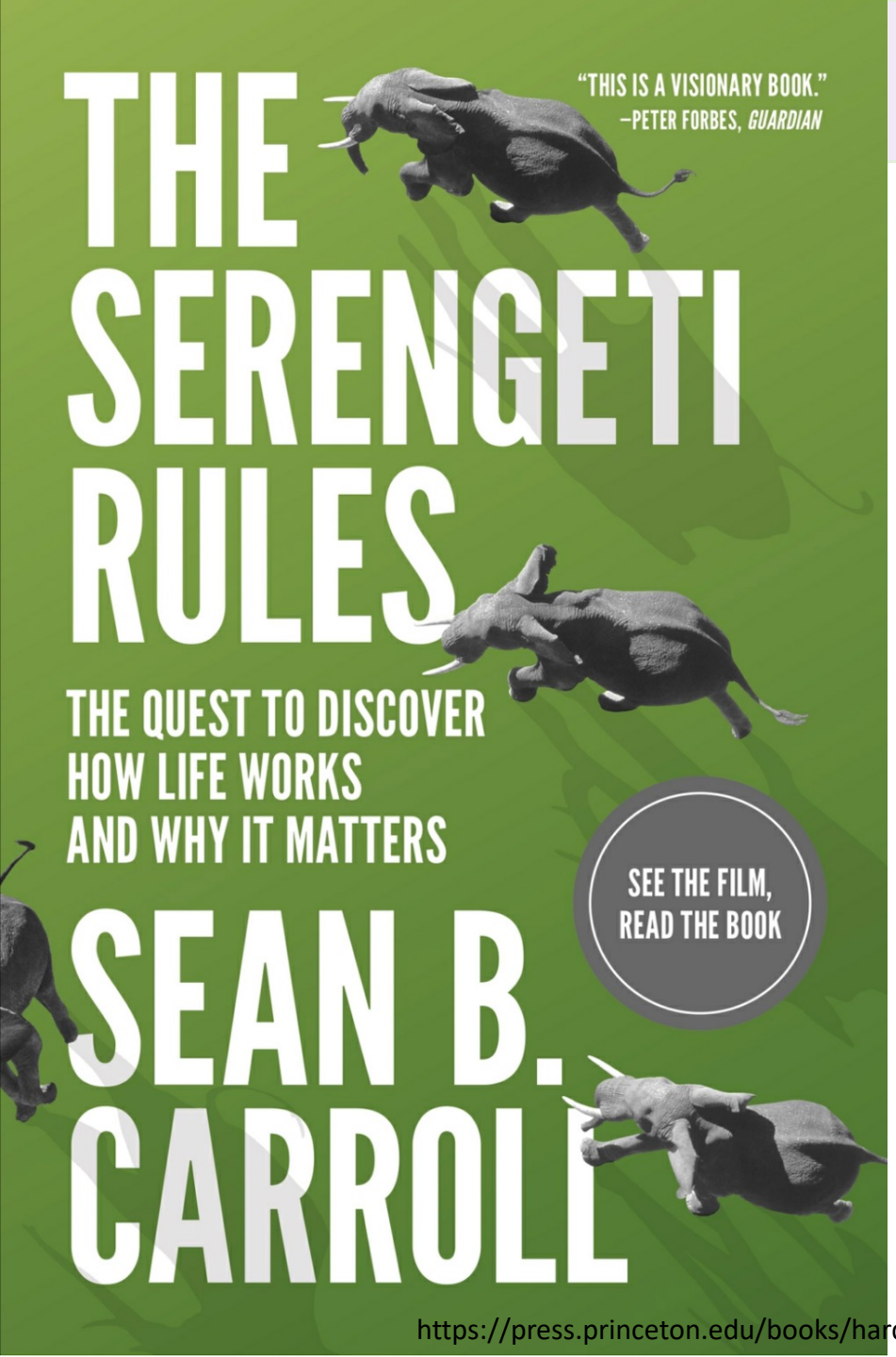
Field of vision, depth of focus

Video by Prof. Sudesh Balan, IDC School of Design, IIT Bombay

Zoom in or zoom out?



We zoom in or zoom out depending upon our needs



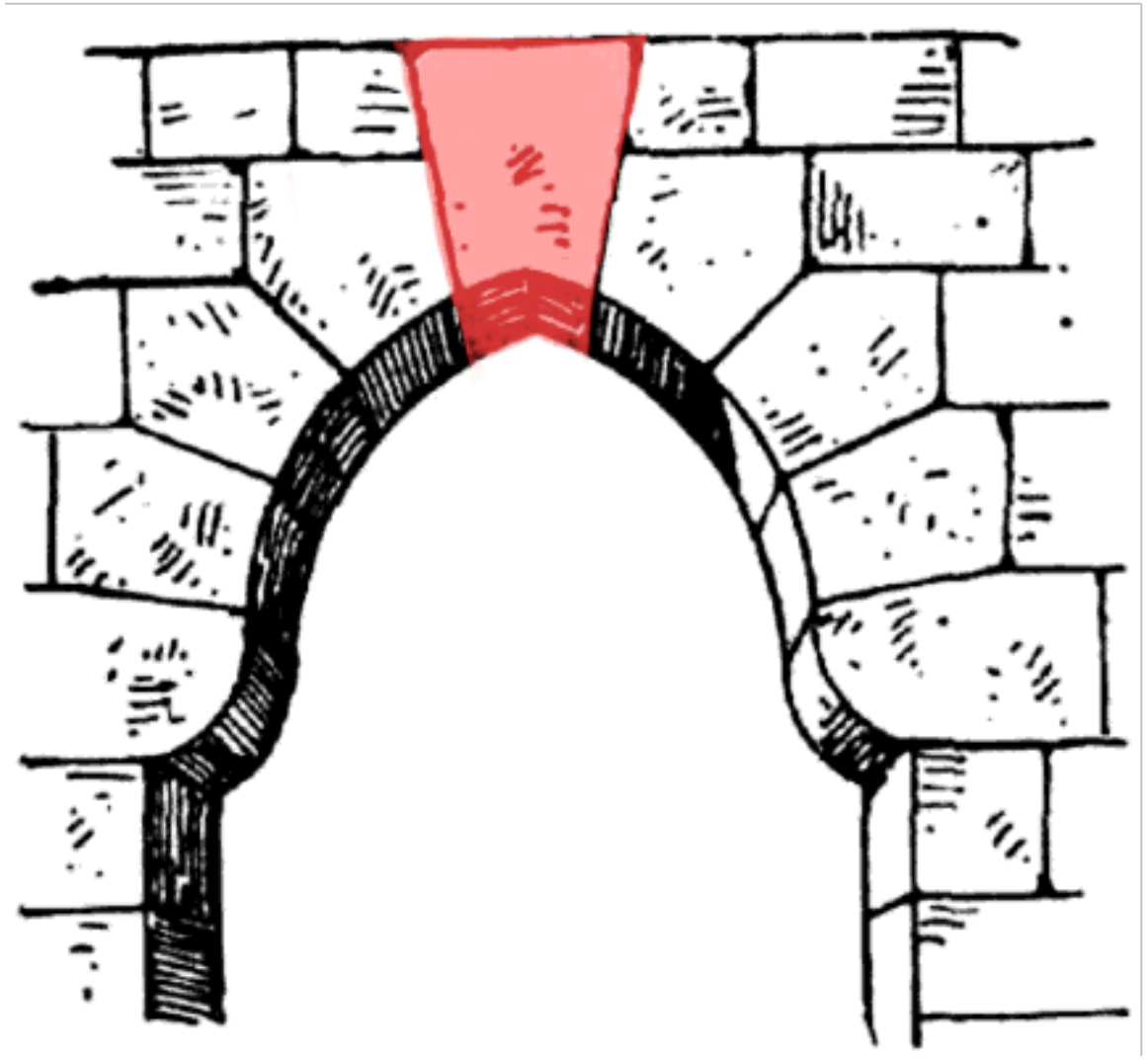
- Narrates how life works at vastly different scales
- Everything in the natural world is regulated
- Rules that regulate life at vastly different scales are remarkably similar
- A common underlying logic of life exists.

