

LS1101

Introduction to Biology

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Biology is the science that studies life, but what exactly is life?

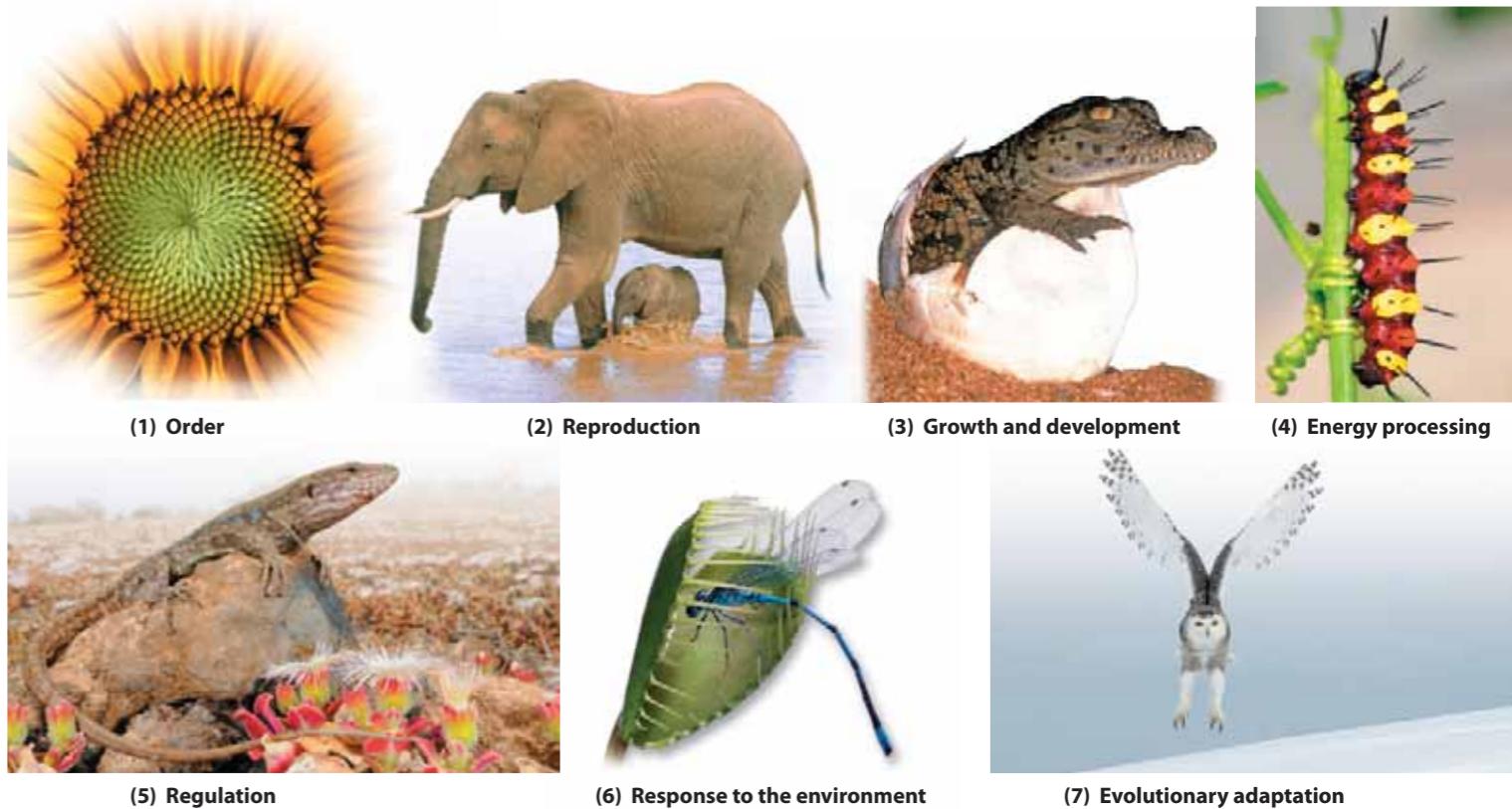
Biology - Exploring Life

Biology is the study of living things. It encompasses the cellular basis of living things, the energy metabolism that underlies the activities of life, and the genetic basis for inheritance in organisms. Biology also includes the study of evolutionary relationships among organisms and the diversity of life on Earth.



Characteristics of Life

1. Made of one or more cells
2. Displays organization
3. Grows and develops
4. Reproduces
5. Responds to stimuli
6. Requires energy
7. Maintain homeostasis
8. Adaptations evolve over time



The Hierarchy of Life

A cell is the smallest functional unit that can perform all of life's tasks. A living organism may consist of a single cell or a huge number of cells. In multicellular organisms, cells are specialized and depend on other cells to maintain life. The specialization and interdependence of cells contribute to a characteristic hierarchy of life, with each level defined by its structure and function.



