

LSM1301 GENERAL BIOLOGY

Looking at the macro- and
micro- aspects of life

Dr. Nalini Puniamoorthy

S3 level 4

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Course introduction

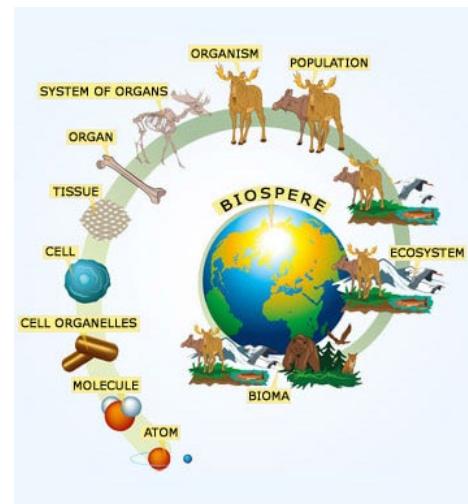
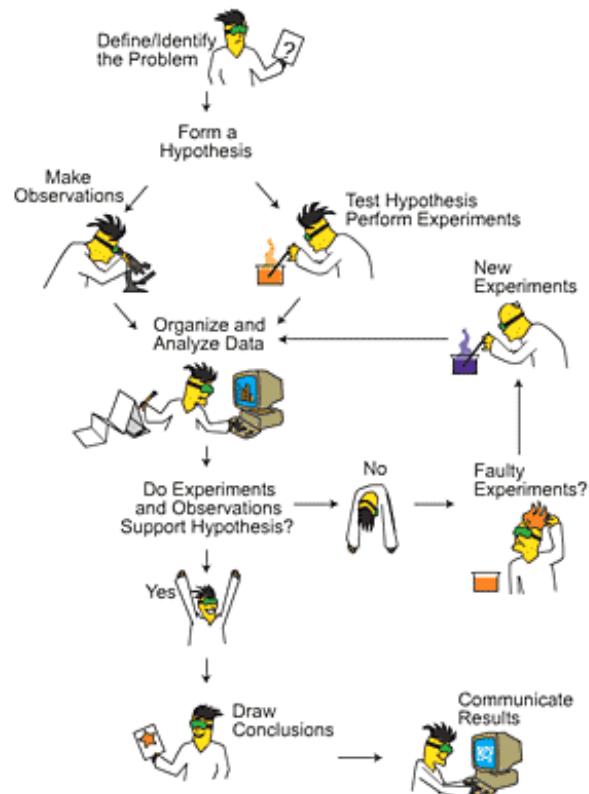
1. Course Management

- Contents
- Schedule
- Learning objectives
- Grading and policies
- Rules & Regulations
- Blended Learning



2. Overview of Science of Biology

- What is life?
- What is the scientific method?
- How we study life?



Course contents

Organismal biology

➤ Dr. Nalini Puniamoorthy

Cell and molecular biology

➤ Dr. Maxine Mowe

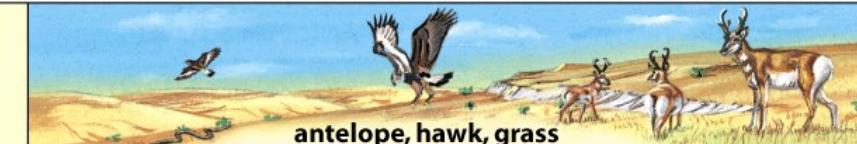
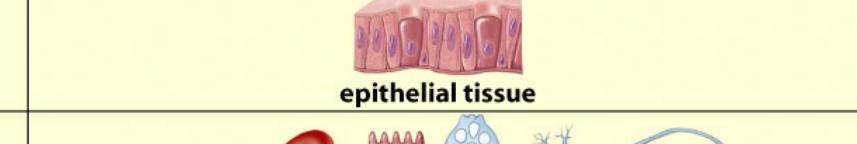
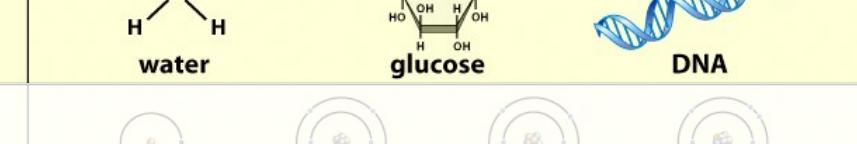
Community	Two or more populations of different species living and interacting in the same area	 antelope, hawk, grass
Population	Members of one species inhabiting the same area	 herd of pronghorn antelope
Multicellular Organism	An individual living thing composed of many cells	 pronghorn antelope
Organ System	Two or more organs working together in the execution of a specific bodily function	 the digestive system
Organ	A structure usually composed of several tissue types that form a functional unit	 the stomach
Tissue	A group of similar cells that perform a specific function	 epithelial tissue
Cell	The smallest unit of life	 red blood cells epithelial cells nerve cell
Molecule	A combination of atoms	 water glucose DNA
Atom	The smallest particle of an element that retains the properties of that element	 hydrogen carbon nitrogen oxygen

Figure 1-1 Biology: Life on Earth, 8/e

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Course schedule

Organismal biology

➤ Week 1-6

Cell and molecular biology

➤ Week 7-13

LSM1301 - GENERAL BIOLOGY

Module Coordinator: Dr Nalini Puniamoorthy

Email: nalini@nus.edu.sg; Tel: 6516-2852

Updated 7 Dec 2021

Lecture:	Tuesday (e-learning)	Practical:	Thursday (in-person practical)
Time:	1000 – 1200 hr	Time:	1000 – 1200 hr; 1200 – 1400 hr; 1400 – 1600 hr; 1600 – 1800 hr
		Venue:	LS Lab 3 @S1A Level 4

Wk	Month	Lecture	Tutorial/Practical
		Tuesday	Thursday
1	Jan	11 Science of Biology (NP)	13 *No Lab / No Tutorial
2		18 Evolution (NP)	20 Lizard Tales (online tutorial) (NP)
3		25 Biodiversity (NP)	27 Primate Skulls (NP) - F2F practical
4	Feb	01 CNY (Public Holiday)	03 **Plant Form and Function (NP)
5		08 Animal Form and Function (NP)	10 Plant Reproduction practical (NP) - F2F practical
6		15 Ecology (NP)	17 Museum Visit (self-conducted)
Recess Week: Sat, 19 Feb – Sun, 27 Feb 2022 (1 week)			
7	Mar	01 E-Exam (NP)	03 ***Chemistry of Life (MM)
8		08 Cell Structure and Function (MM)	10 Macromolecules and food (MM) - F2F practical
9		15 Energy of Life (MM)	17 Living cells (MM) - F2F practical
10		22 DNA and Heredity (MM)	24 Energy release (MM) - F2F practical
11		29 Gene Expression (MM)	31 Molecular Biology (MM) - F2F practical
12	Apr	05 Biotechnology (MM)	07 Tutorial (Online Review) (MM)
13		12 E-Exam (MM)	14 No Lab / No Tutorial
Reading Week: Sat, 16 Apr – Fri, 22 Apr 2022 (1 week)			
No Final Exam			
Vacation: Sun, 8 May – Sun, 31 July 2022 (12 weeks)			

