

# LSM1301 GENERAL BIOLOGY

Looking at the macro- and  
micro- aspects of life

Dr. Nalini Puniamoorthy & Dr. Maxine Mowe

S3 level 4 & S2 Level 4

[nalini@nus.edu.sg](mailto:nalini@nus.edu.sg) & [dbsmadm@nus.edu.sg](mailto:dbsmadm@nus.edu.sg)

# Course introduction

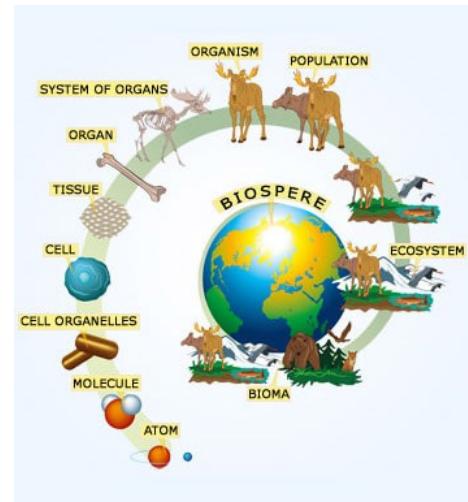
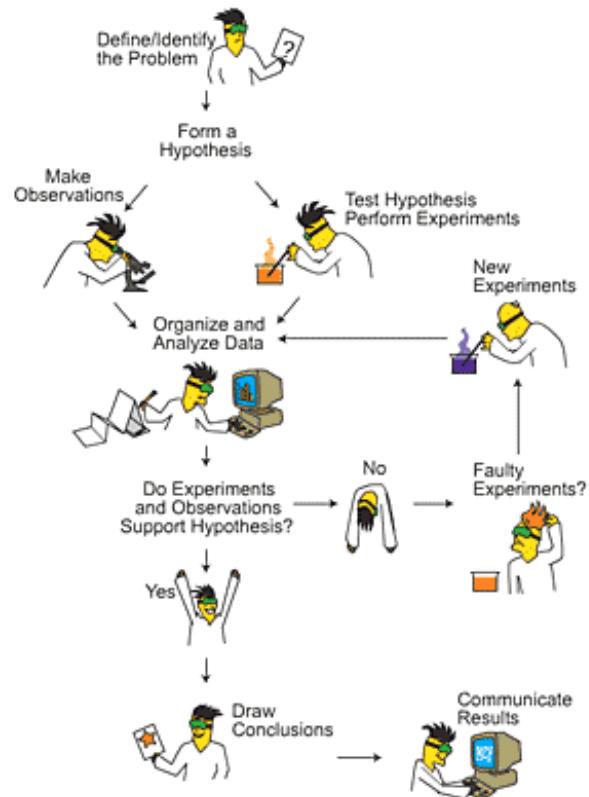
## 1. Course Management

- 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?



# Teaching team

## Organismal biology

- Dr. Nalini Puniamoorthy  
[nalini@nus.edu.sg](mailto:nalini@nus.edu.sg)



## Cell and molecular biology

- Dr. Maxine Mowe  
[maxinemowe@nus.edu.sg](mailto:maxinemowe@nus.edu.sg)



LAW SZE JOO, SYLVIA (Instructor)  
[dbslsjs@nus.edu.sg](mailto:dbslsjs@nus.edu.sg)



CHUA LING LIH (Lab Tech)  
[dbscll@nus.edu.sg](mailto:dbscll@nus.edu.sg)



TAY BEE LING (Lab Tech)  
[dbstaybl@nus.edu.sg](mailto:dbstaybl@nus.edu.sg)

# Course contents

## Organismal biology

➤ Dr. Nalini Puniamoorthy

## Cell and molecular biology

➤ Dr. Maxine Mowe

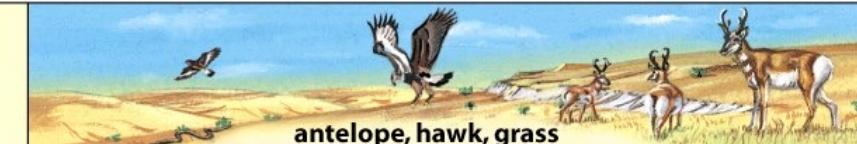
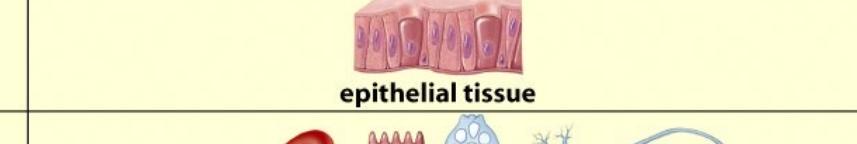
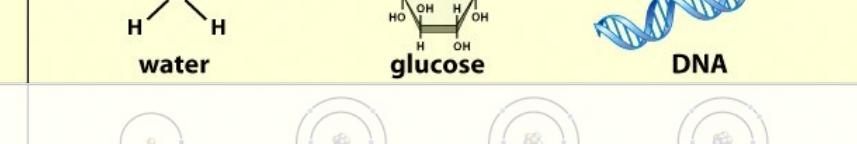
|                        |  |   |
|------------------------|--|---|
| Community              | Two or more populations of different species living and interacting in the same area | <br>antelope, hawk, grass   |
| Population             | Members of one species inhabiting the same area              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