A documentary based on this book is available on YouTube.

https://press.princeton.edu/books/hardcover/9780691167428/the-serengeti-rules?srsltid=AfmBOorH5og_DsoO5cdzaPPIxrDlnRX6bUxQlkgyiD8OR_mWId9h41zk

Keystone in an arch

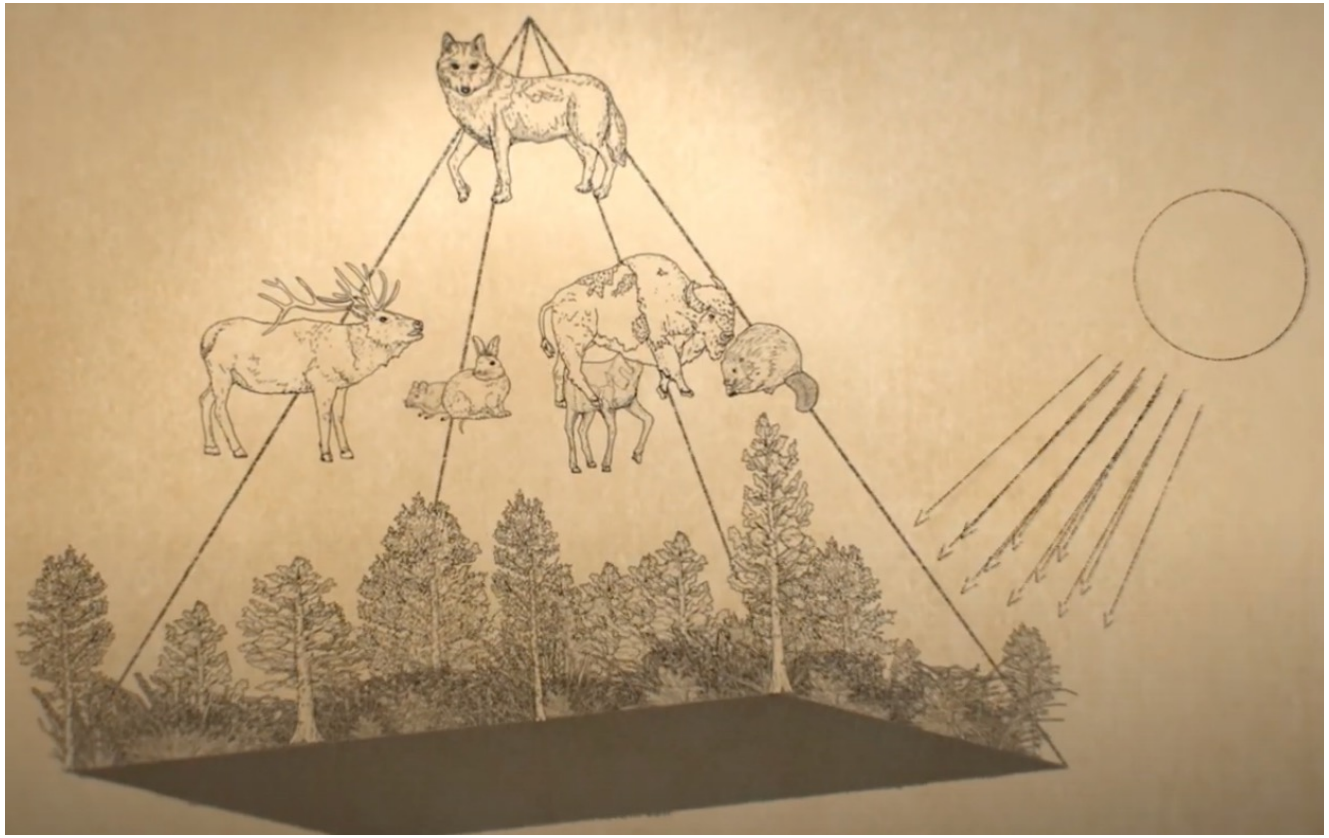
Most critical component for the stability of the arch