* Watch supplementary videos on LumiNUS

** Watch recorded lecture on LumiNUS

*** Watch recorded lecture on LumiNUS

Learning objectives

Organismal biology

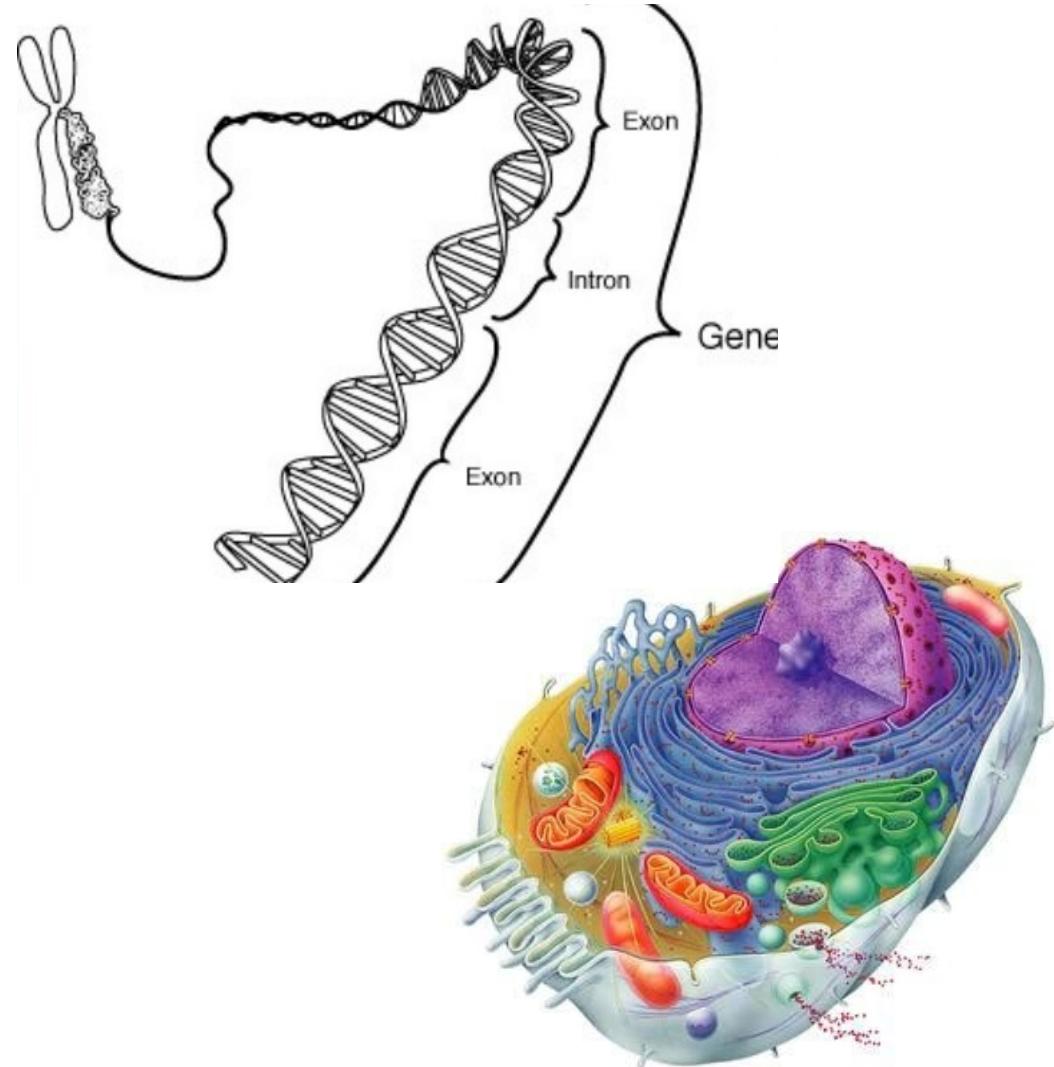
- What are biological species?
- How do populations and species evolve?
- How are different organisms classified?
- How do species interact with the environment and each other?



Learning objectives

Cell and molecular biology

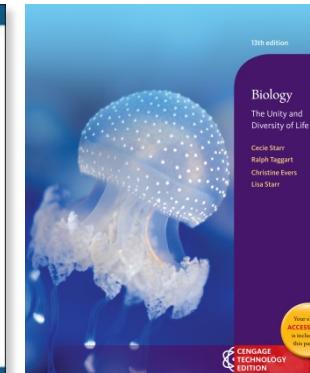
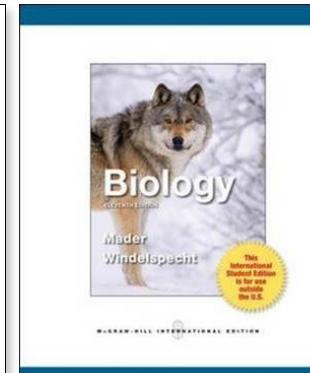
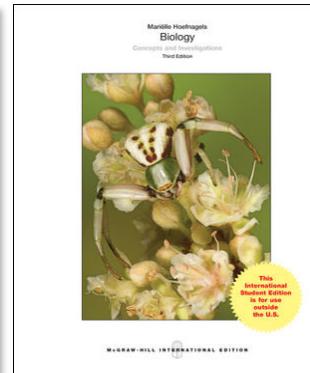
- What are the chemical building blocks of life?
- What is the structure and function of cells?
- How is genetic information transmitted and expressed in living organism?
- How does biotechnology impact our lives?



Course material

Stay informed of the latest changes from LumiNUS announcement, updated module details and FAQ.

- Lecture Notes
- Multimedia (animations, videos on LumiNUS)
- Online-Lectures/Videos (from websites)
- Assignments
- Quizzes (Examplify, LumiNUS)



Recommended Text Books/References

Grading and policies

100% CA

- Lab assignments	40%
- Online tutorial	5%
- Museum visit	5%
- Two E-exams	50%

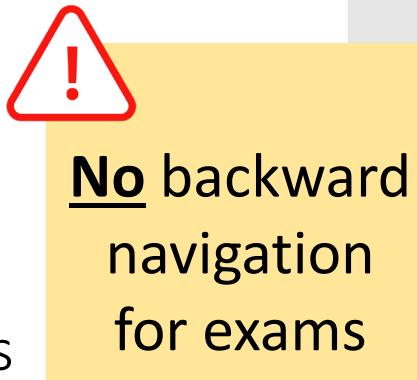
✓ Open book assessments

✓ No rote memory

✓ Non-graded post-class quizzes

To Note:

- A. Previous exam questions are not released.
However, we will provide non-graded questions on LumiNUS for practice.
- B. No marks are deducted for incorrect answers (no penalty marking) in the exams.
- C. Students are not allowed to use the internet during the e-exams.
 - E-exam 1 will be held on **01st March 2022** during the 10am to 12pm lecture slot. E-exam 2 will be held on **12th April 2022** during the lecture slot.
 - There will **mandatory ZOOM proctoring** during these exams for students to clarify any questions/queries.



Lab assignments

- **Organismal biology**

Lab 1 Primate skulls

Lab 2 Reproduction in flowering plants

- **Cell and molecular biology**

Lab 3 Macromolecules and food

Lab 4 Living cells

Lab 5 Energy release

Lab 6 DNA Extraction, PCR and electrophoresis

F2F practical sessions will involve **safe-distancing** protocols.

Read through **FAQ section** in **LumiNUS** carefully



All students **must** register green pass via **uNivUS** app

Two Points For A Meaningful Learning Experience

– NUS Honour Code*

1. Honesty in academic communication

In academia, we pursue truth and knowledge founded on trust that the work is one's own and is accurate, reproducible, and truthful. This trust and the reputation of the individual and NUS are destroyed by dishonest behaviour.



- **Fabrication** – making up data or information (lying)
synthesizing or creating data for unperformed experiments,
constructing graphs and figures unsupported by data or information
- **Falsification** – deliberately manipulating or altering data or
academic/professional credentials (cheating), doctoring photos and graphs,
altering data in tables, using data from one experiment for a different experiment

*<http://www.nus.edu.sg/registrar/adminpolicy/acceptance.html#NUSCodeofStudentConduct>

Two Points For A Meaningful Learning Experience

– NUS Honour Code

1. Honesty in academic communication

- **Plagiarism** – submission of ideas, phrases, paragraphs or figures of **others'** as your own (stealing)
 - “**Others**” includes books, journals, internet sources and classmates – they must be acknowledged
 - reusing your own work without attribution
 - The university considers plagiarism an offence and will subject students to disciplinary action
- What is plagiarism and how to avoid it?
 - Short note
 - <http://www.cdtl.nus.edu.sg/success/sl7.htm>
 - E-tutorials on plagiarism
 - <http://emodule.nus.edu.sg/ac>
 - <https://connect.le.ac.uk/p72155629/>



**Applies to ALL LSM1301
CA components:
Lab assignments,
museum visit, online
tutorial, e-exams**

E.g.: Online assignments/ practical reports

Turn-it-in

- Whole paragraphs/long sentences highlighted as **identical** to previous semester reports.
- **Word-for-word** from museum exhibit description, Wikipedia or Encyclopedia Britannica.
 - Need to cite the appropriate sources and give credit.
- Several instances of same sentence structure, including incorrect answer.
- **50% penalty** if observed in one answer. **Zero** if observed in multiple answers.