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

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# Course schedule

## Cell and molecular biology

➤ Week 1-6

## Organismal biology

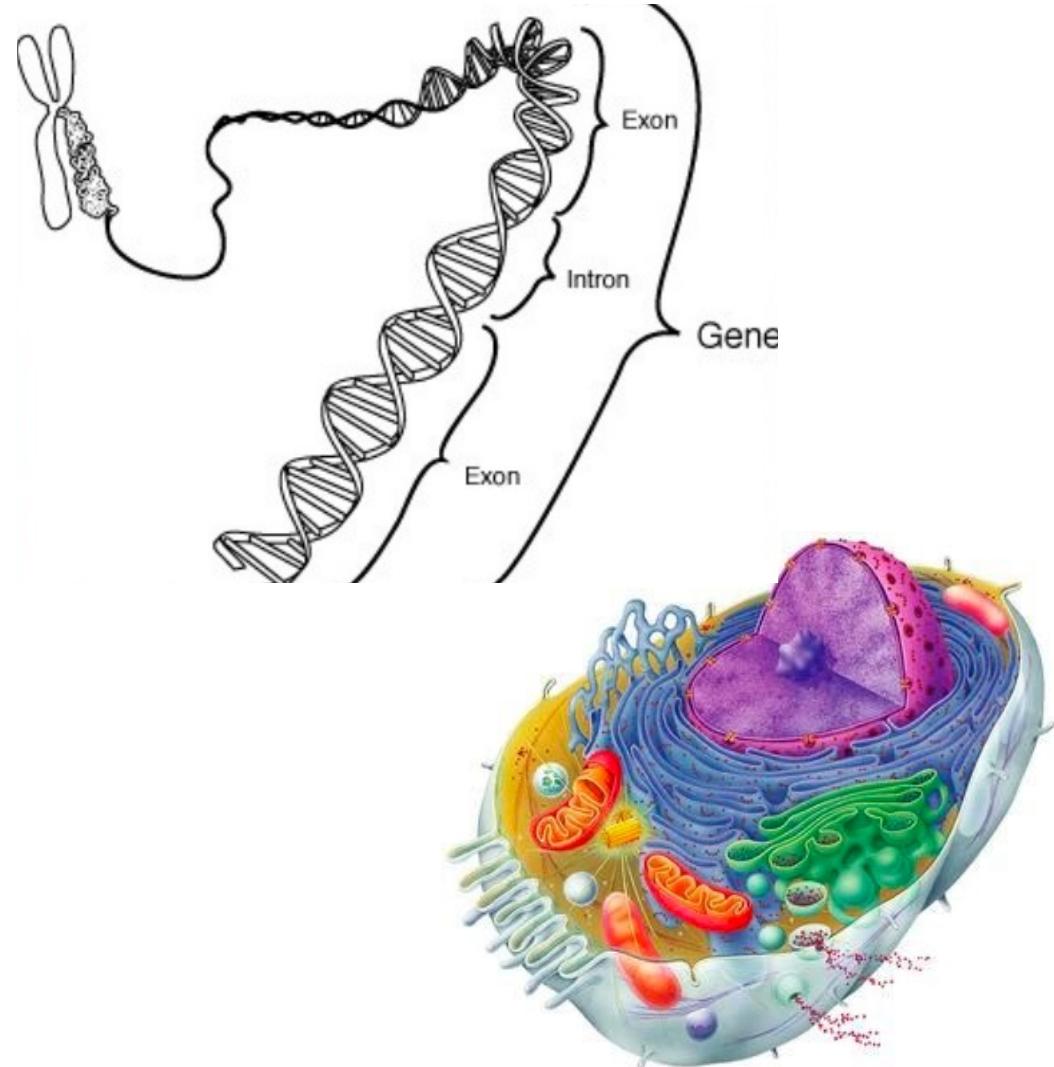
➤ Week 7-13

| Wk  | Month   | Lecture                            | Tutorial/Practical                         |
|---|---------|------------------------------------|--|
|   |         | Tuesday                            | Thursday                                   |
| 1   | Jan     | 09 Science of Biology (MM)         | 12 *Chemistry of Life (MM)                 |
| 2   |         | 16 Cell and Molecular biology (MM) | 19 **E-tutorial 1 - Life                   |
| 3   |         | 23 CNY (Public Holiday)            | 26 No Tutorial/Lab *Energy of Life (MM)    |
| 4   | Feb     | 30 DNA and Heredity (MM)           | 02 Lab: Living cells & Energy Release (MM) |
| 5   |         | 06 Gene Expression (MM)            | 09 Lab: Molecular Biology                  |
| 6   |         | 13 Biotechnology (MM)              | 16 *Review for midterm                     |
| Recess Week: Sat, 18 Feb – Sun, 26 Feb 2023 (1 week)  |         |                                    |  |
| 7   | Feb/Mar | 27 E-Exam 1                        | 03 No Tutorial/Lab                         |
| 8   | Mar     | 06 Evolution                       | 10 **E-tutorial 2 - (Self-conducted)       |
| 9   |         | 13 Biodiversity                    | 16 Lab: Primate Skulls (NP)                |
| 10  |         | 20 Animal form and function        | 23 Museum Visit (Self-conducted)           |
| 11  |         | 27 Plant form and function         | 30 Plant Reproduction (NP)                 |
| 12  | Apr     | 03 Ecology                         | 06 *Review for final                       |
| 13  |         | 10 E-Exam 2                        | 13 No Tutorial/Lab                         |
| Reading Week: Sat, 15 Apr – Fri, 21 Apr 2023 (1 week) |         |                                    |  |
| No Final Exam   |         |                                    |  |
| Vacation: Sun, 7 May – Sun, 6 Aug 2023 (13 weeks)     |         |                                    |  |

# 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?



# Learning objectives

## Organismal biology

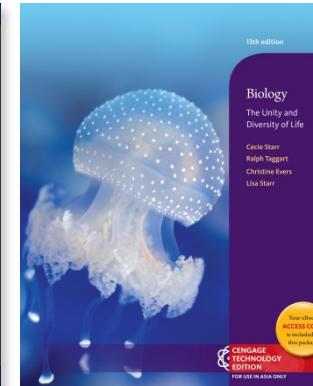
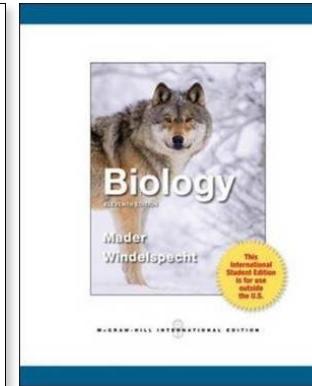
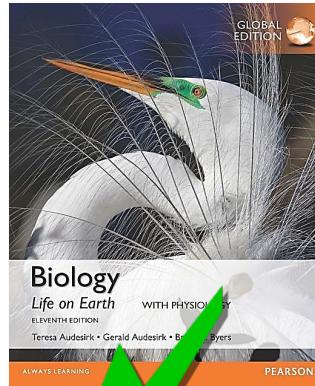
- What are biological species?
- How do populations and species evolve?
- How are different organisms classified?
- How do species interact with the environment and each other?



# Course material

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

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



Recommended Text Books/References

# Grading and policies

100% CA

|                   |      |
|-------------------|------|
| - Lab assignments | 35 % |
| - E-tutorial 1    | 5%   |
| - E- tutorial 2   | 5%   |
| - Museum visit    | 5%   |
| - Two E-exams     | 50%  |

- ✓ Open book assessments
- ✓ No rote memory
- ✓ Non-graded post-class quizzes

To Note:

- Previous exam questions are **NOT** released.  
However, we will provide non-graded questions on Canvas for practice.
- No marks are deducted for incorrect answers (no penalty marking) in the exams.
- Students are **NOT** allowed to use the internet during the e-exams.
  - E-exam 1 will be held on **27th Feb 2023** during the lecture slot. E-exam 2 will be held on **10th April 2023** during the lecture slot.
  - Exam venues will be announced at a later date.

# Lab assignments

Read through **FAQ section**  
in **CANVAS** carefully

## ○ Cell and molecular biology

Lab 1      Living cells and Energy release      (7.5 %)

Lab 2      Molecular biology      (7.5 %)

## ○ Organismal biology

Lab 3      Primate skulls      (10 %)

Lab 4      Reproduction in flowering plants      (10 %)

# 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

## Turnitin

- 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. Lecture & F2F practical sessions
  - In-lecture activities help student access comprehension via PollEverywhere quizzes and real-time Q&As
3. Asynchronous non-graded assessment and interaction
  - Post-lecture quizzes (non-graded) and forum discussions help student apply and test their understanding of content

# Using the Canvas forum

# Any questions on course content and structure?

**Top**

# 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.

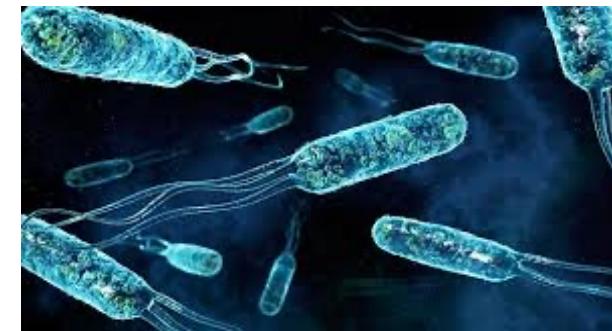


# The cell is the basic unit of life

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

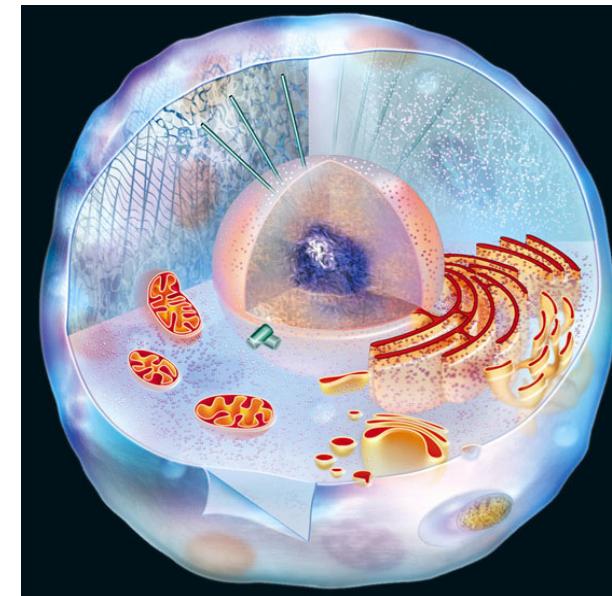
## Basic structure of a cell

- 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.