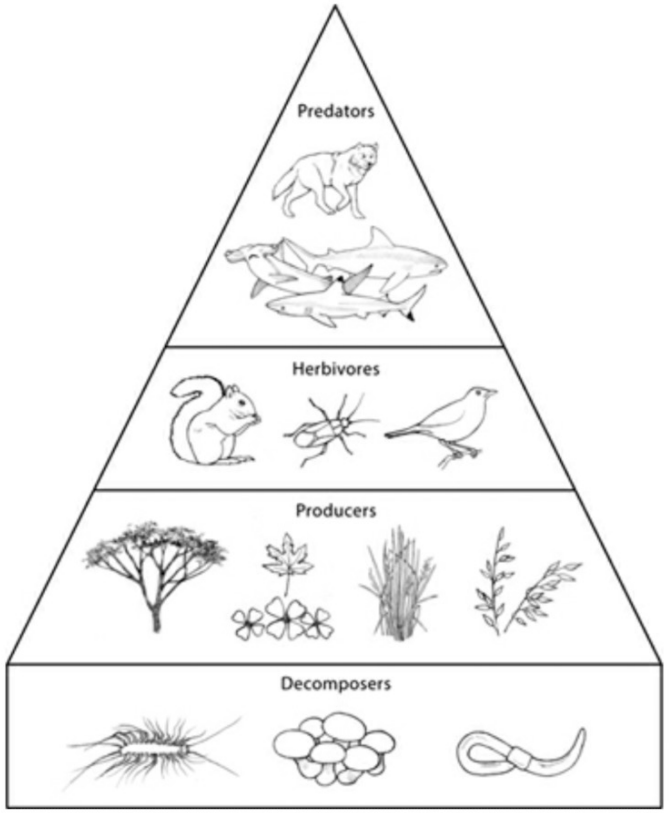


https://en.wikipedia.org/wiki/Keystone_(architecture)#

Keystone species in an ecosystem

- A species that can dramatically alter the ecosystem
- This species need not be an abundant species





Video grab from the documentary Serengeti Rules

Figure 6.2 in Serengeti Rules

Keystone species in an ecosystem

Keystone species belongs to which trophic level?

Keystone?

Keystone?

Keystone?

Keystone?

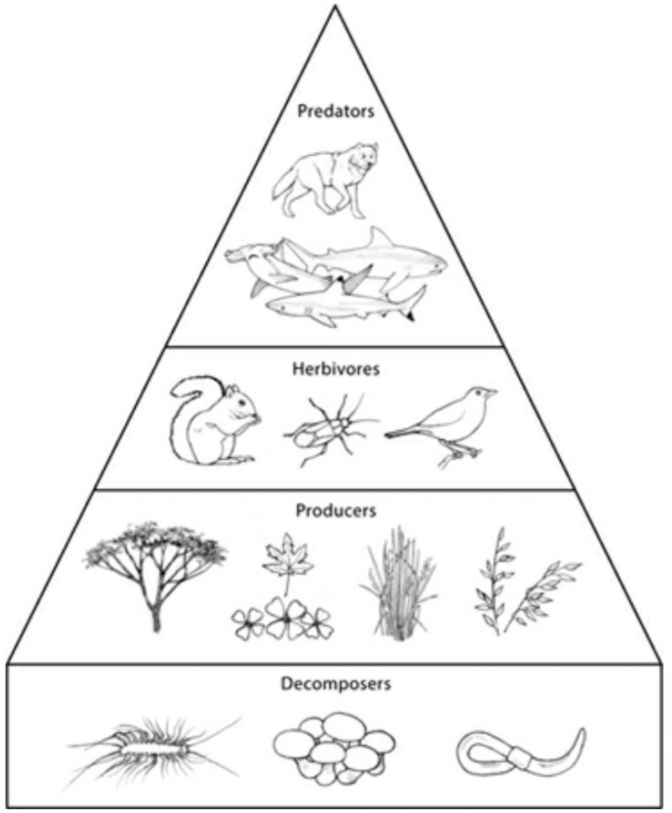
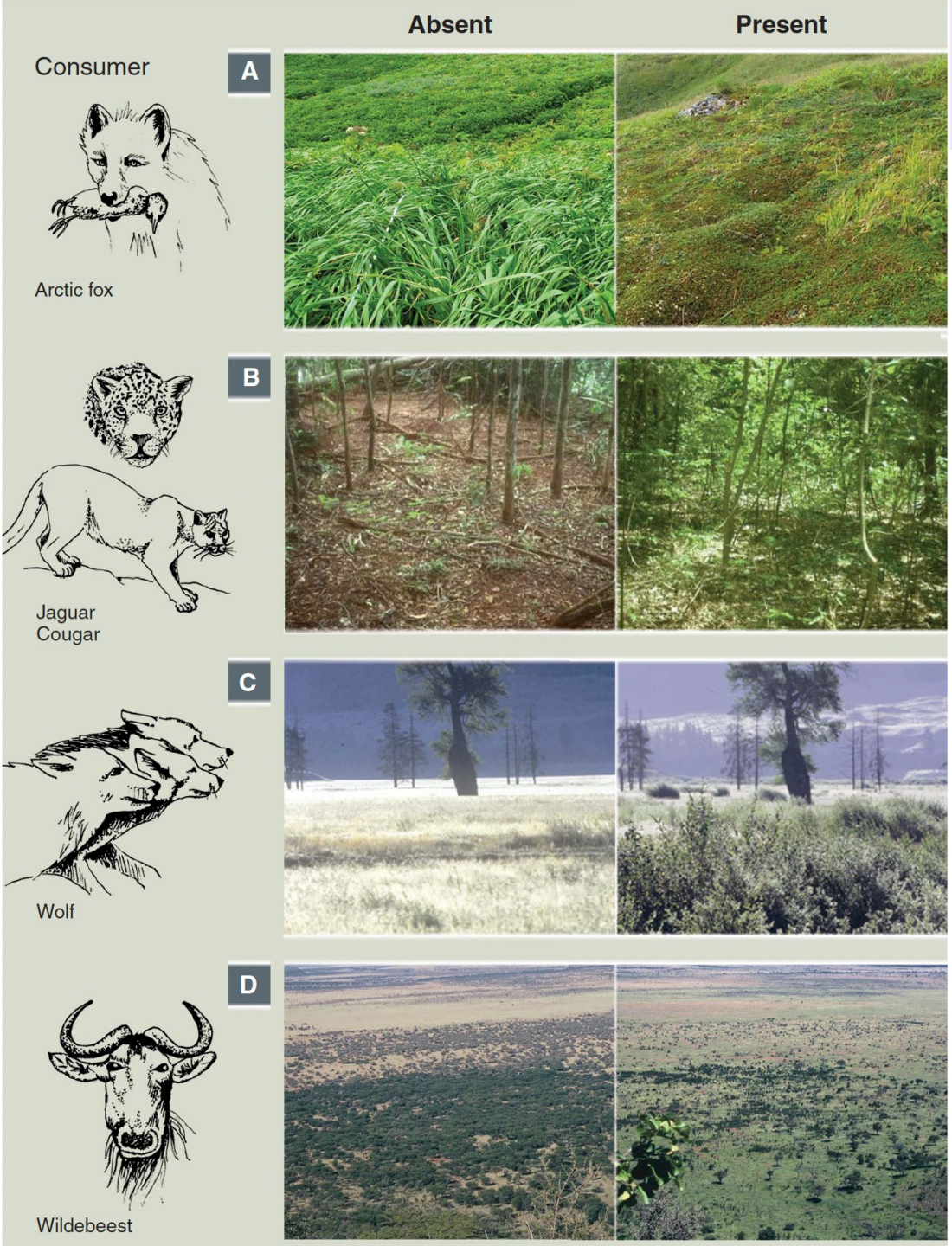