Excluding single word/species answers

Two Points For A Meaningful Learning Experience

– NUS Honour Code

2. Respecting the rights of others

Not infringing the learning process of fellow students

- **Distractions**, e.g. talking, mobile phone browsing, arriving late
- Uncooperative or failure to listen to others during **group lab work**
- Improper **attire** for field/lab work – resulting in others having to work alone
- Allowing one's work to be **copied** – depriving others opportunity to learn

All assessment should be completed individually.

Applies to ALL LSM1301 CA components: Lab assignments, museum visit, online tutorial, e-exams

Blending learning

Mixed-mode of instruction

1. Exposure to course content prior to class
 - Pre-class videos help students prepare for pertinent topics
2. Synchronous content delivery via Zoom & F2F practical sessions
 - In-lecture activities help student access comprehension via PollEverywhere quizzes and real-time Q&As (PollEv.com/lsm1301)
3. Asynchronous non-graded assessment and interaction
 - Post-lecture quizzes (non-graded) and forum discussions help student apply and test their understanding of content

What is life?



How do we know what is alive or not alive?

Life is intangible and defies simple definition.

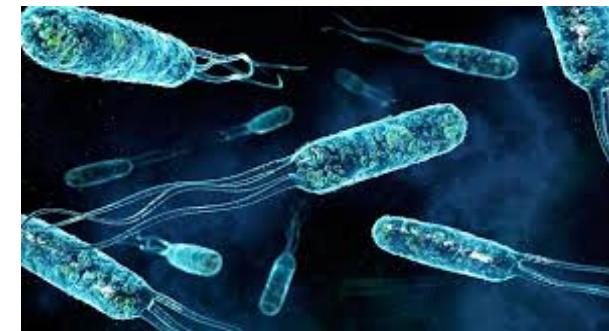
Living things are extraordinary and our quest to define life is one of the most fundamental questions in biology.

The cell is the basic unit of life

Every organism, or living individual, consists of one or more cells.

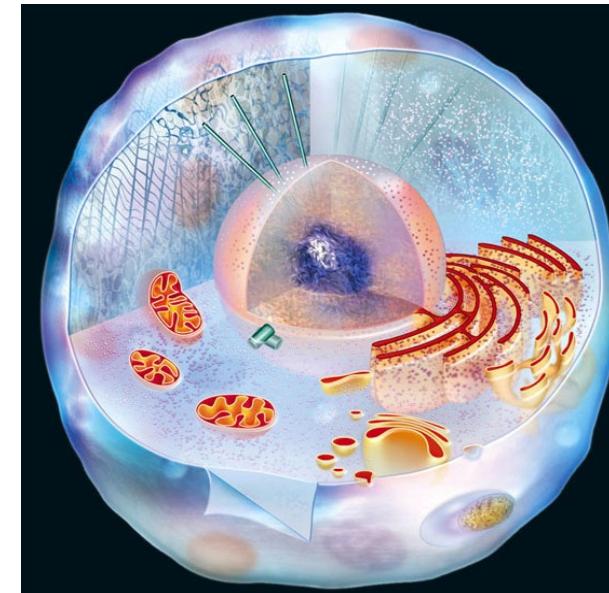
Basic structure of a cell

- Is surrounded by plasma membrane
- Has elaborate internal structure
- Contains hereditary material DNA



Two cell types

- Prokaryotic (“before nucleus” in Greek)
- Eukaryotic (“true nucleus” in Greek)



The Characteristics of Life

All living things share certain characteristics that, taken together, define life:

1. Organisms acquire and use materials and energy.
2. Organisms actively maintain organized complexity.
3. Organisms sense and respond to stimuli.
4. Organisms grow and develop
5. Organisms reproduce.
6. Organisms, collectively, evolve.

Nonliving objects may possess some of these attributes, but only living things can do them all.

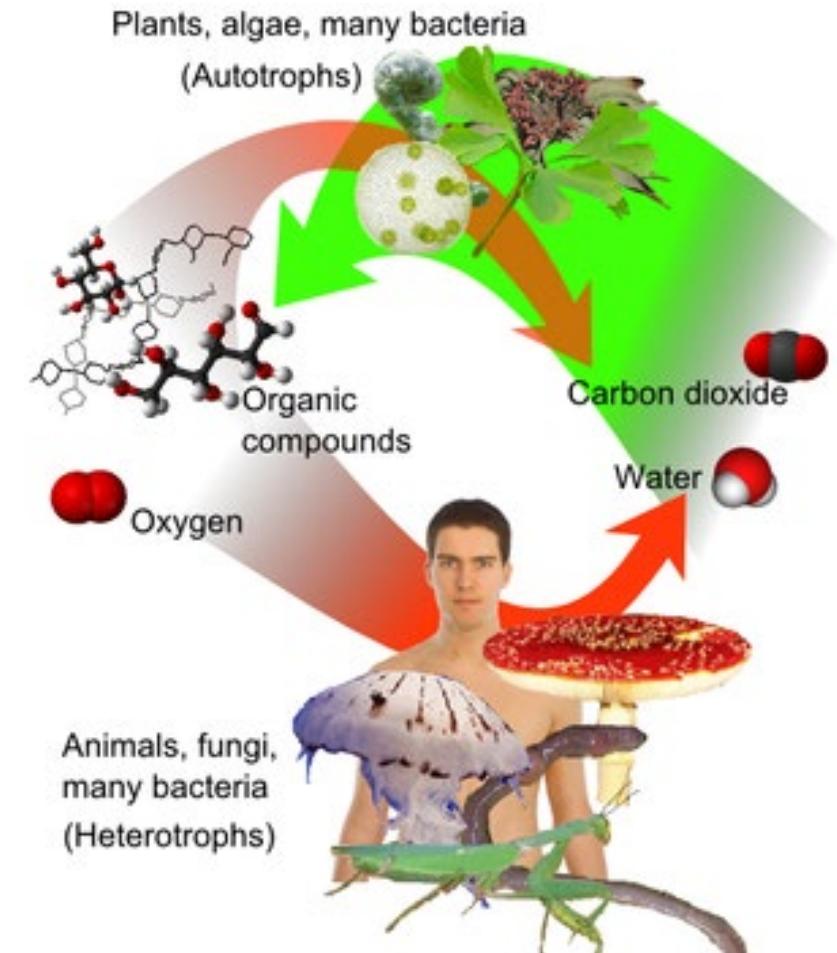
1. Acquire and use materials and energy

Autotrophs

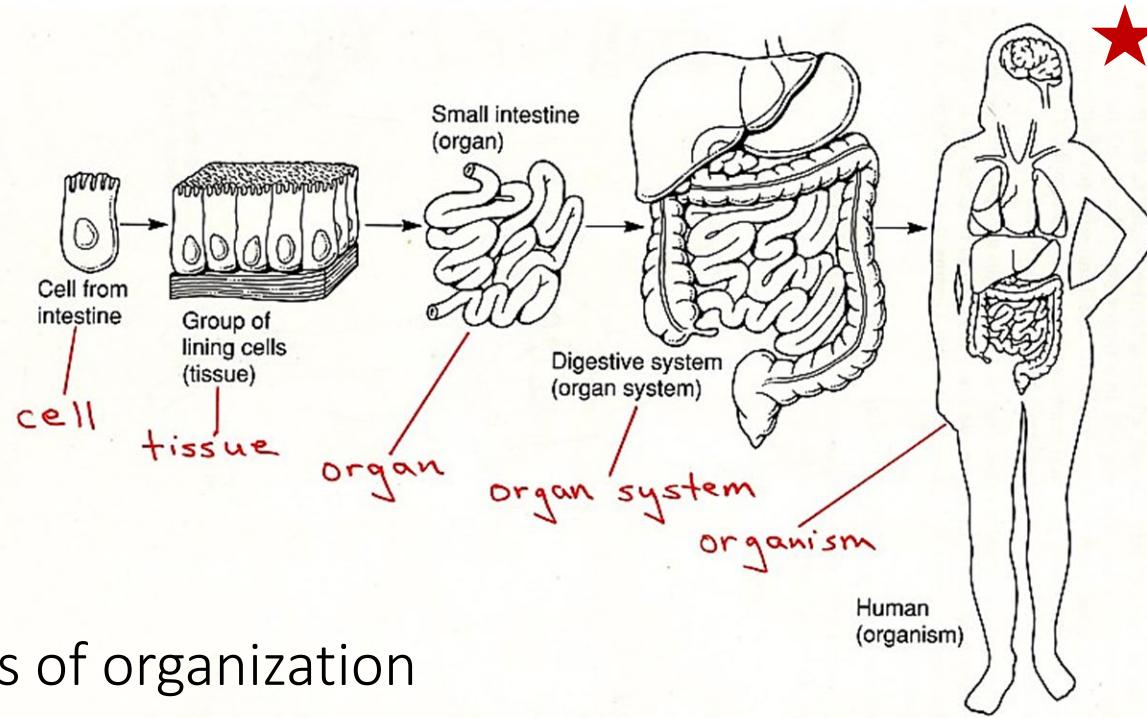
- autos = self; trophe = nutrition
- Self-feeders, producers
- Plants capture light energy to make food
→ photosynthesis