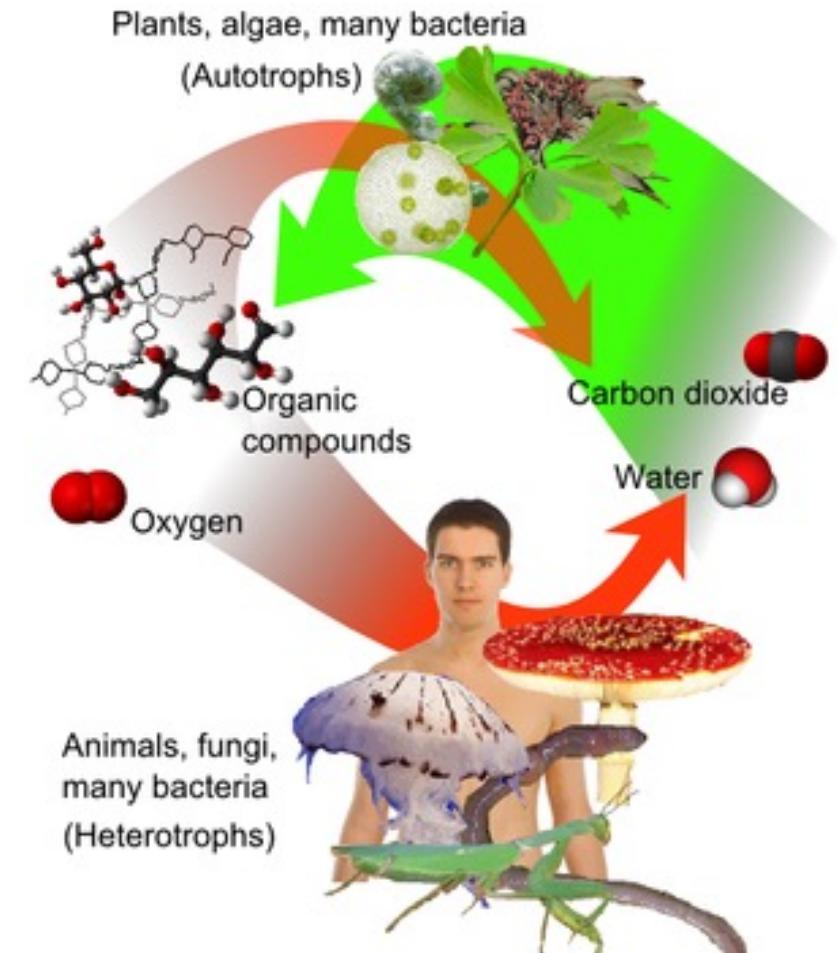
# 1. Acquire and use materials and energy

## 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



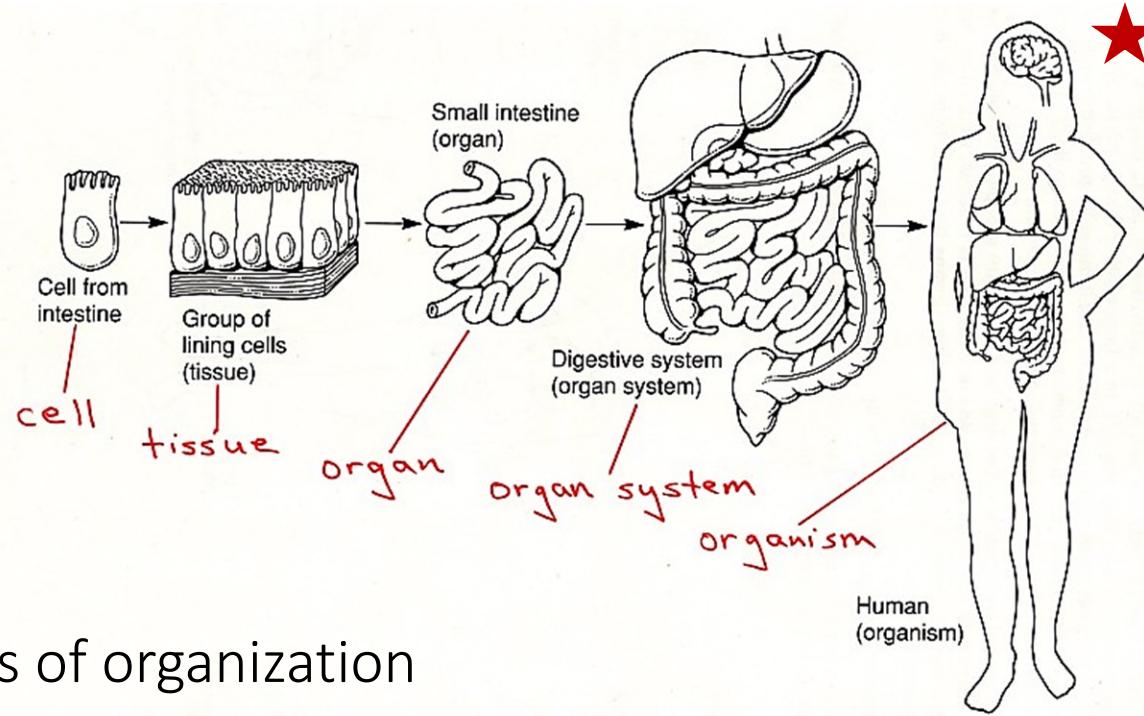
## 2. Maintain organised Complexity



Seemingly simple building blocks give rise to incredible complexity



## 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.

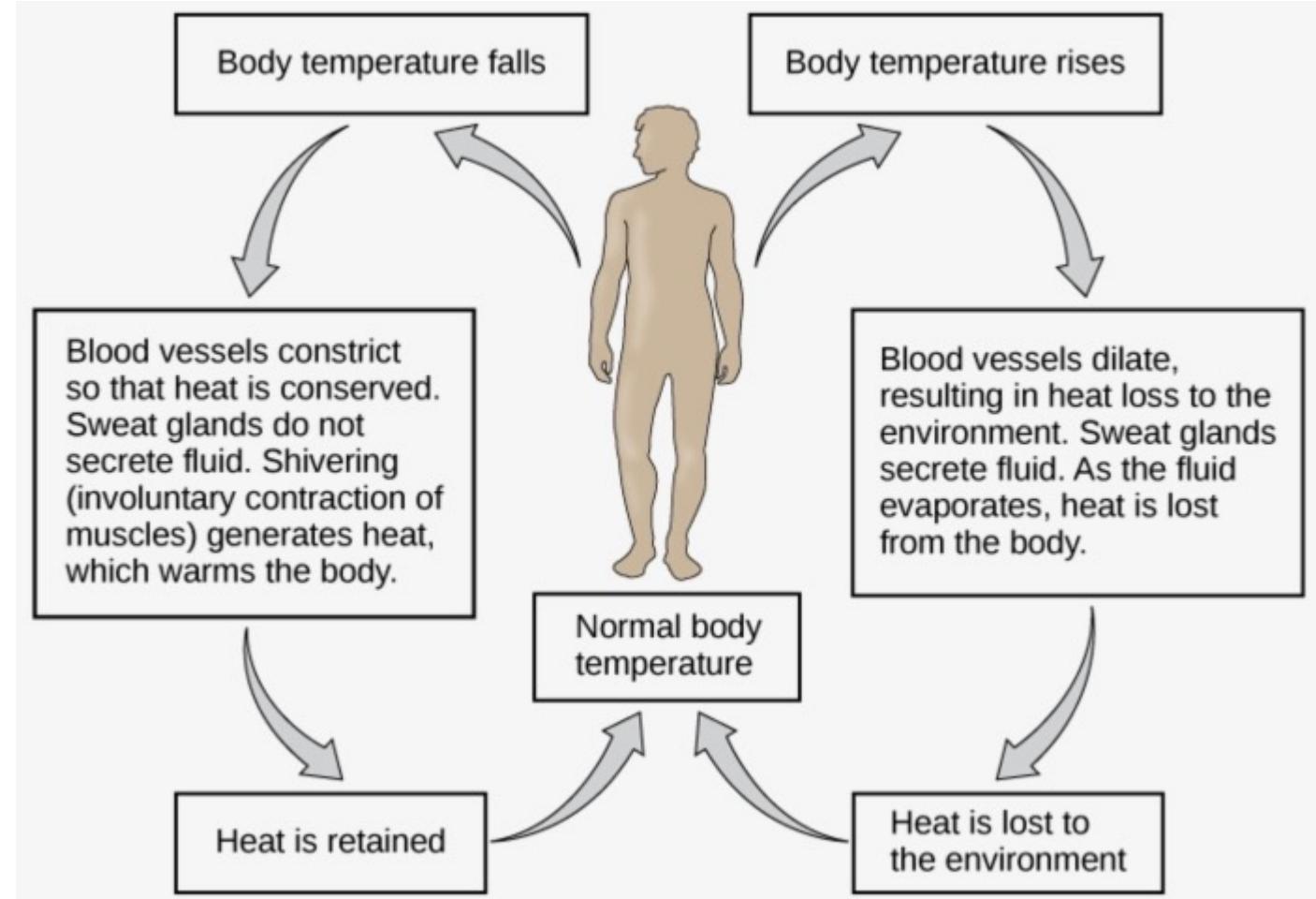
### 3. Sense and respond to stimuli

- 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)