Figure 6.2 in Serengeti Rules

Landscape-level effects of trophic cascades



A. Arctic fox. Aleutian archipelago
B. Jaguar, cougar, harpy eagle. A Venezuelan island (Guri)
C. Wolf. Yellowstone national park.
D. Wildebeest. Serengeti

A. Foxes drive terrestrial ecosystems from grasslands to tundra by limiting seabirds and thereby reducing nutrient inputs from sea to land

B. A diverse herbivore guild erupted with the loss of predators from the island, thereby reducing plant recruitment and survival

C. Stature of willow plants during suppression (left, 1997) from long-term elk browsing and their release from elk browsing (right, 2001) after wolf reintroductions of 1995 and 1996.

D. Decline of woody vegetation in Serengeti after eradication of rinderpest (by early 1960s) and the recovery of native ungulates (by middle 1980s). Left, 1986; right, 2003.

Figure 2 of Science (2011) 333:301

Summary so far...

- Lack of awareness creates myths
- Biology in the 21st century is critical for understanding and resolving several issues that affect human beings
- Biology is studied at various scales of
  - size (area of a region, size of an organism, etc.),
    - Keystone organisms
  - time (nanoseconds to years to ...),
  - number (of atoms, organisms, etc.)

Biology in the 21st century

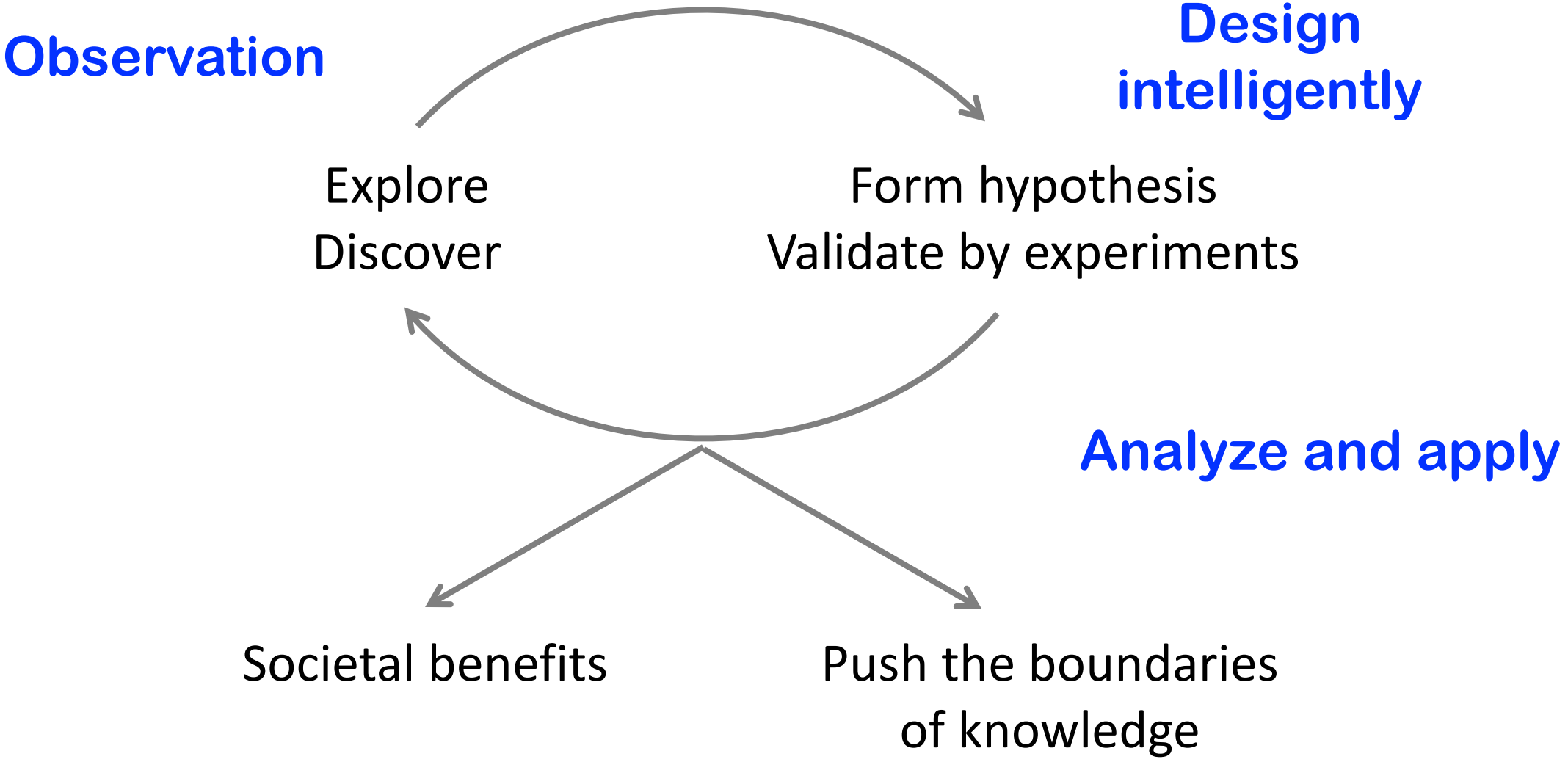
Our understanding of living systems has increased tremendously

From medieval times to the last couple of centuries...

And, now after a quarter of the 21st century, where are we...