CELL

Basic unit of life

TISSUE

A group of specialized cells that work together for a particular function

ORGAN

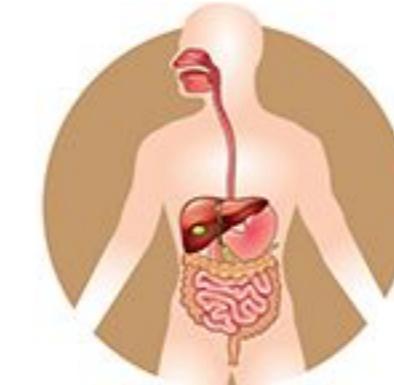
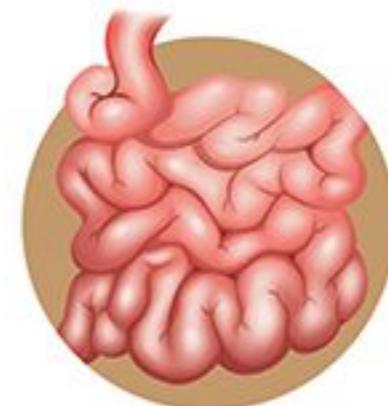
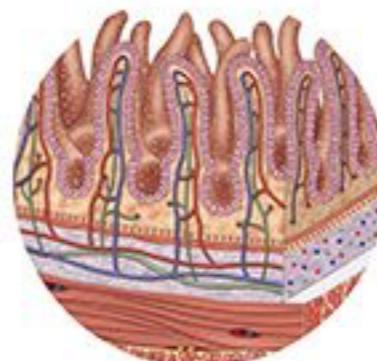
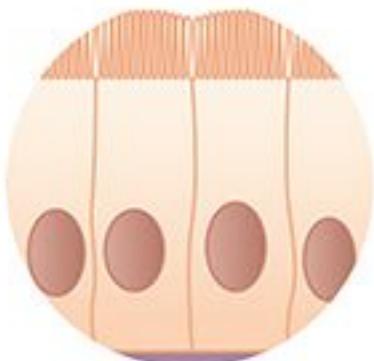
A distinct structure made up of different tissues that have a specific function

ORGAN SYSTEM

A collection of organs that carry out specific functions within an organism

ORGANISM

A living thing that carries out all of life's functions



The Cell

The lowest level of structure that can perform all activities required for life.

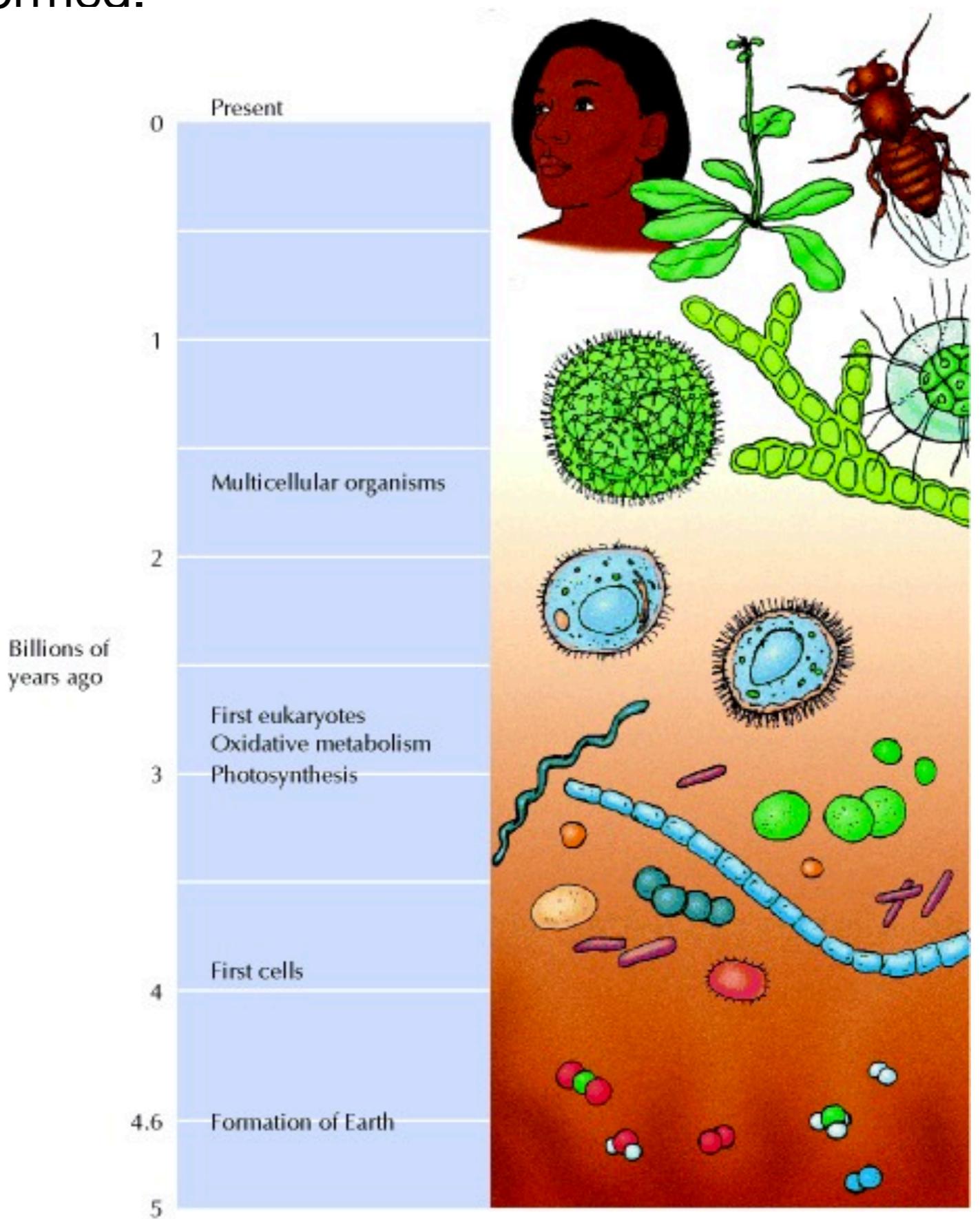
A cell can regulate its internal environment, take in and use energy, respond to its environment, and build and maintain its complex organization. The ability of cells to give rise to new cells is the basis for all reproduction and also for the growth and repair of multicellular organisms.