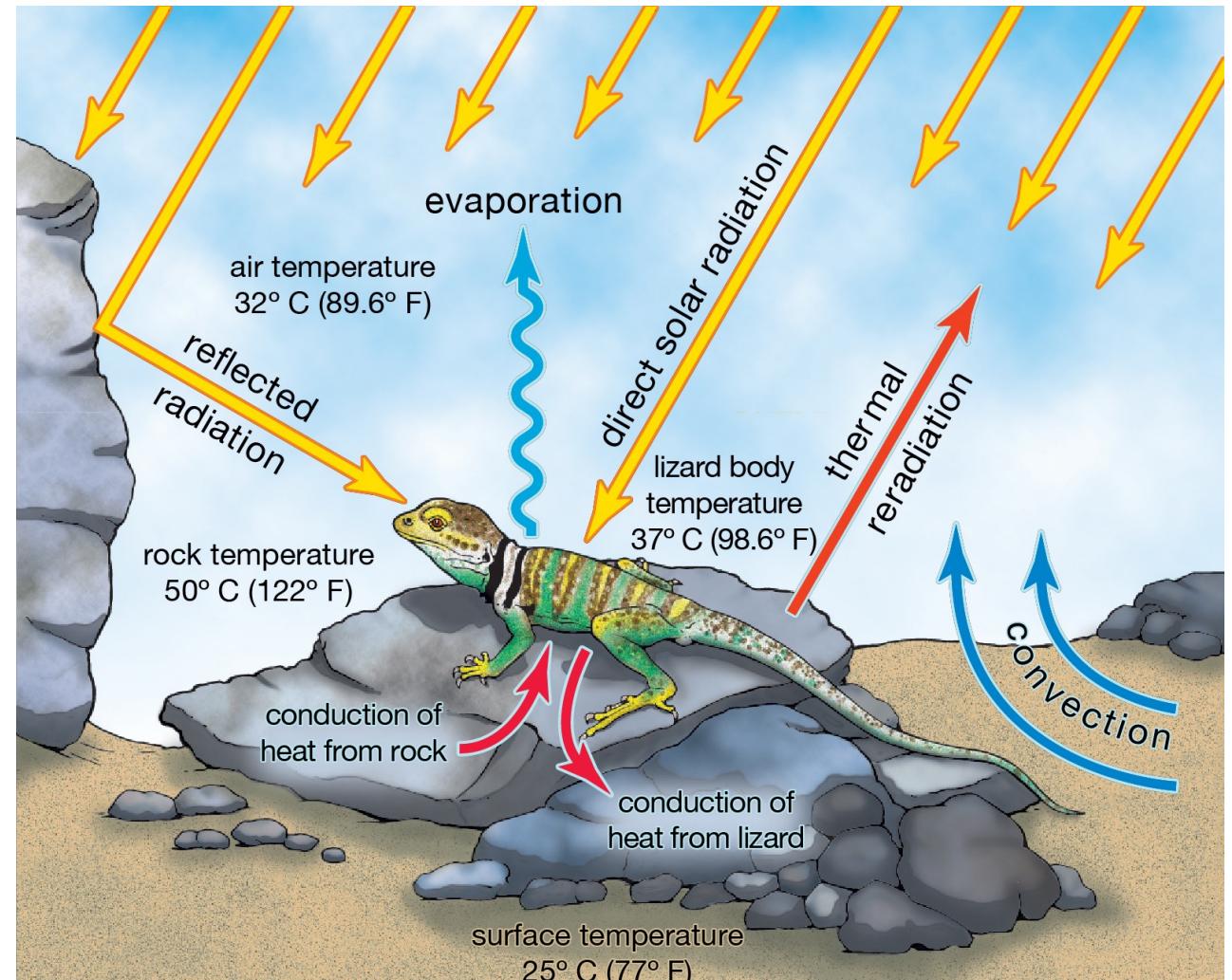
**Endothermic** organisms (aka ‘warm-blooded’) maintain body at a metabolically favorable temperature by the use of heat set free by its internal bodily functions and not the external environment



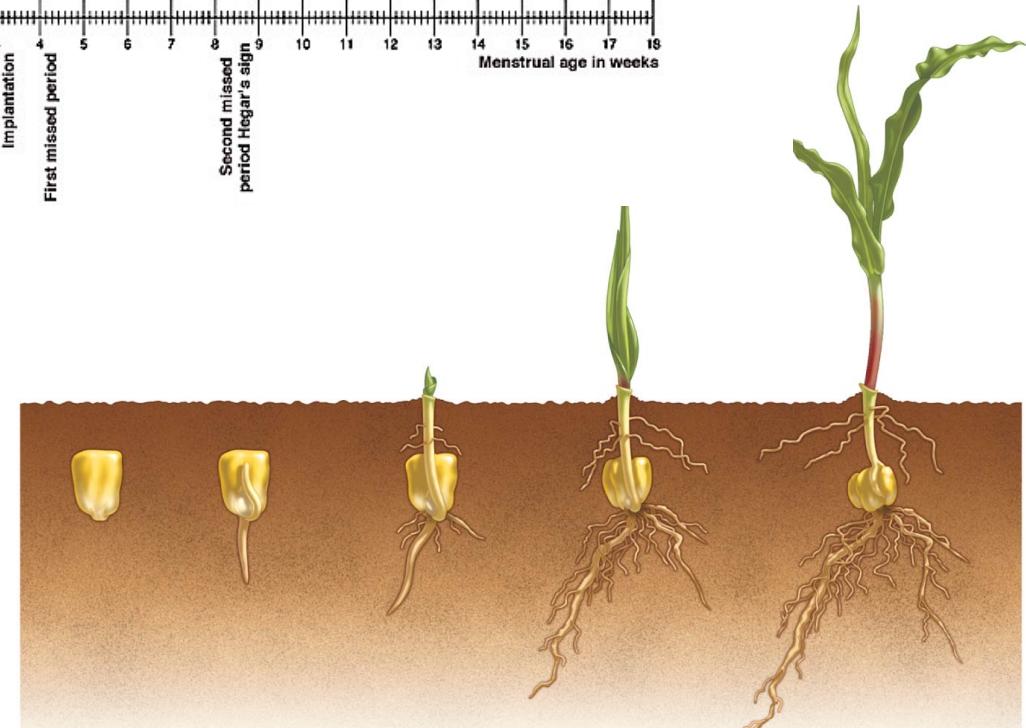
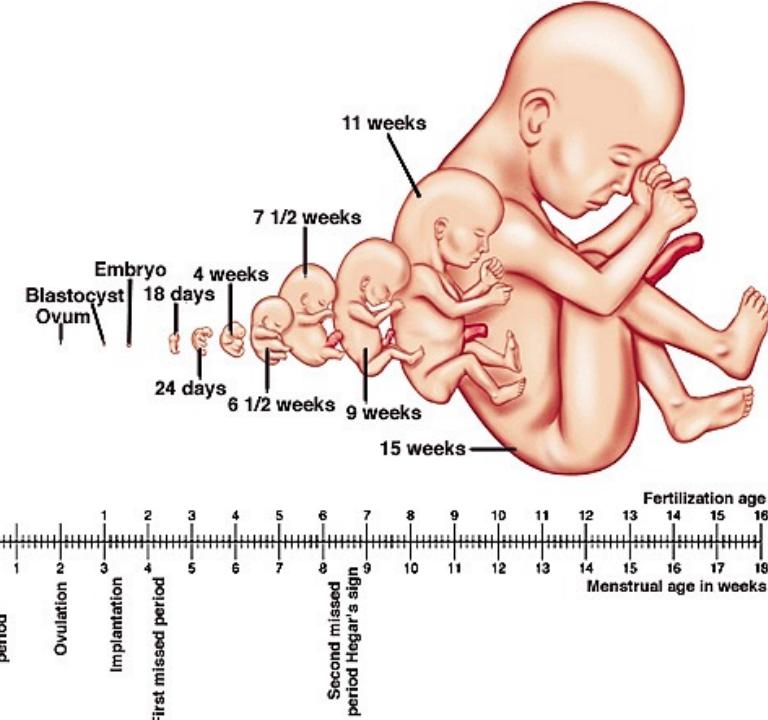
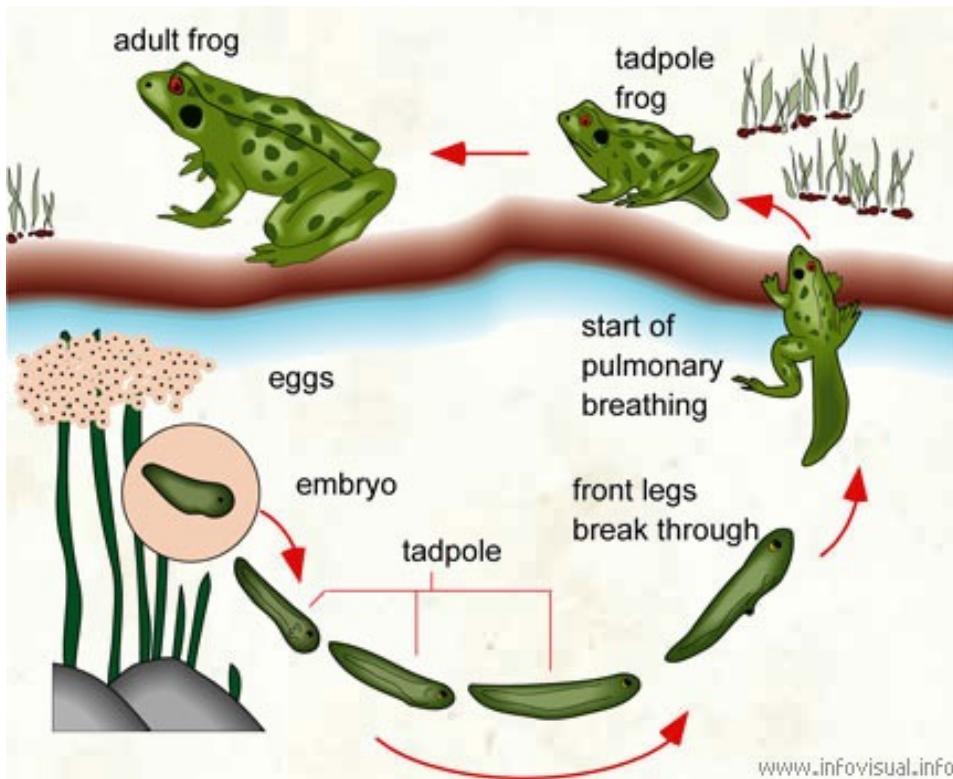
# Homeostasis