- **Eradication of small pox**
- **Far higher yields of agriculture produce**
- **Far higher life expectancy**
- **…**

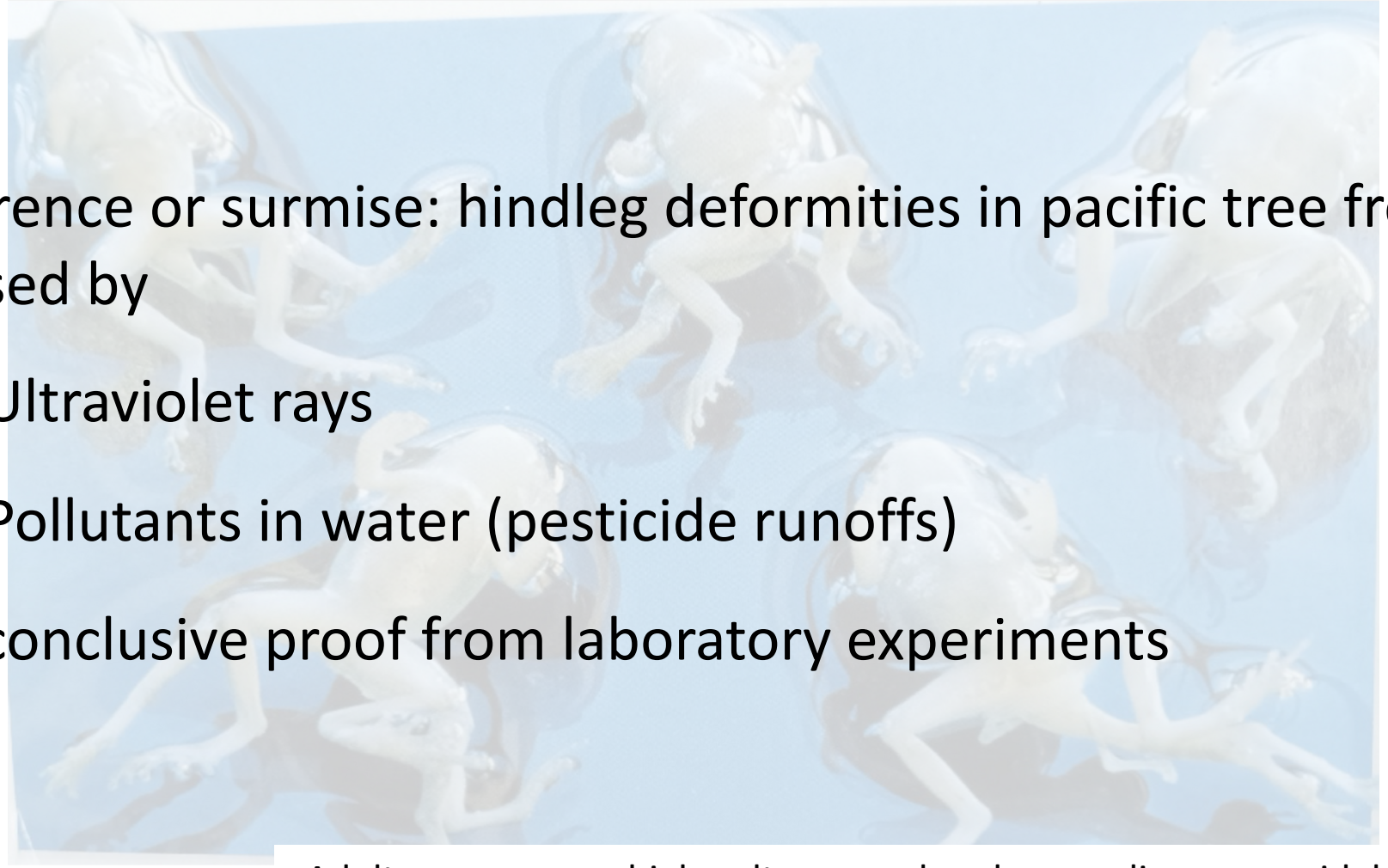
Current Biology



Pacific tree frogs: hindleg deformities

Life. The science of biology. 8th edition. By Sadava and others. Image from page 2

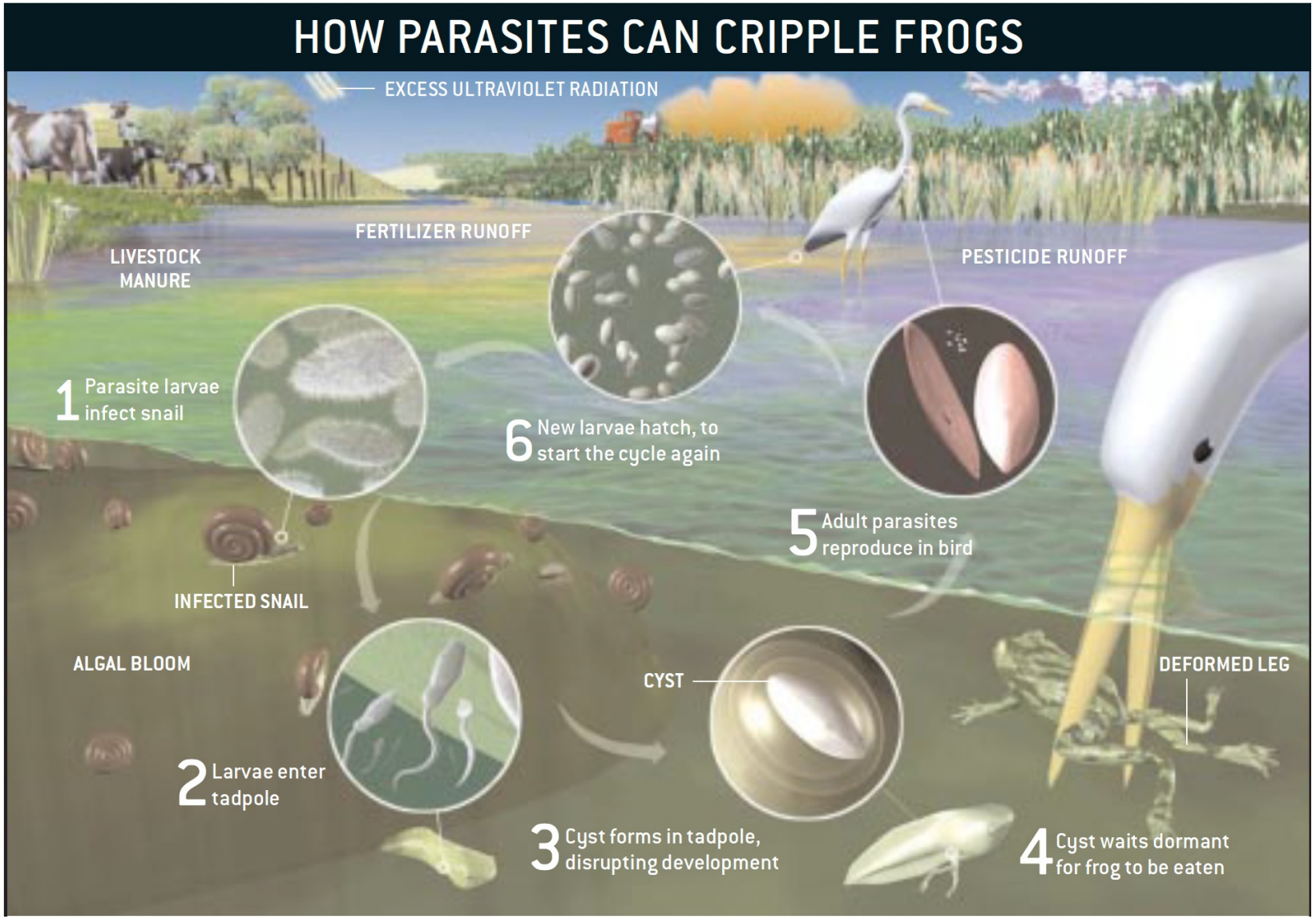
What is causing hindleg deformities?