Heterotrophs

- heterone = (an)other
- Other-feeders, consumers
- Most other organisms acquire energy found in molecules of other organisms



2. Maintain organised Complexity



- Different levels of organization
- Living things are more than the sum of their parts;
- The complexity and ordered interactions of parts give rise to new properties (emergent properties)

3. Sense and respond to stimuli

Organisms sense changes in their environments and make responses to changes

- Changes in internal environment
Temperature, water level, blood sugar level, etc.
- Changes in external environment
Food and water, bitterness, light, sound, etc.

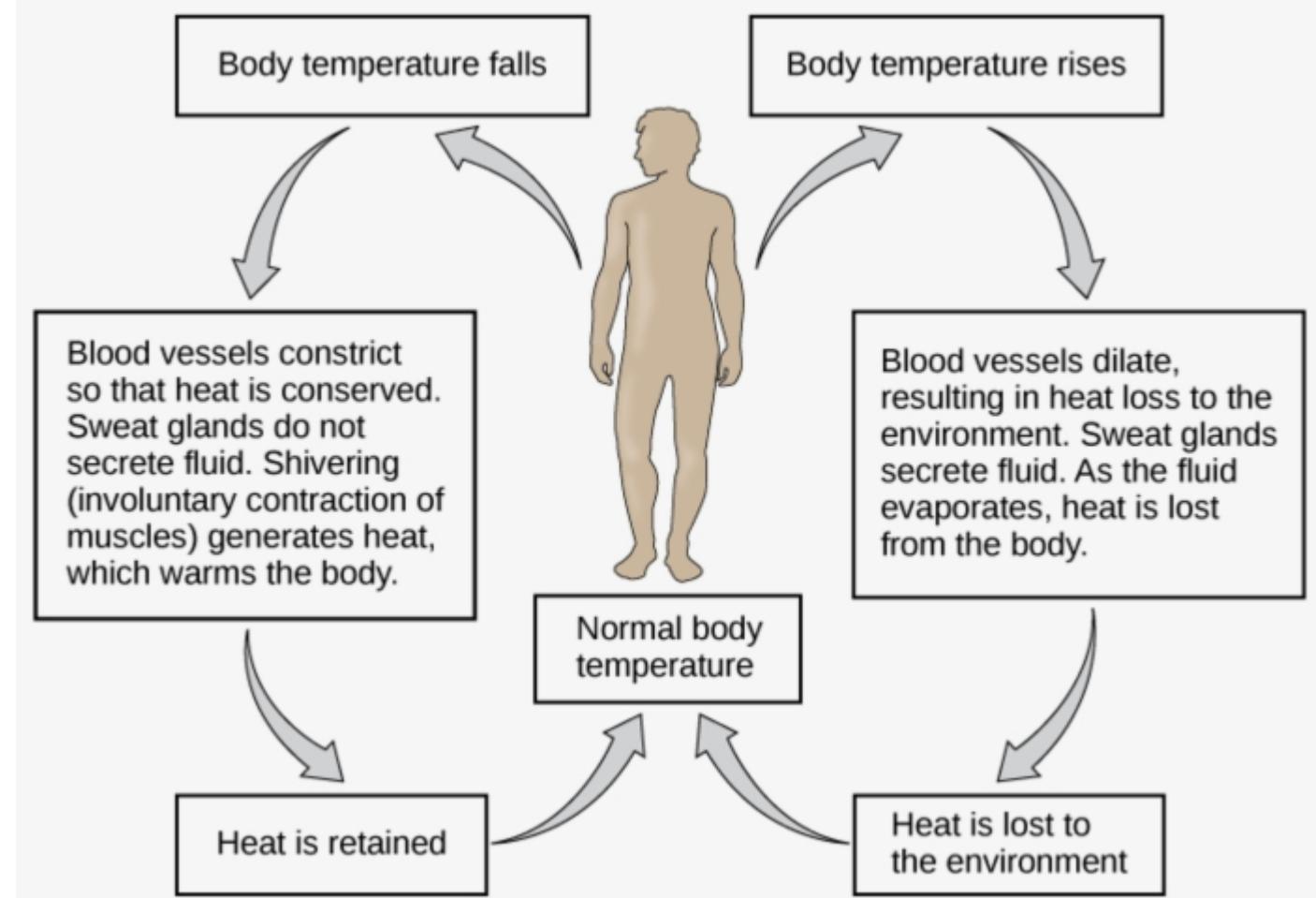
3. Sense and respond to stimuli

- To maintain relatively constant internal conditions
 - Homeostasis (“*to stay the same*” in Greek)
 - Animals regulate temperature, thirst, hunger, sperm production
 - Plants regulate direction of growth (towards light source)
- To grow and change while maintaining homeostasis

Homeostasis

(e.g. maintain body temperature)

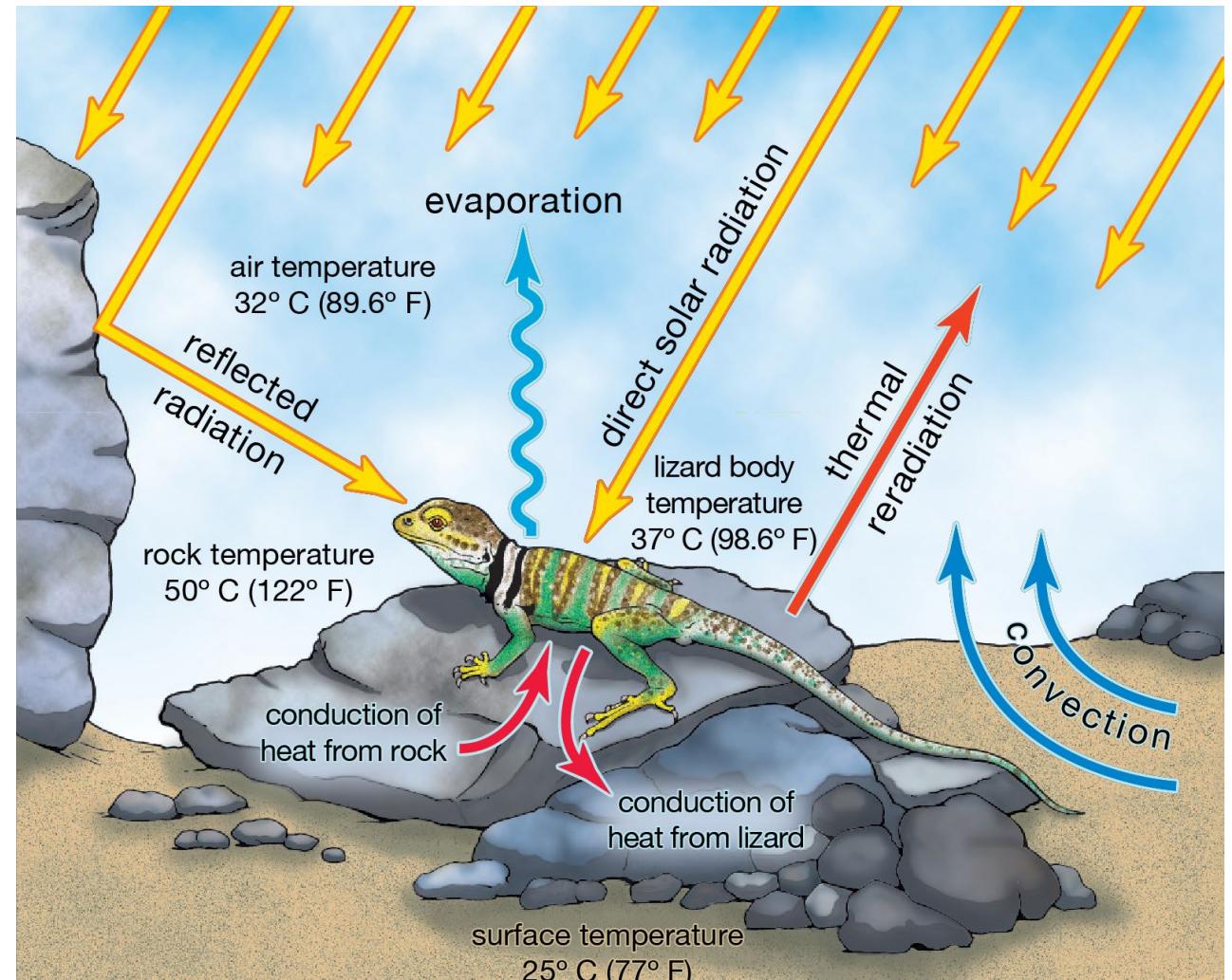
Endothermic organisms (aka ‘warm-blooded’) maintain body at a metabolically favorable temperature by the use of heat set free by its internal bodily functions and not the external environment