(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

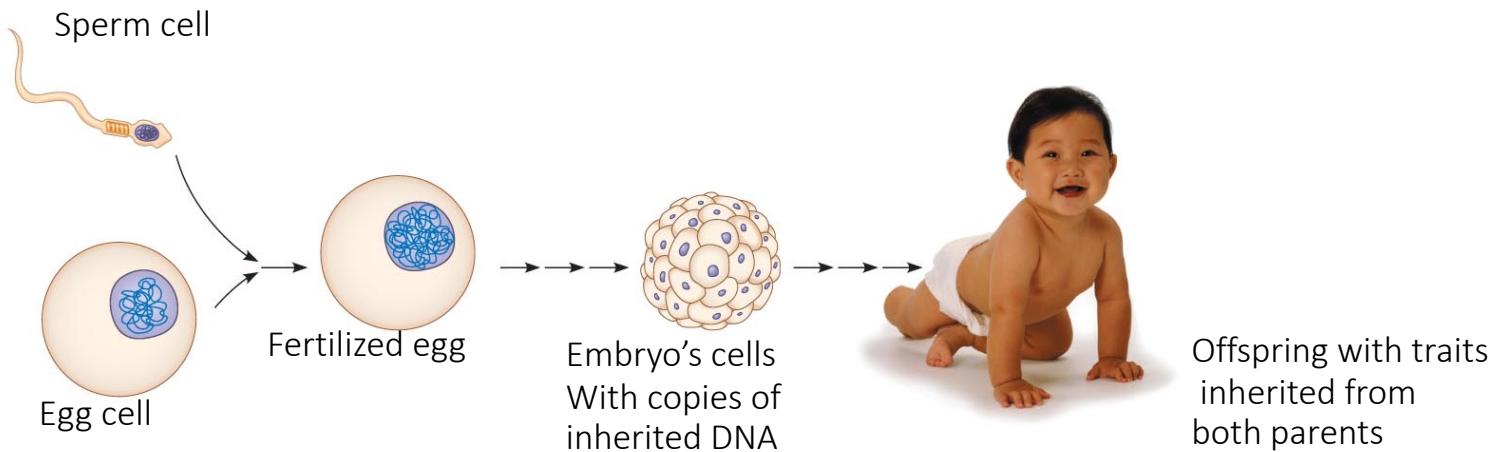
## Growth

- 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

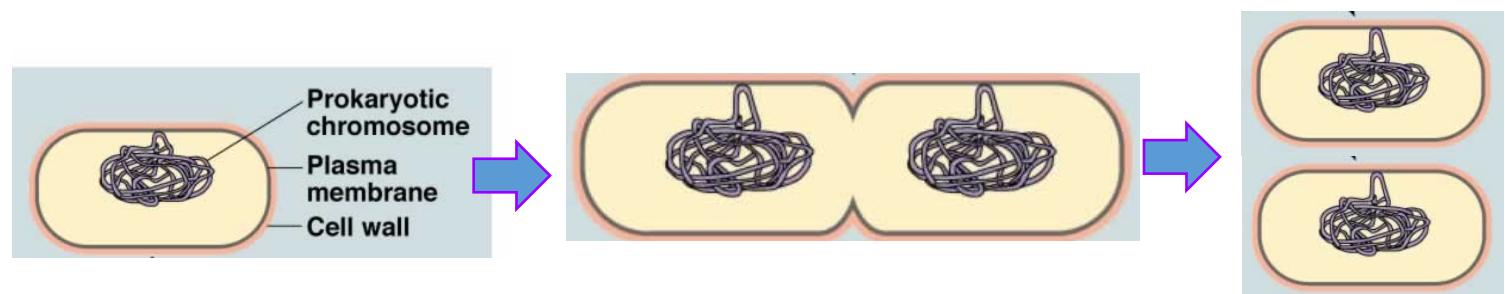


## Sexual reproduction

two genetic contributions  
to the formation of a new  
individual

## Asexual reproduction

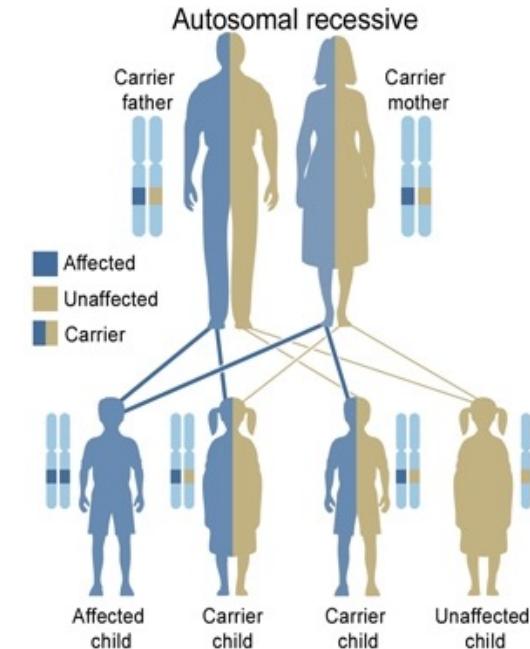
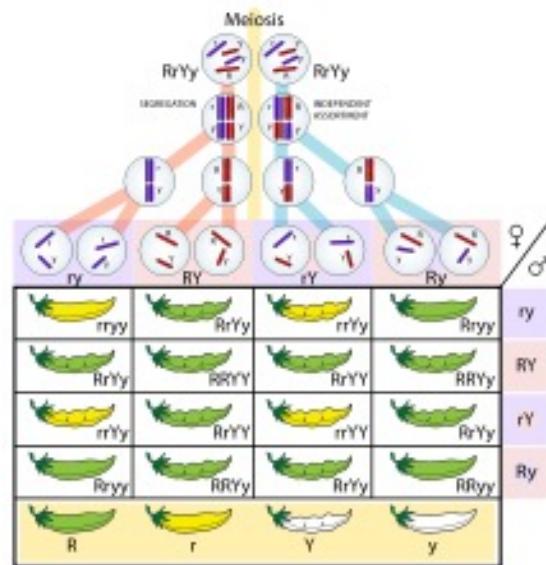
A mode of reproduction by  
which offspring arise from a  
single parent