- Inference or surmise: hindleg deformities in pacific tree frogs are caused by
  1. Ultraviolet rays
  2. Pollutants in water (pesticide runoffs)
- No conclusive proof from laboratory experiments

Adult cancers near high-voltage overhead power lines was widely reported in the media
No conclusive evidence.
1992 Eddie Murphy movie, The Distinguished Gentleman

Experiments with proper controls...



Scientific American (2003) 288:60

Study of Biology

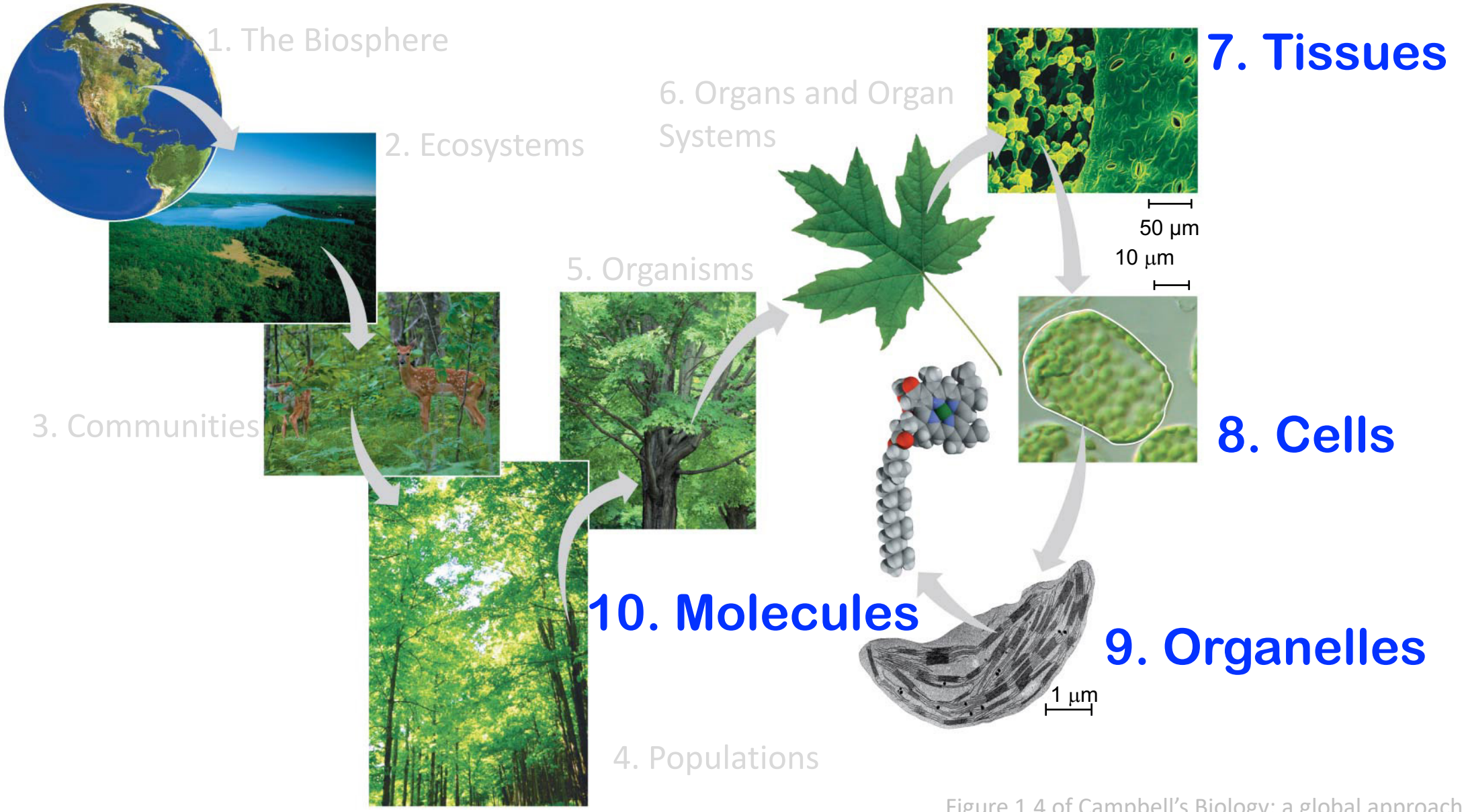


Figure 1.4 of Campbell's Biology: a global approach

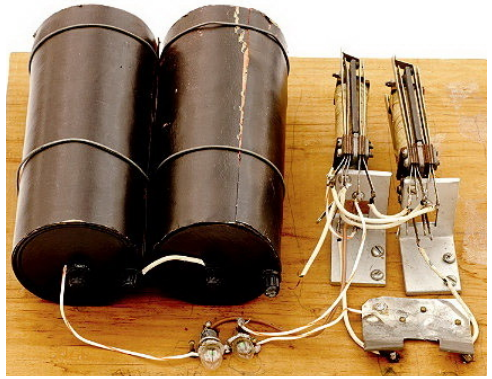
Summary so far...