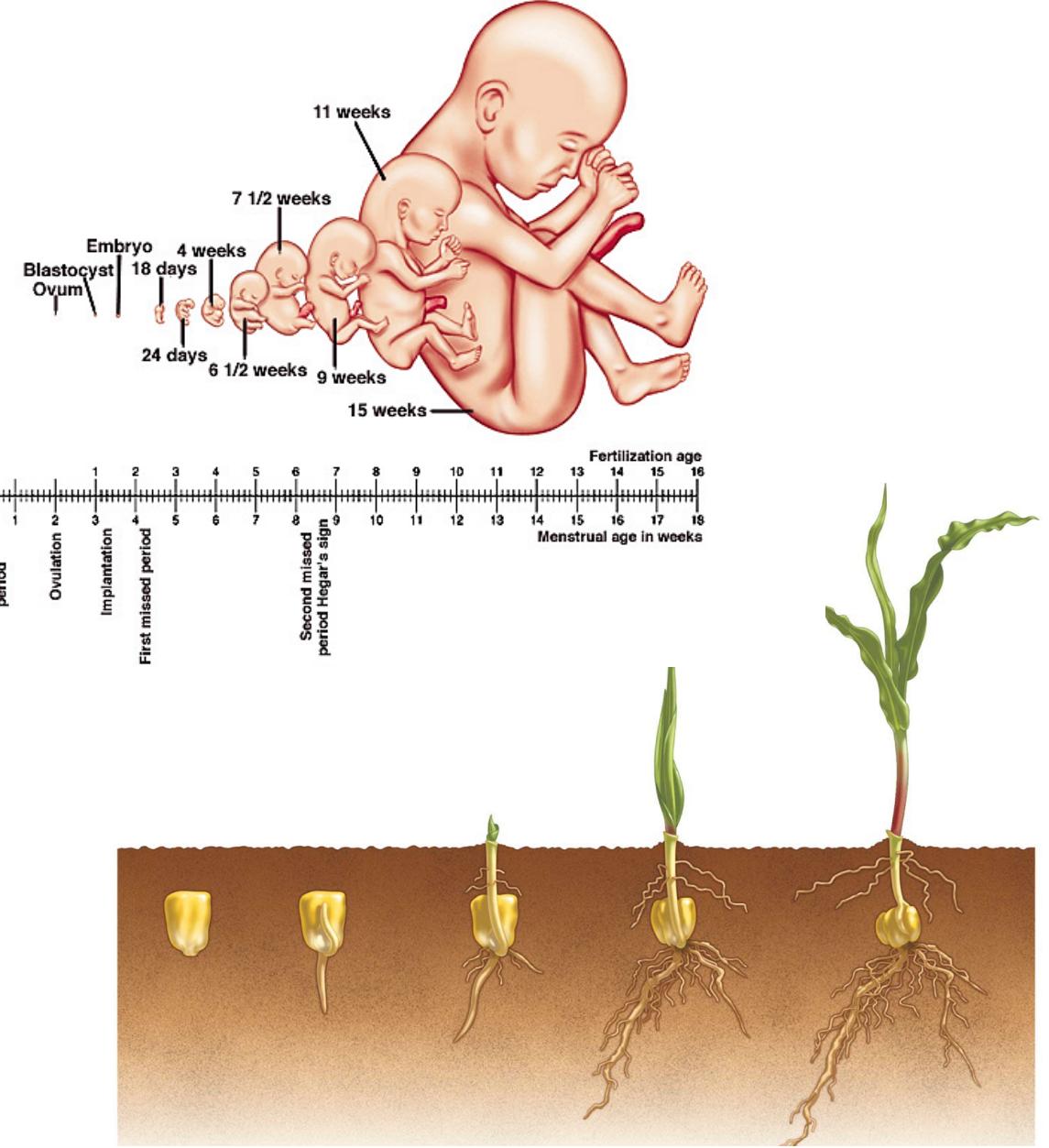
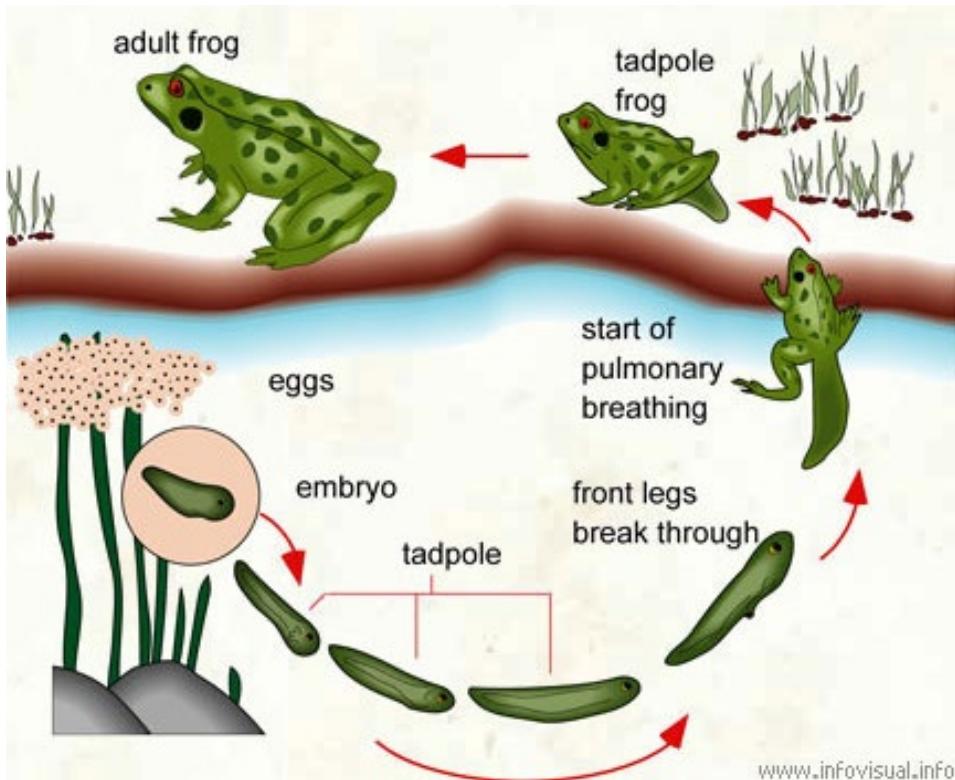
Homeostasis