# 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**



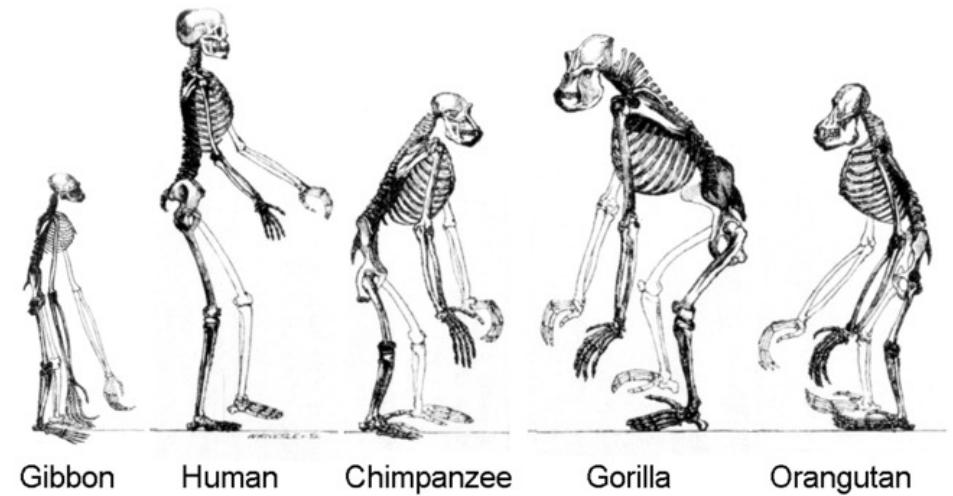
# 6. Evolve

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



🌐 When poll is active, respond at **pollev.com/evo2021**

SMS Text **EVO2021** to **+65 8241 0042** once to join

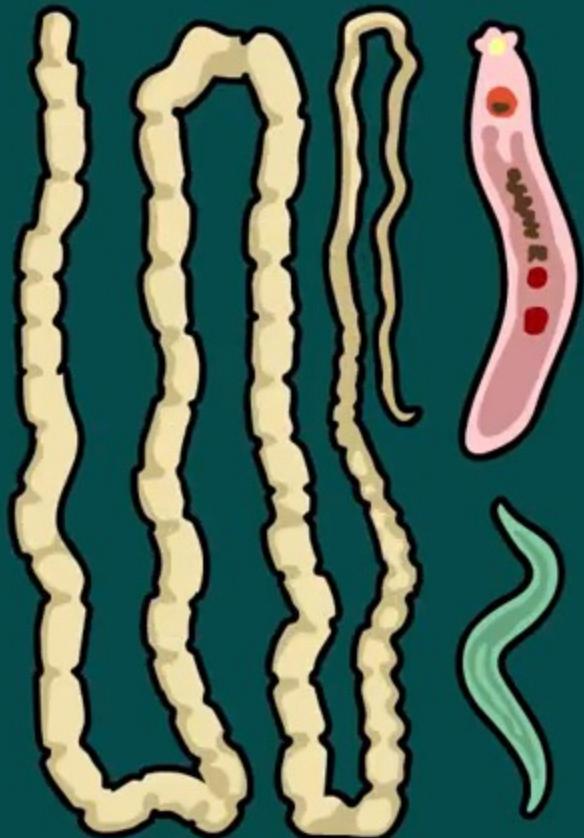


**Based on the six criteria we have just discussed, would you consider viruses as living organisms?**

Yes

No

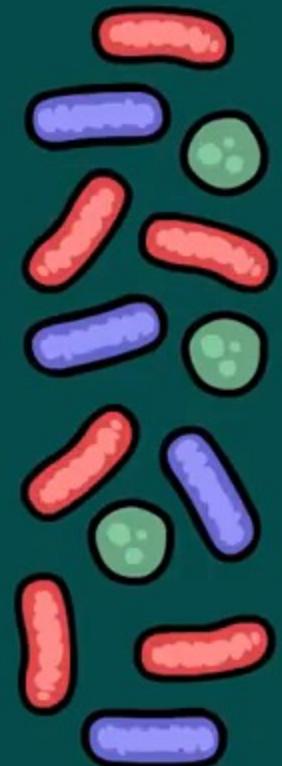
# THINGS THAT CAN INFECT YOU



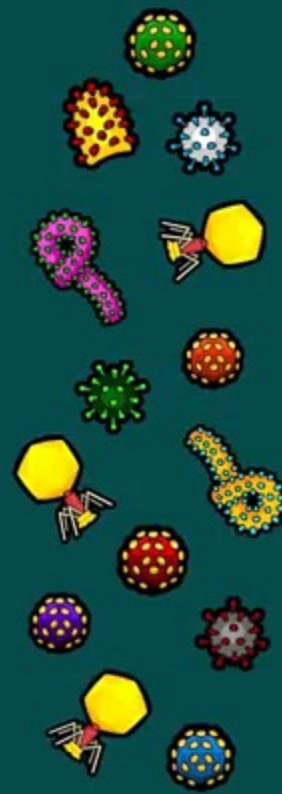
Parasitic Worms



Protists



Bacteria



Viruses



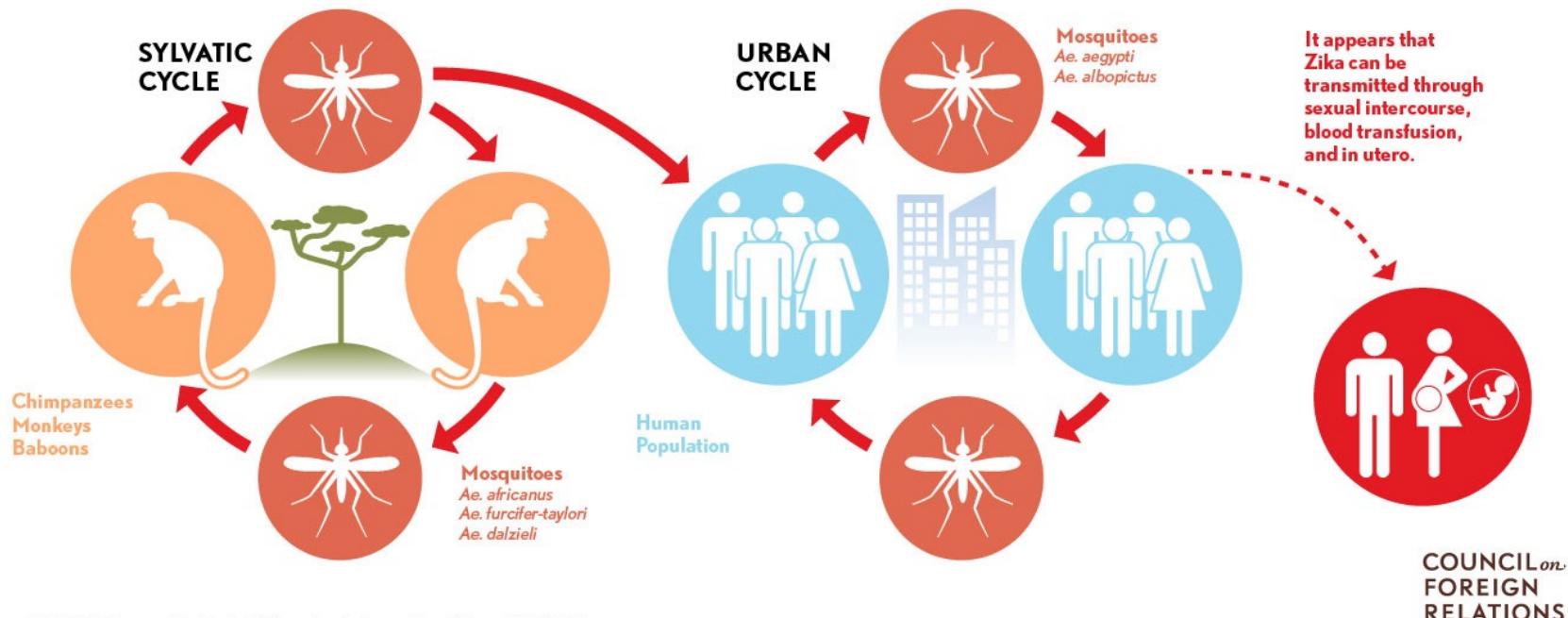
Virusoids

Note: there are way more than this, from fungi to prions and a bunch of fascinating arthropods!