- Lack of awareness creates myths
- Biology in the 21st century is critical for understanding and resolving several issues that affect human beings
- Biology is studied at various scales of size, time, and number
- Biology involves careful observation, design of experiments, and "connecting the dots" – critical for understanding natural phenomena

Engineering and reverse engineering

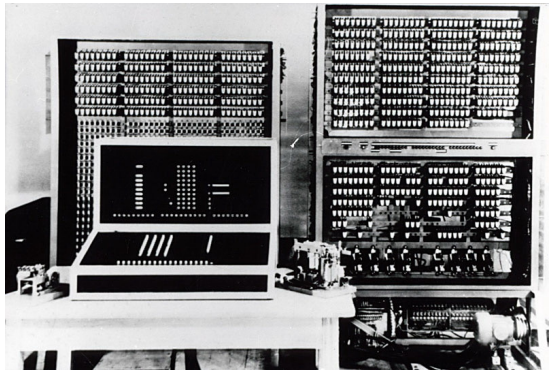
- Engineering : gradual (or incremental) increase in the complexity of a system
- Reverse engineering: Identify the components and how they work together

Engineering... man-made systems



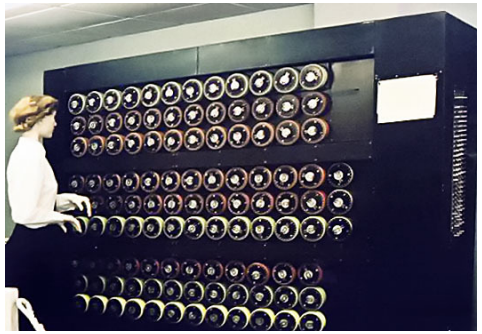
Model K adder

Hewlett-Packard

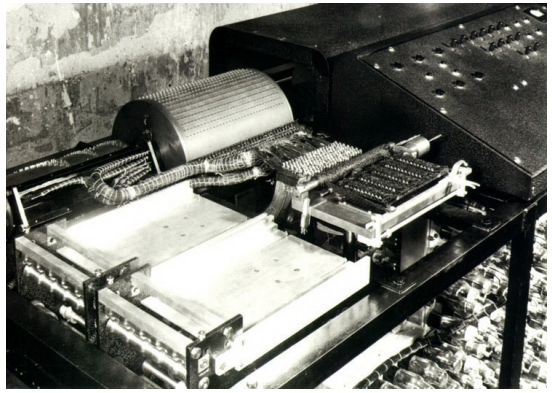


Z3

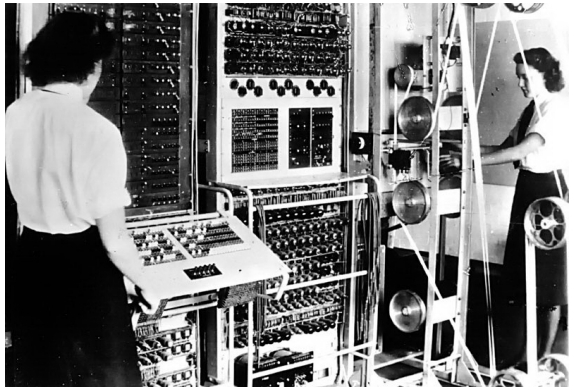
Complex number calculator



Bombe



A-B computer



Colossus

Harvard mark 1

All images are taken from http://www.computerhistory.org/timeline/computers/

Development is incremental + targeted

- Sustained intellectual inputs have led to incremental and gradual evolution
- Newer versions may or may not resemble earlier versions
  - neither in appearance
  - nor in the way they work internally
- With the development and arrival of newer models, old models are gradually phased out…
- Old models are scrapped
  - At best, a few are retained in museums as relics

Reverse engineering of organisms

- Mother Nature has given us end products (= organisms) of millions of years of evolution
- The components of these end products are invisible to naked eye. In fact, most organisms are themselves invisible

Organisms are “complex systems”

- All extant organisms have evolved from ancestor organisms
- Some ancestors have survived, others are extinct
- Each life form has evolved, and is evolving…, to adapt to changing environment
- Some of the ancestors still exist…
  In fact, co-exist with the “so-called” evolved organisms
- Funnily, often, both need each other for survival…

Reductionistic approach

- Top-down approach: break the system down
- Breaking down reduces the complexity of a system
- Components may be separately studied
- Build the system by bottom-up approach

https://www.wisdomtimes.com/wp-content/uploads/2012/04/destructive-behaviour.jpg

Biology in the 21st century

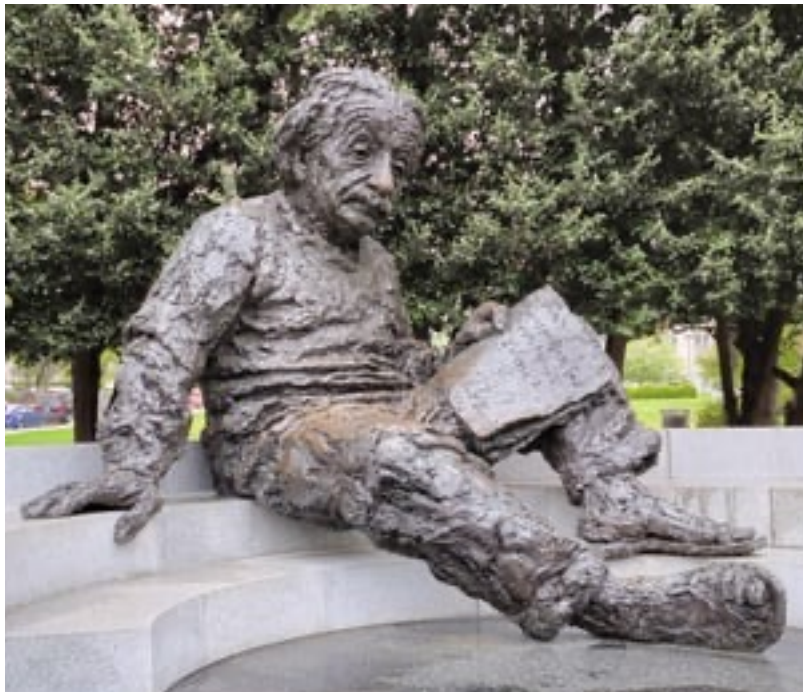
This slide is limited to aspects related to human health care