All organisms are composed of cells. They occur singly as a great variety of unicellular (single-celled) organisms, such as amoebas and most bacteria. And cells are the subunits that make up multicellular organisms, such as owls and trees. Your body consists of trillions of cells of many different kinds.

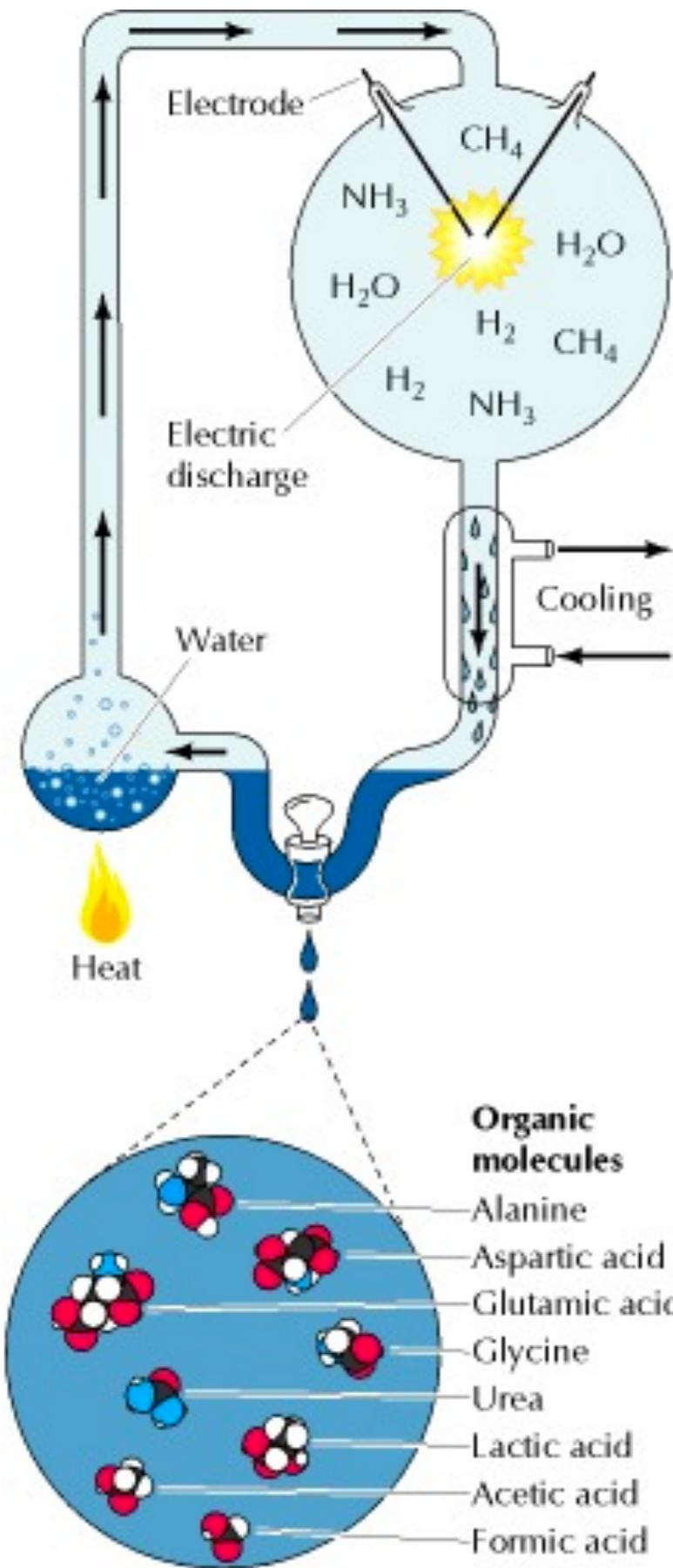
It appears that life first emerged at least 3.8 billion years ago, approximately 750 million years after Earth was formed.