# 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.

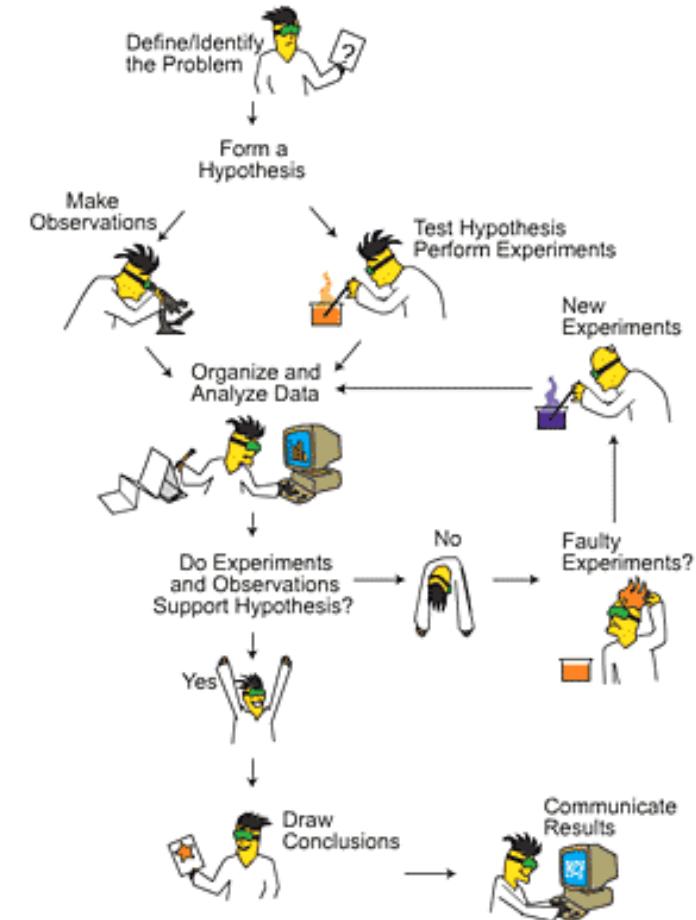


# What is the Scientific Method?



# 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)

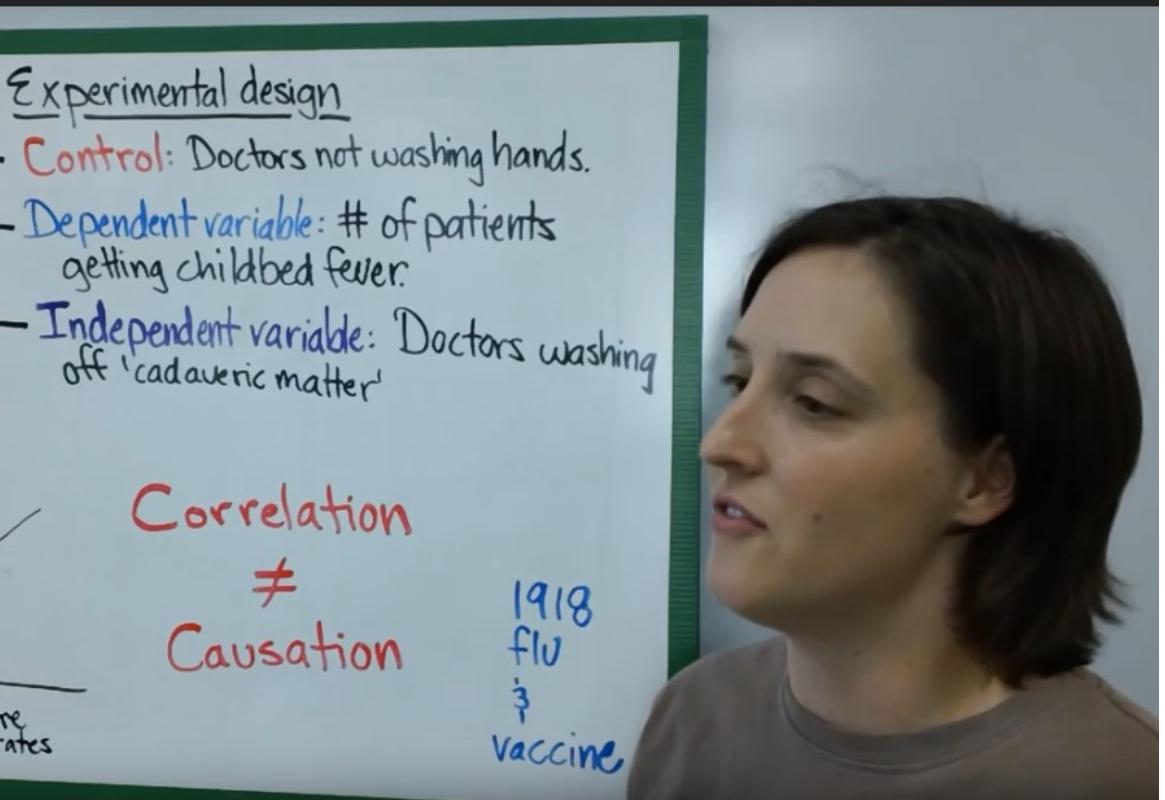
### Observations

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

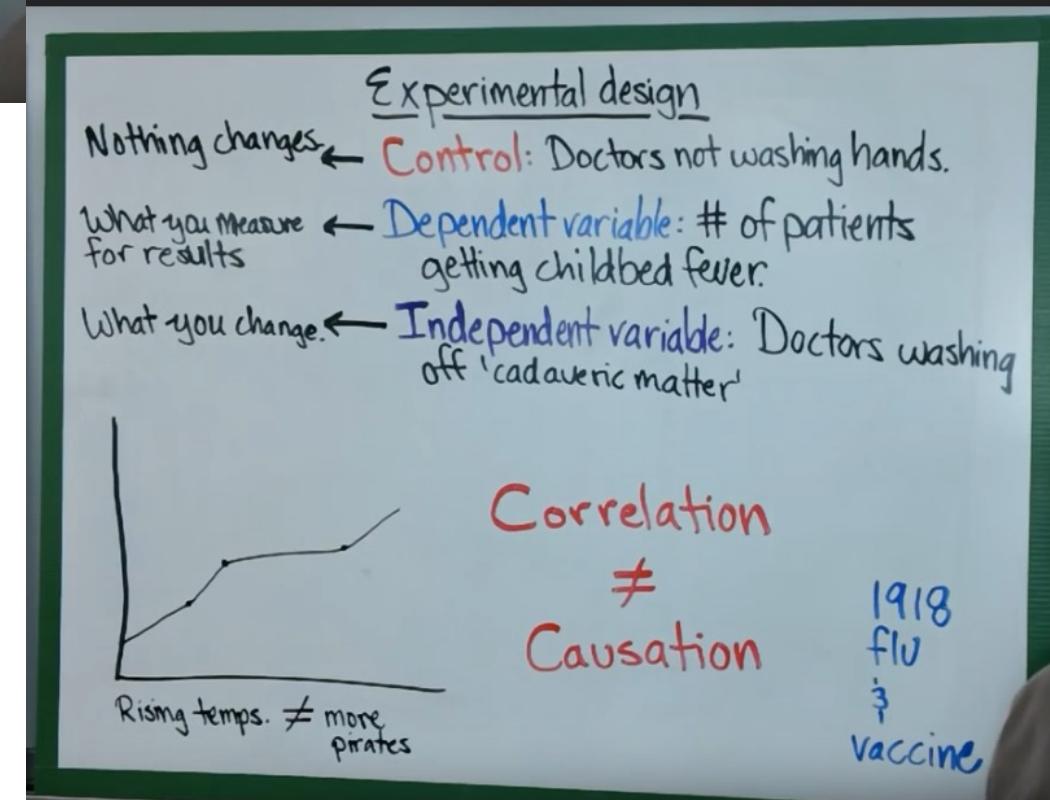
Hypothesis → Doctors transmit 'cadaveric matter' to their patients