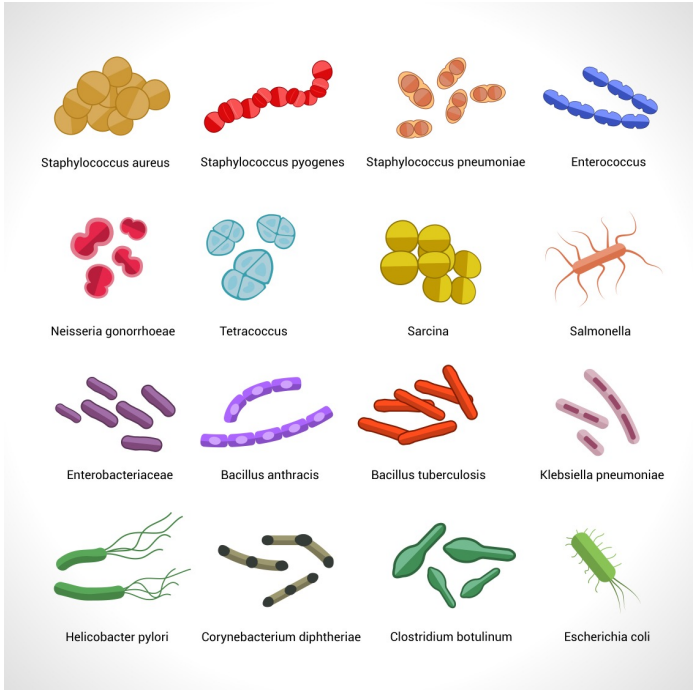
- Basis of many things that happen to us today
  - Cancer
  - Life style diseases (diabetes, heart attacks, hyper- and hypo-tension, ...
  - Addiction (drugs, pornography, social media, alcohol, ...
  - Pandemics (covid-19, ...)
- Biology is the future
  - Sustainable living and “quality” of life (especially in older age)
    - Personalized medicine, genetically modified crops, ...

Make informed decisions

Reverse engineering and re-engineering

For a better quality of life (self and surroundings)





https://www.freepik.com/free-photos-vectors/rice-saplings
https://www.freepik.com/free-vector/bacteria-icons-set_4665731.htm
https://www.reddit.com/r/washingtondc/comments/mspdyq/einstein_statue_outside_the_national_academy_of/

Summary

- Lack of awareness creates myths
- Biology in the 21st century is critical for understanding and resolving several issues that affect human beings
- Biology is studied at various scales of size and time
  - Size: area of a region, size of an organism, number
- Engineering and reverse engineering

END of Lecture slides

Instructors

Name	Division	LDAP id
Prof. Petety V. Balaji	D1	balaji
Prof. Rajesh Patkar	D3	rajeshpatkar

http://www.bio.iitb.ac.in/people/faculty

Lecture plan

Sl. No.	Major topic	No. of lectures
1	Introduction	1 lecture
2	About cells	3 lectures
3	DNA and genetic information	5 lectures
4	Proteins	3 lectures
5	Metabolism	2 lectures
6	Interactions in Biology	3 lectures
7	Big data in Biology	2 lectures
8	Applications	3 lectures

Lecture hours, venue

Division	Slot	Days of the week	Time	Venue
D1	5	Wednesday, Friday	11:05 am to 12:30 pm	LH 302
D3	6	Wednesday, Friday	11:05 am to 12:30 pm	LH 301

Tutorial hours, venue

Division	Slot	Day of the week	Time	Venue
D1	3C	Thursday	8:30 to 9:25 am	LT 001 LT 002 LT 003 LT 004 LT 005 LT 006
D3	3A	Monday	10:35 to 11:30 am	LT 001 LT 002 LT 003 LT 004 LT 005

Tutorial batches for BB 101 are NOT the same as those for other courses

Evaluation scheme

What	Weightage towards grading
Quiz at the end of every tutorial Will cover lecture(s) of the previous week	40%
Mid-semester exam (covers all lectures up to the mid-sem)	30%
End-semester exam (covers all lectures after mid-sem)	30%

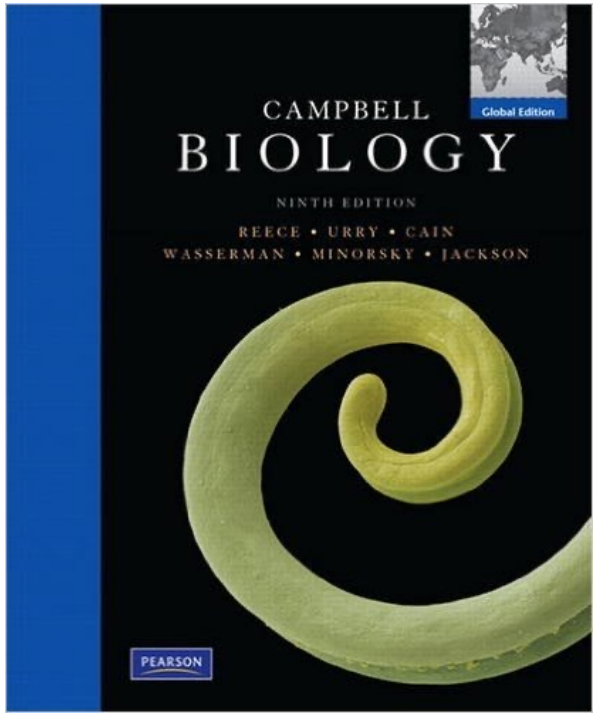
1-page handwritten cheat sheet is allowed for mid-sem and end-sem exams

Grading scheme

Range of marks	Grade
91 to 100	AA
81 to 90	AB
71 to 80	BB
61 to 70	BC
51 to 60	CC
41 to 50	CD
30 to 40	DD
<30	FR

- Grade AP is awarded to students whose performance is exceptional
- AP is treated on par with AA for SPI/CPI calculations
- AP is awarded to only 2% of the registered students

Primary reference book



Excerpts from selected chapters

Campbell Biology, 9th (or more recent) edition

by Reece, Urry, Cain, Wasserman, Minorsky, Jackson

We will use material / information from other sources also
Will give source of information in respective slides

Lecture slides on Moodle

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- Course enrollments are usually synced every hour. Please wait for your course to appear on Moodle.
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  1. Year 2020-2022
  2. Year 2015-2019 (requires VPN for outside IITB connection)
- For all Moodle related issues, kindly send an e-mail to moodle [dot] help [at] iitb [dot] ac [dot] in with roll number / employee code.

No tutorial on 31st July