How life originated and how the first cell came into being are matters of speculation, since these events cannot be reproduced in the laboratory.

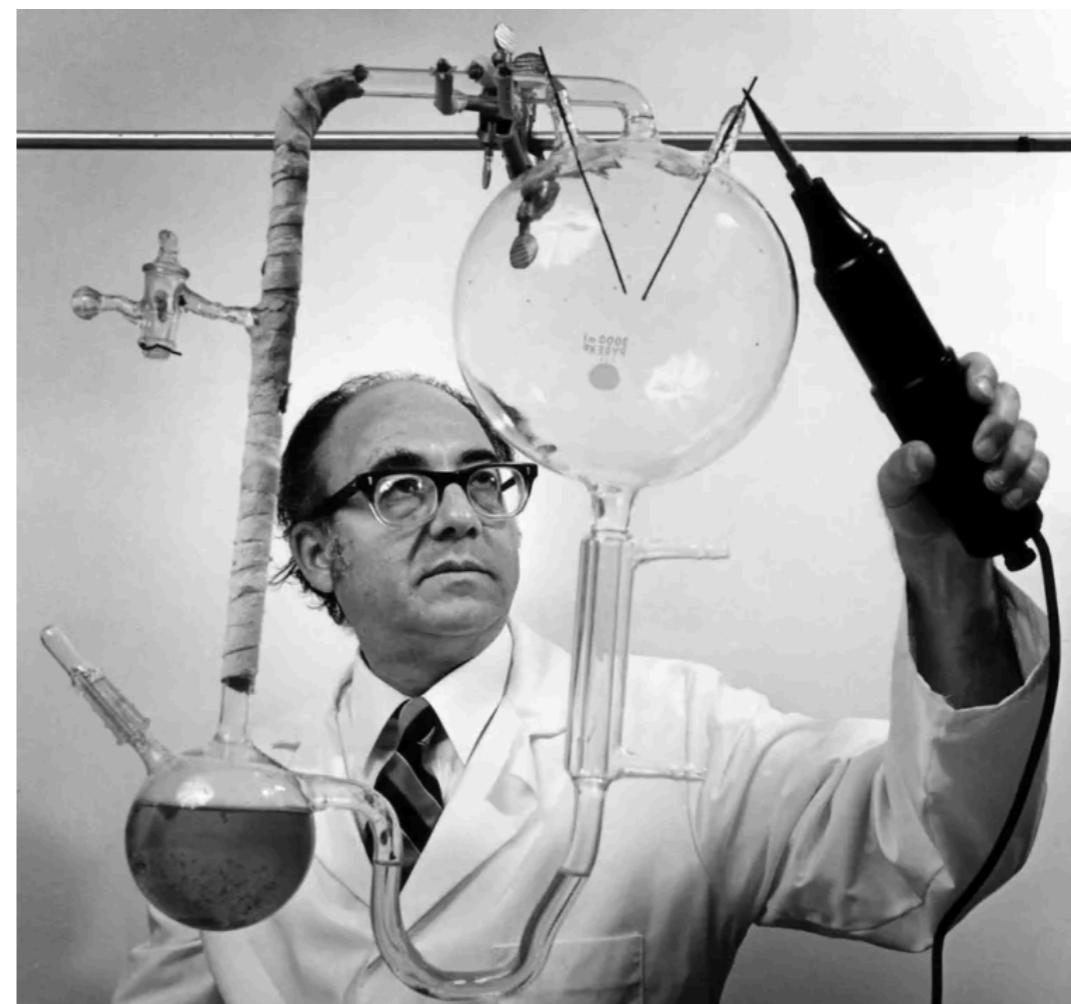
Nonetheless, several types of experiments provide important evidence bearing on some steps of the process.