(e.g. maintain body temperature)

Ectothermic organisms (aka 'cold-blooded') are dependent on external environment for regulation of body temperature such as direct sunlight or heated surfaces



4. Grow and Develop



4. Grow and Develop

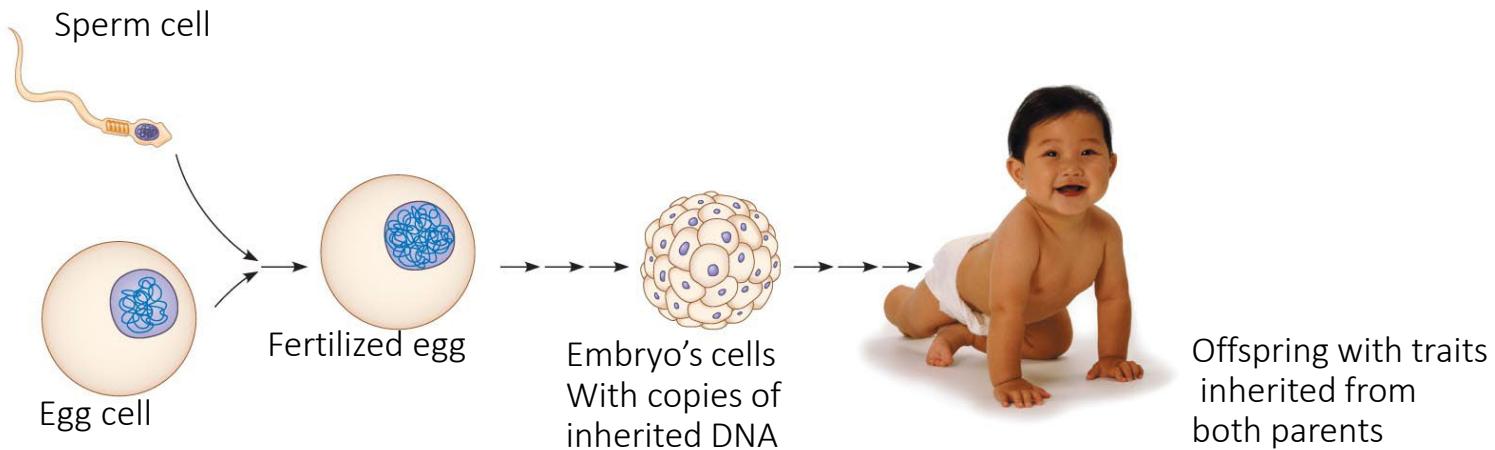
Growth

- Plants and animals grow by producing more cells to **increase mass and size**
- Bacteria grow by enlarging cells and dividing to make **more** individuals
- Involves **conversion** of acquired materials to molecules of organism's body
- Based on **genetic information**, well programmed and coordinated

Development

- The **progressive changes** in size, shape, and function (**differentiation**) during the life of an organism

5. Reproduce

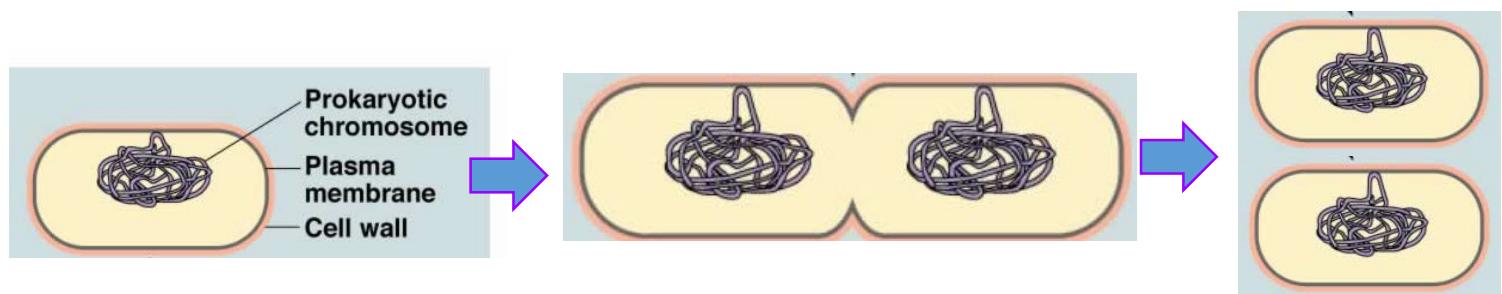


Sexual reproduction

two genetic contributions
to the formation of a new
individual

Asexual reproduction

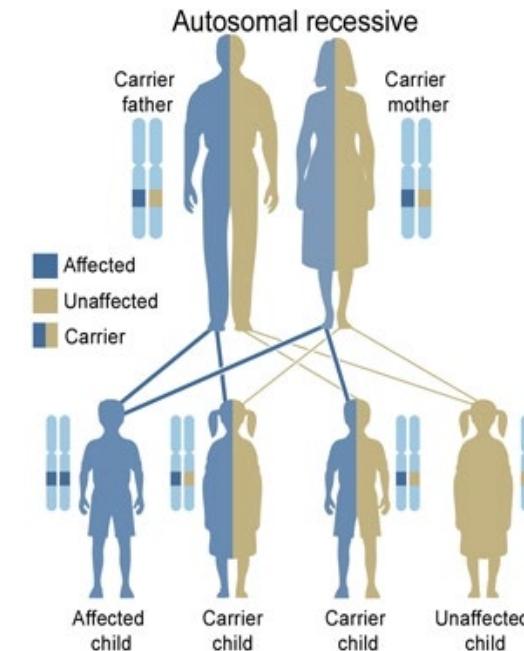
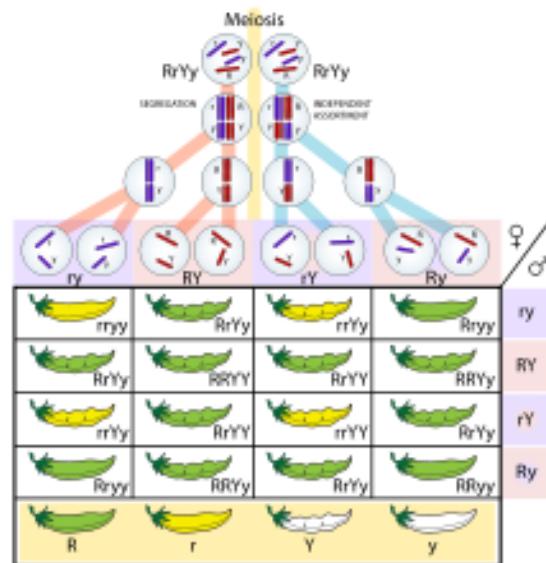
A mode of reproduction by
which offspring arise from a
single parent



5. Reproduce

To maintain population

- Transmission of parents' genetic material to offspring – **continuity of life**
- Offspring may be genetically different from parents – **diversity of life**

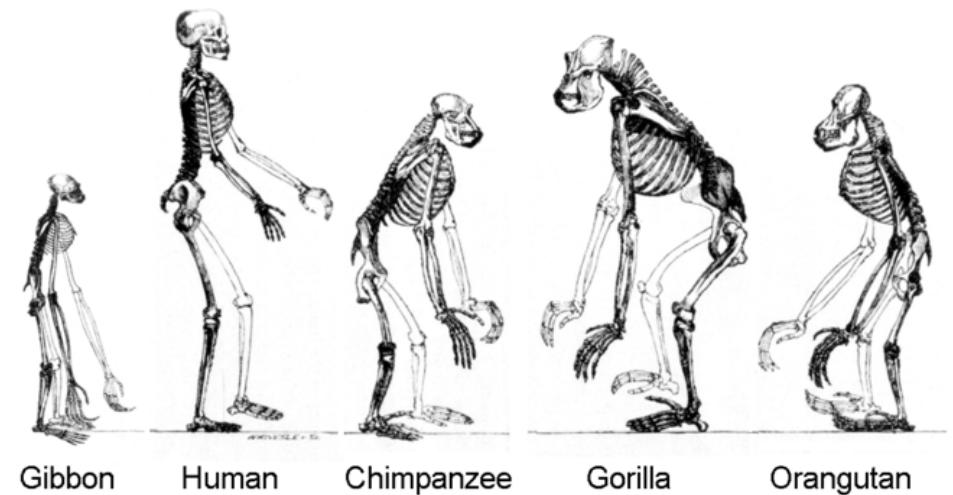


6. Evolve

Evolution is the process by which modern organisms descended, with modifications, from common ancestors