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

## The Scientific Method



Correlation  
≠  
Causation



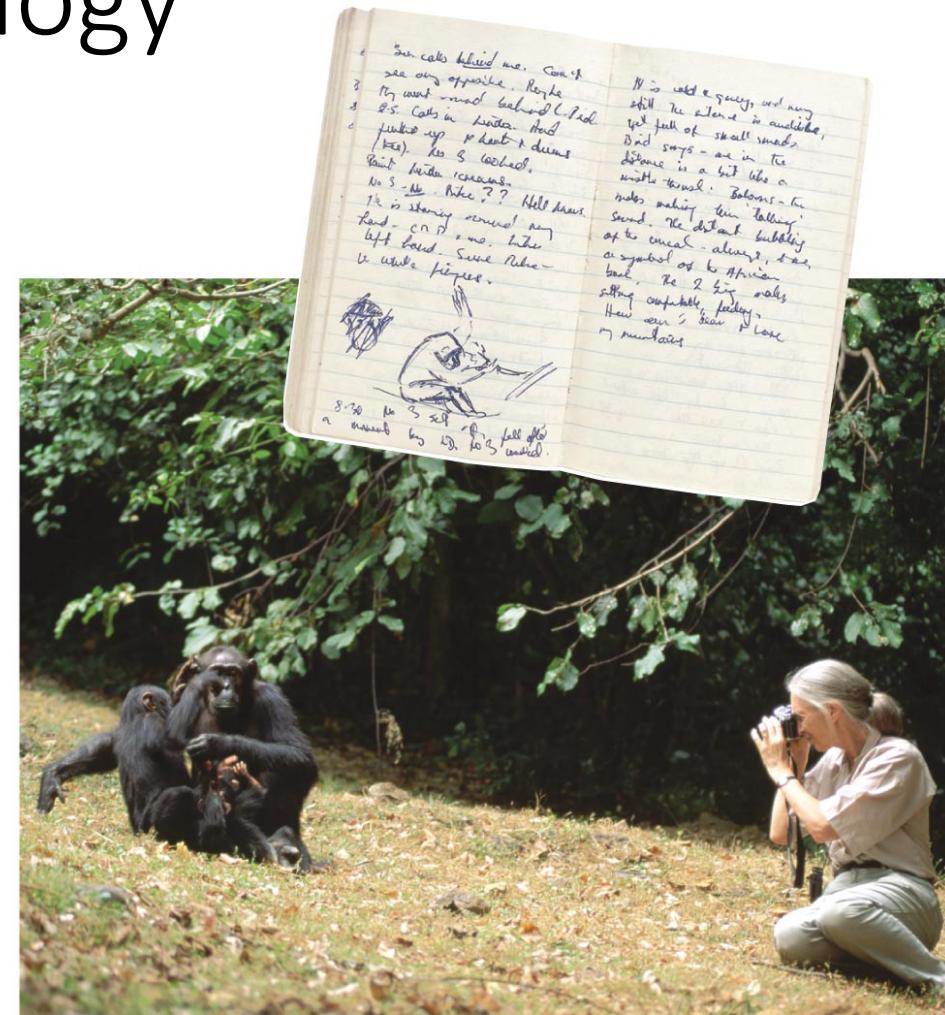


How do we apply the scientific method to study life?



# 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



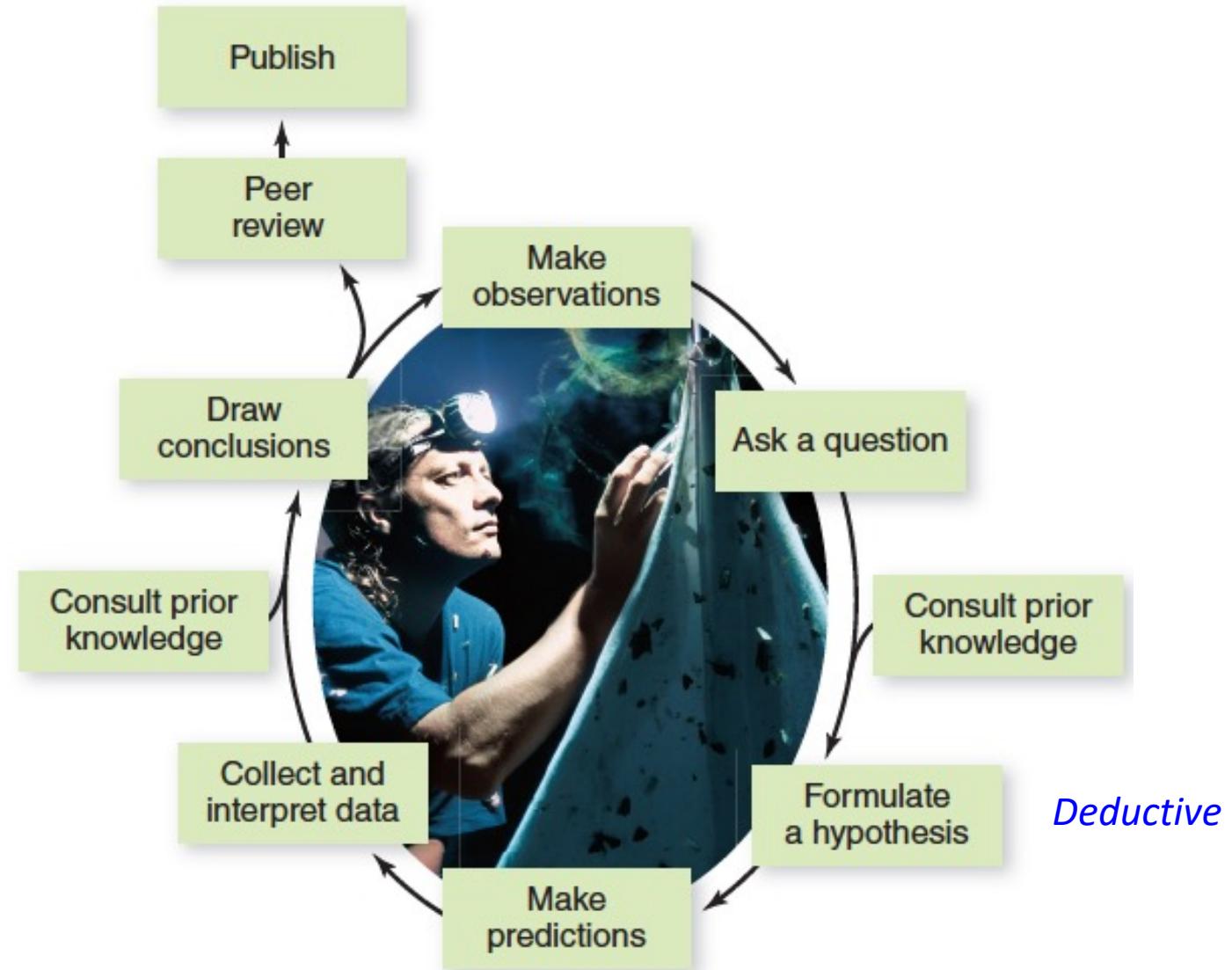
# Hypothesis-based science in biology

- 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

# Experiment

Test and challenge the hypothesis under known and controlled conditions

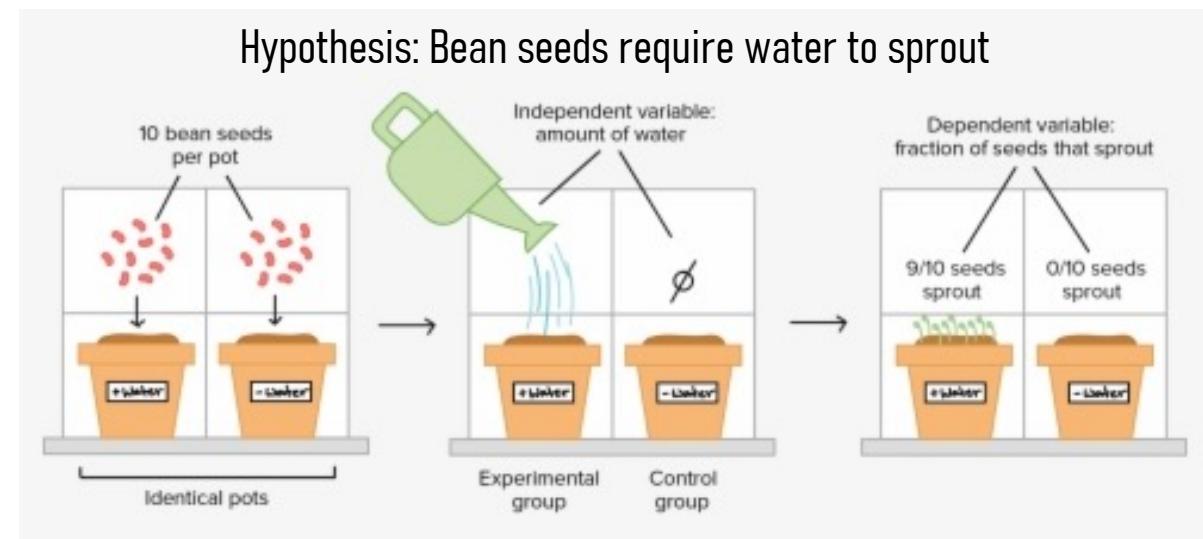
## Experimental group

- 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

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**Based on your observations, you suggest that the presence of water could accelerate the growth of bread mold. This is**

-----.

- a conclusion
- a hypothesis
- an experiment
- an analysis
- a prediction

# 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](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](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>



Start the presentation to see live content. For screen share software, share the entire screen. Get help at [pollev.com/app](https://pollev.com/app)