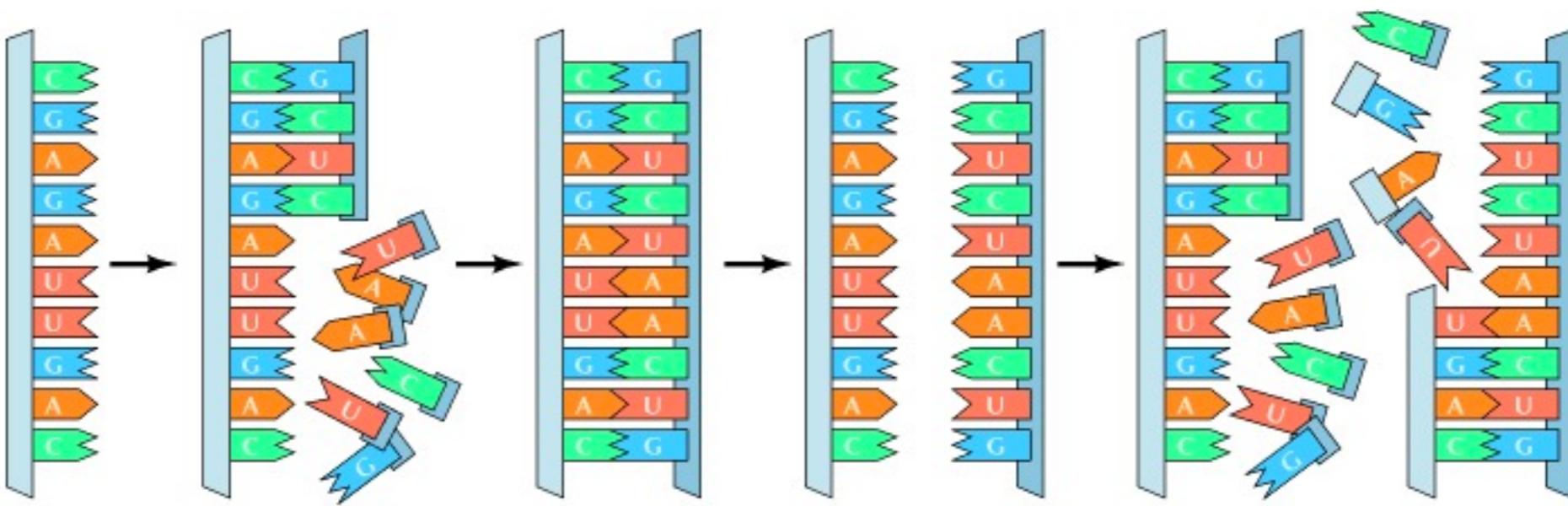
Spontaneous formation of organic molecules



Water vapor was refluxed through an atmosphere consisting of CH_4 , NH_3 , and H_2 , into which electric sparks were discharged. Analysis of the reaction products revealed the formation of a variety of organic molecules, including the amino acids alanine, aspartic acid, glutamic acid, and glycine.

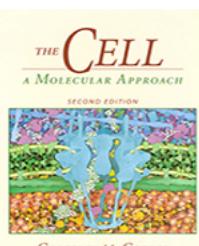
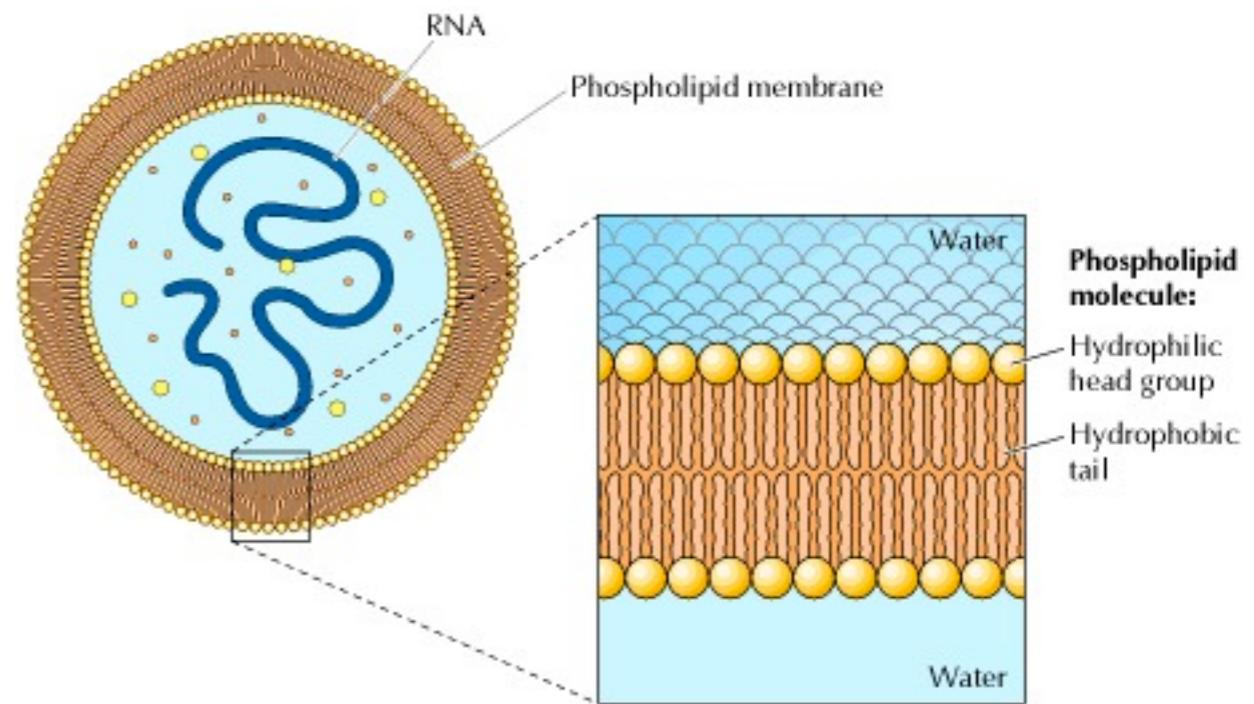


Self-replication of RNA



Complementary pairing between nucleotides (adenine [A] with uracil [U] and guanine [G] with cytosine [C]) allows one strand of RNA to serve as a template for the synthesis of a new strand with the complementary sequence.