Organisms that best meet environmental challenges leave the most offspring

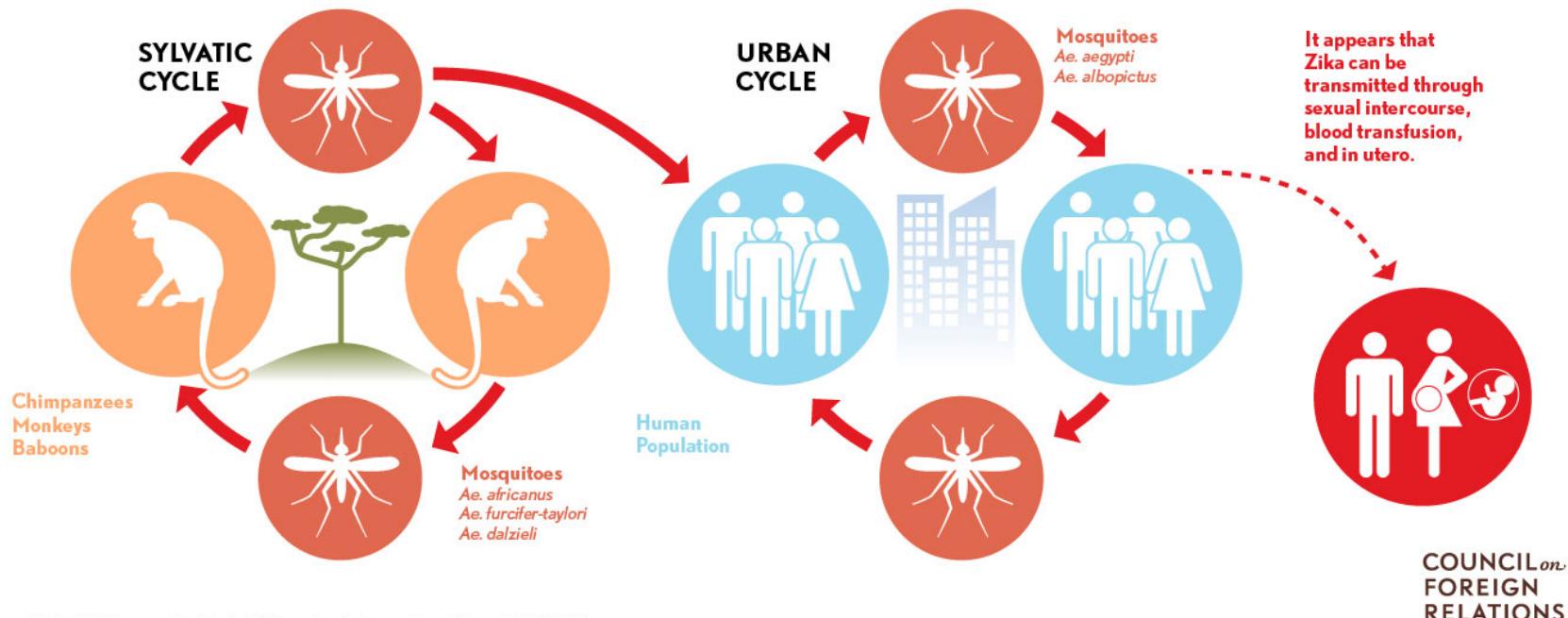
- **Adaptations** are structures, physiological process, or behaviors that aid in **survival** and **reproduction** in a certain environment
- Species that **cannot adapt** to environmental change go **extinct** e.g. dinosaurs



Viruses are not composed of cells and yet possess characteristics of living things.

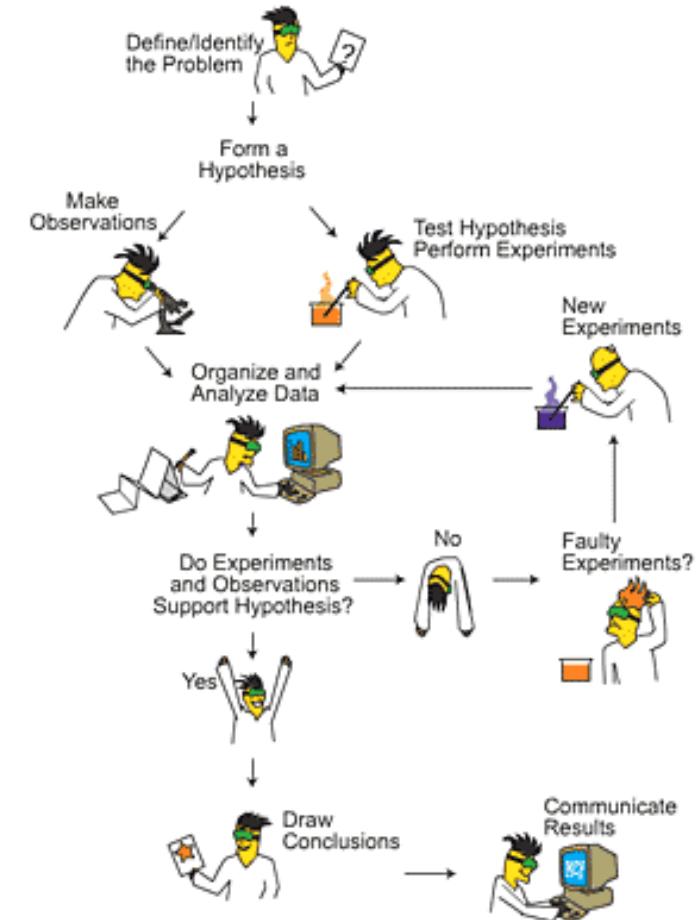
How the Zika Virus Enters the Human Population

The virus originates with nonhuman primates in tropical rainforests but can infect humans. Warm, urban environments with standing pools of water attract mosquitoes, and can lead to the virus's spread.



What is the Scientific Method?

- The word *Science* means “to know”
- Inquiry is the search for information and explanation
- There are two main types of scientific inquiry:
 - discovery/descriptive science
 - hypothesis-based science
- Most scientific inquiries combine these two approaches.



Semmelweis (1856)

Observations

- Childbirth deaths 5x's higher from doctors than nurses due to 'childbed fever'!
- Doctors often did autopsies before attending a birth.

Hypothesis → Doctors transmit 'cadaveric matter' to their patients

Prediction → If doctors washed their hands, it would eliminate cadaveric matter and reduce fever deaths.

The Scientific Method



Experimental design

Nothing changes ← **Control:** Doctors not washing hands.

What you measure ← **Dependent variable:** # of patients getting childbed fever.

What you change ← **Independent variable:** Doctors washing off 'cadaveric matter'



Rising temps. ≠ more pirates

Correlation
≠
Causation

1918
flu
↳
vaccine





How do we apply the scientific method to study life?