The first cell is presumed to have arisen by the enclosure of self-replicating RNA in a membrane composed of phospholipids.



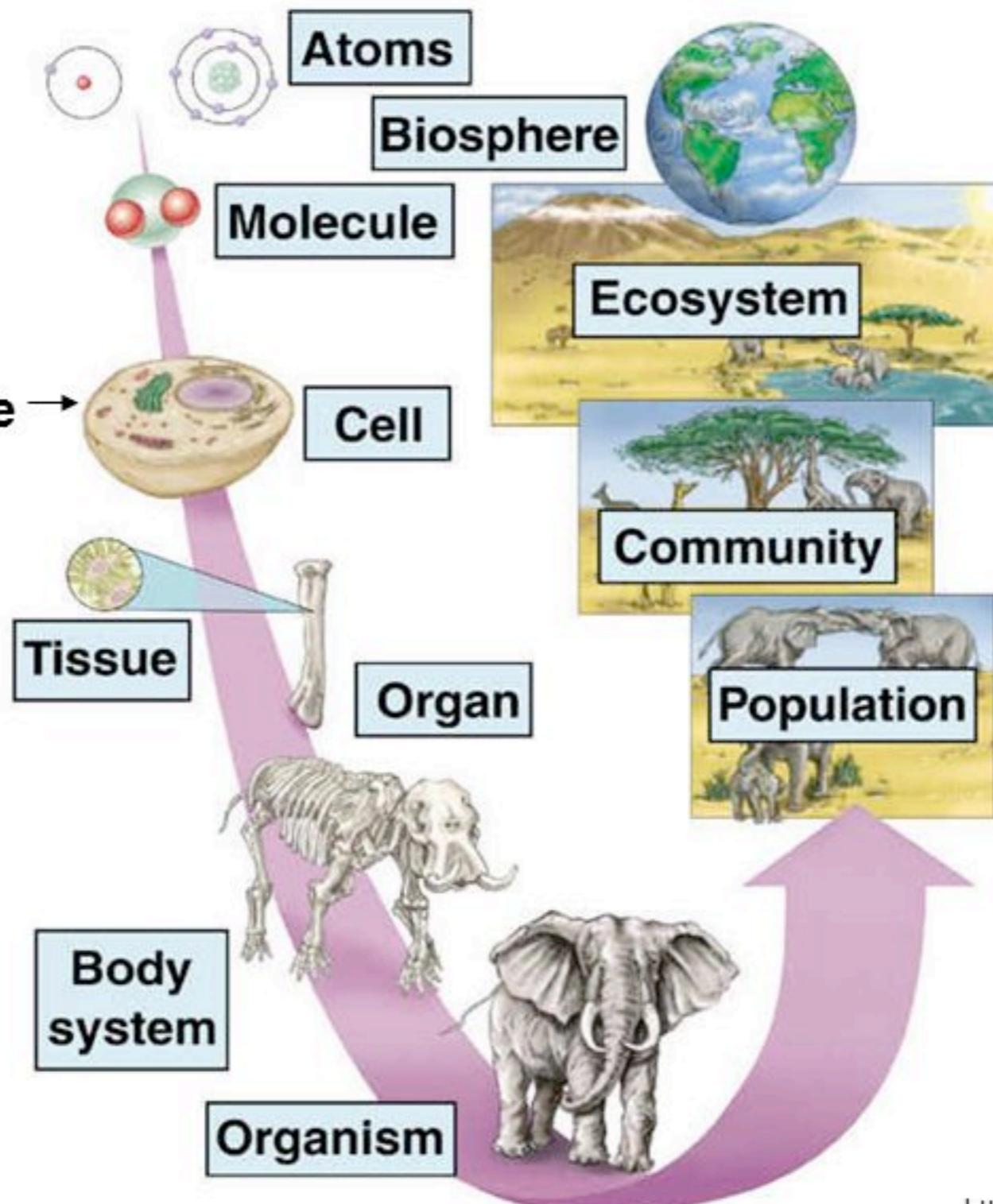
The Cell: A Molecular Approach. 2nd edition.
Cooper GM.
Sunderland (MA): [Sinauer Associates](#); 2000.

Biological Hierarchy of Organization:

Raven/Berg, Environment, 3/e
Figure 4.1

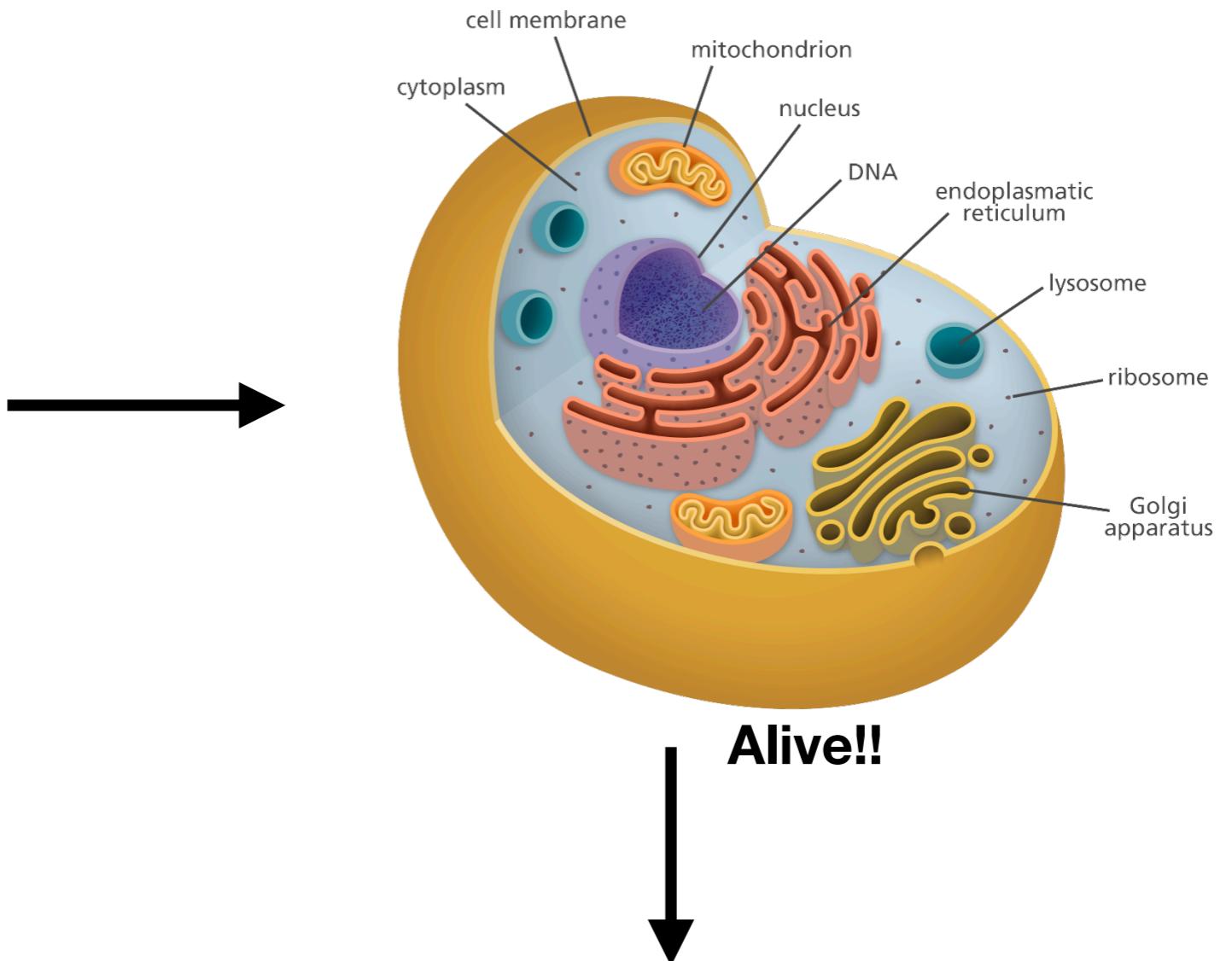
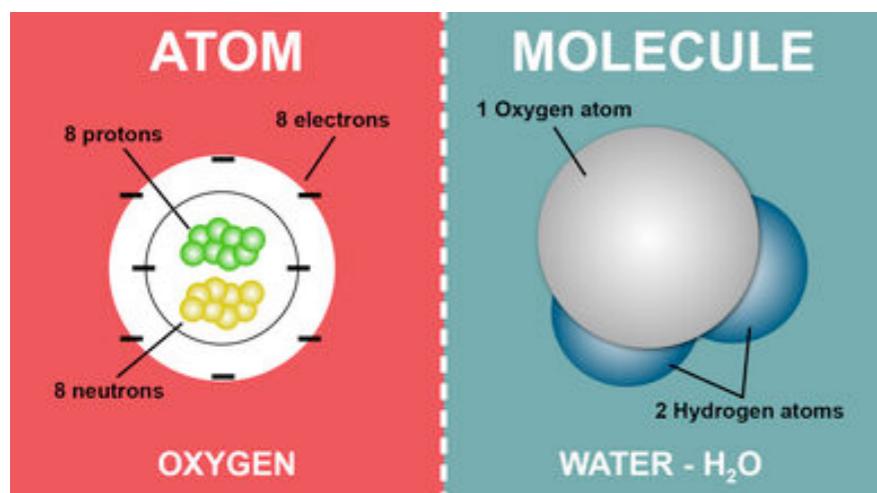
In Life's hierarchy, new properties emerge at each level

Life can exist here →



http://www.ux1.eiu.edu/~cfruf/images/bio3002/els_le2.jpg

At each higher level, there are novel properties that arise, properties that were not present at the preceding level. For example, life emerges at the level of the cell—a test tube full of organelles is not alive. Such **emergent properties** represent an important theme of biology.