Discovery science in biology

- Describes natural structures and processes
- This approach is based on observation and the analysis of data
- Lead to conclusions based on inductive reasoning/induction



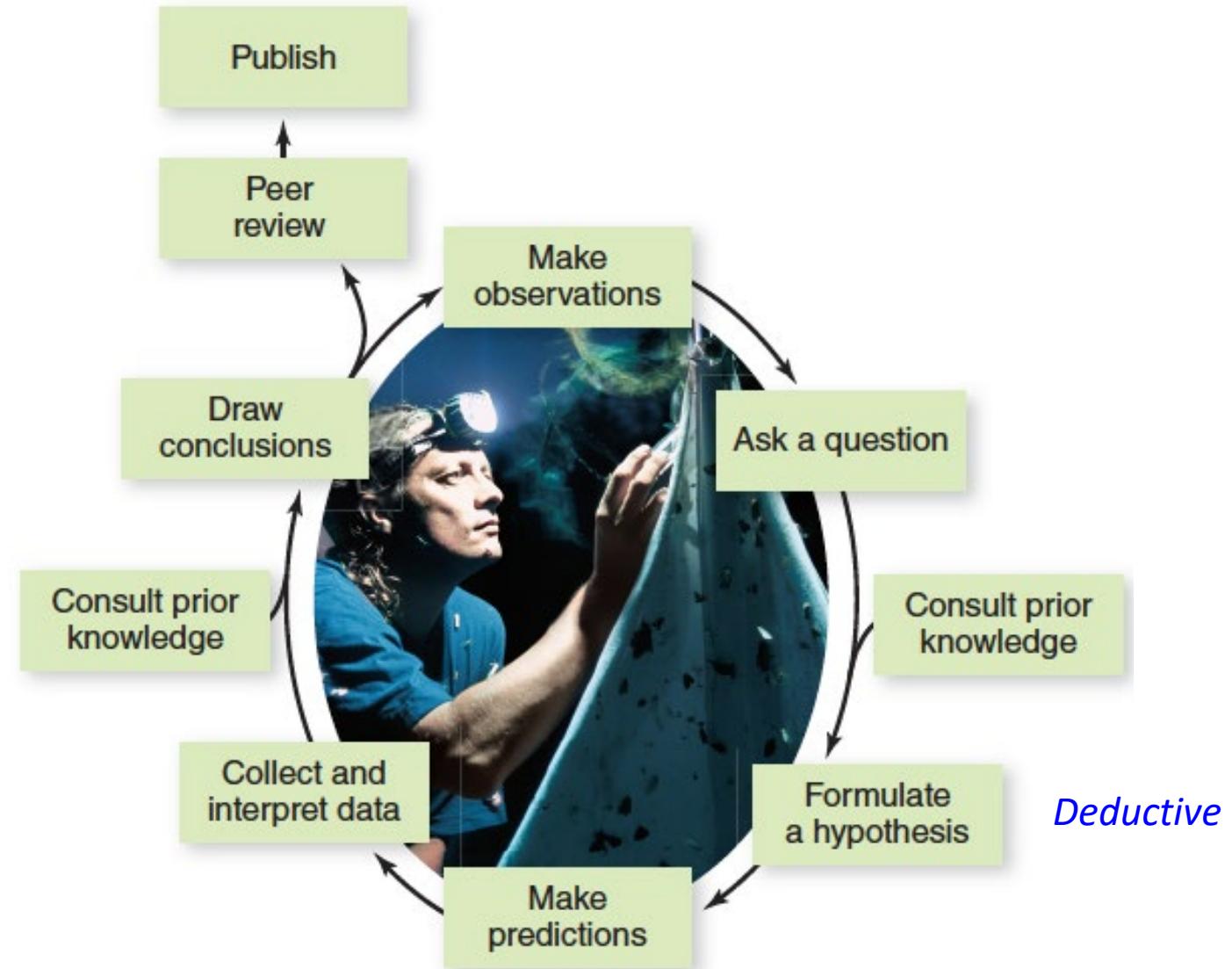
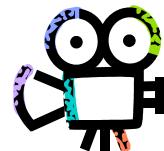
Hypothesis-based science in biology

- Is mostly about explaining nature
- Seek natural causes and explanations for observations, ask questions and propose **hypotheses**
- A hypothesis is a tentative answer to a well-framed question (educated guess)
- A scientific hypothesis leads to predictions that can be tested
- Lead to conclusions based on deductive reasoning

Hypothesis-based science in biology

In general,
all scientific inquiry
follows a standard
process.

Hypothesis Formation and Testing



Hypothesis and predictions

- Focus on a single answerable question — reductionism
- Tentative **explanation** for observed phenomenon (questions)
- Leads to testable predictions
- “If/then” predictions that can be **tested** by experiments
- If hypothesis incorrect, experiments would disprove hypothesis:
falsifiable

Falsifiability is the capacity for some proposition, statement, theory or hypothesis to be proven wrong. All scientific theories are falsifiable; if evidence that contradicts a theory comes to light, the theory itself is either modified or discarded.

Examples of untestable statements

- 1.“If you could go from 0 to the speed of light in a millisecond you'd go back in time” since it's virtually impossible for us to do that.
- 2.“If the earth had no moon all life on earth would die.” Since there is no way of removing the moon from earth orbit their is no way to test the hypotheses.
- 3.“If dogs display muscle twitches and vocalizations during sleeps, then they must be dreaming.” How do we proceed to test it?

Experiment

Test and challenge the hypothesis under known and controlled conditions

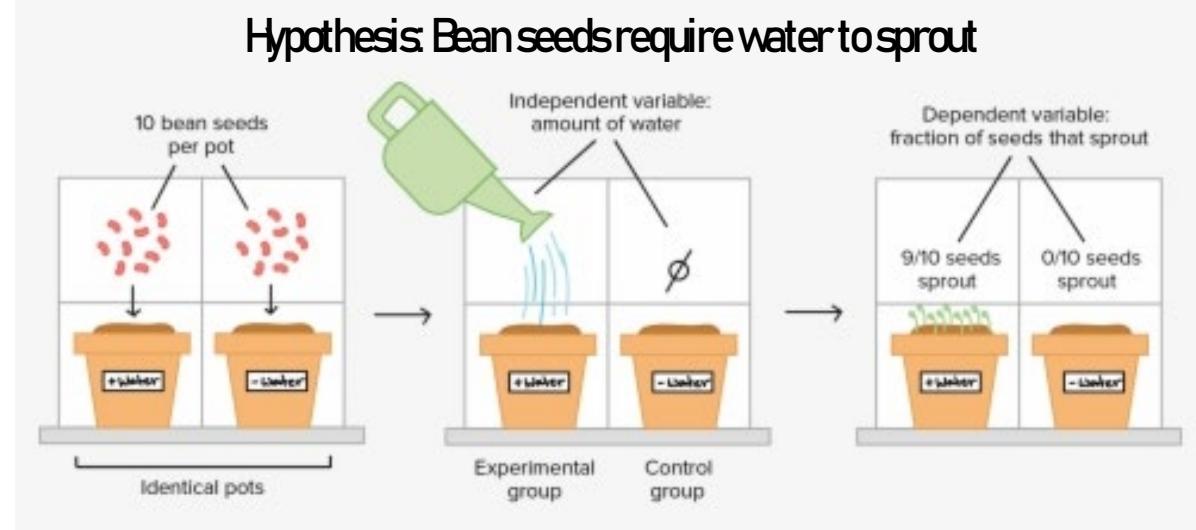
Experimental group

- Group with a single variable characteristic to be tested (what you change, i.e. Independent variable)

Control group (Nothing changed)

- Group identical to the experimental group, except for the variable

Test the results of the experimental group against the control group



Sampling error
should be minimized

- Replicates
- Random sample
- Sample size

Conclusion

Evaluation of hypothesis in light of experimental results that must be repeatable.

May disprove a hypothesis

- Require redesign of experiments

Use of statistical analyses to provide support for hypothesis

Must remain tentative

- Hypothesis may be supported but cannot be proven 100% correct
- Can never be sure all untested variables are controlled

Limits of the scientific method

Scientific approach cannot provide answers to subjective questions

- Such as social decisions, politics, etc.

Cannot provide moral, aesthetic, or philosophical standards

May result in conflict with other forms of knowledge

Use of statistical
analyses to provide
support for hypothesis

Summary

Biology is the scientific study of life

- We can use certain characteristics to classify living things.
- Scientist can use two main forms of inquiry in their study of life.
 - Discovery science
 - Hypothesis-based science

Supplementary material

Optional

- The history of our world in 18 minutes | David Christian
 - http://www.ted.com/talks/david_christian_big_history
 - <https://www.youtube.com/watch?v=yqc9zX04DXs> (watch and read the comments)
- Hidden miracles of the natural world
 - http://www.ted.com/talks/louie_schwartzberg_hidden_miracles_of_the_natural_world
- The Great Debate - What is Life?
 - <http://www.youtube.com/watch?v=xIHMnD2FDeY>