Multicellular organisms are made of millions to trillions of cells!!

Life is an emergent property

“

THE WHOLE IS GREATER THAN
THE SUM OF ITS PARTS

- Aristotle

”



That familiar adage captures the important concept that a combination of components can form a more complex organization called a system. Examples of biological systems are cells, organisms, and ecosystems. To understand how such systems work, it is not enough to have a “parts list even a complete one. The future of biology is in understanding the behaviour of whole integrated systems.

Are emergent properties unique to Biology? NO

But compared to nonliving examples, the emergent properties of life are particularly challenging to study because of the unrivalled complexity of biological systems.



Sodium



Chlorine

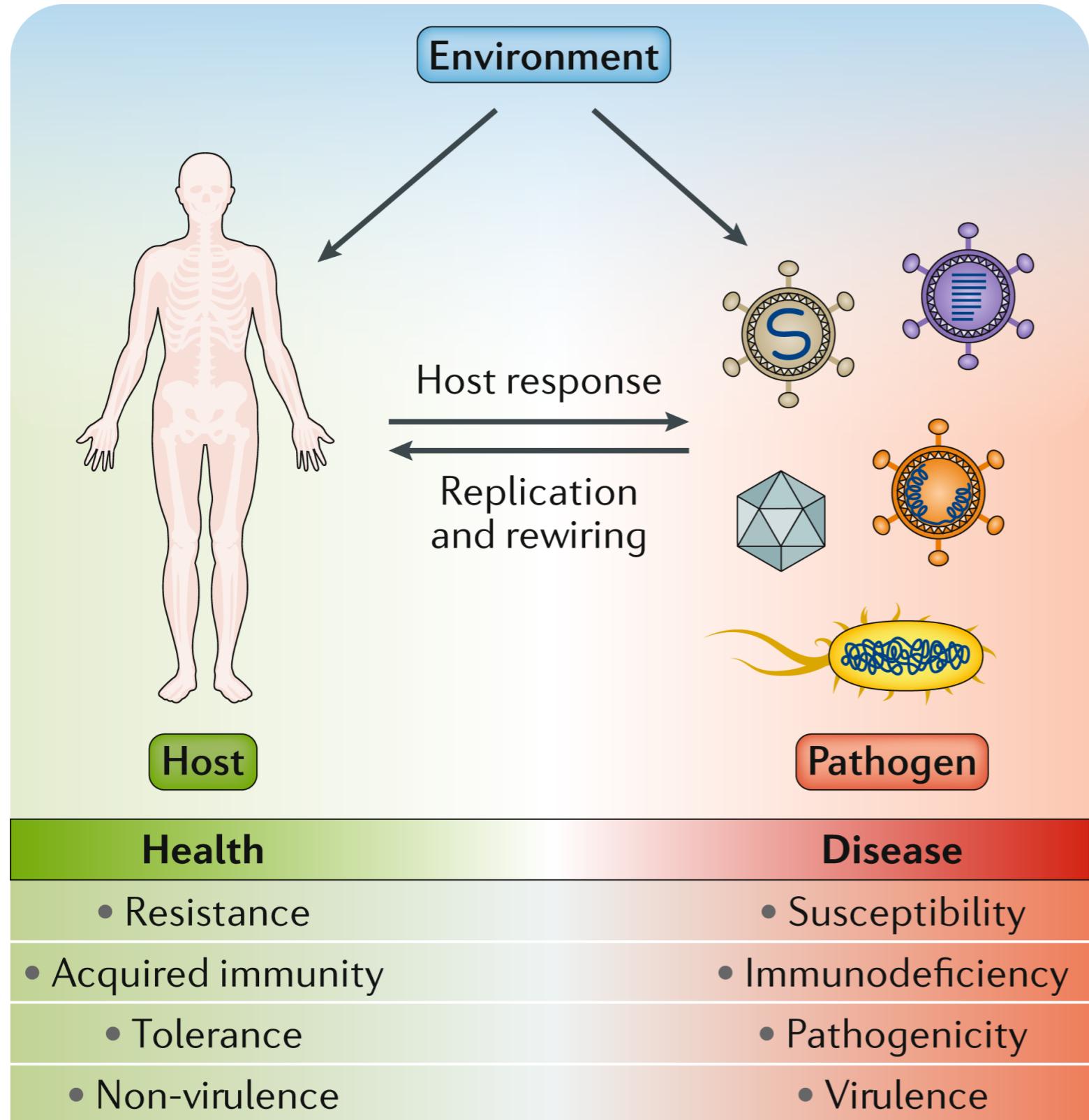


Sodium chloride



What is a pathogen?

A pathogen is usually defined as a microorganism that causes, or can cause, disease.



Environment
Host immunity
Microbe itself

What causes virulence?

Is due to microbe or the host?

But how do new infectious disease arise?

Microbial virulence can only be expressed in a susceptible host.

A microbe can be virulent in one host and avirulent in another.

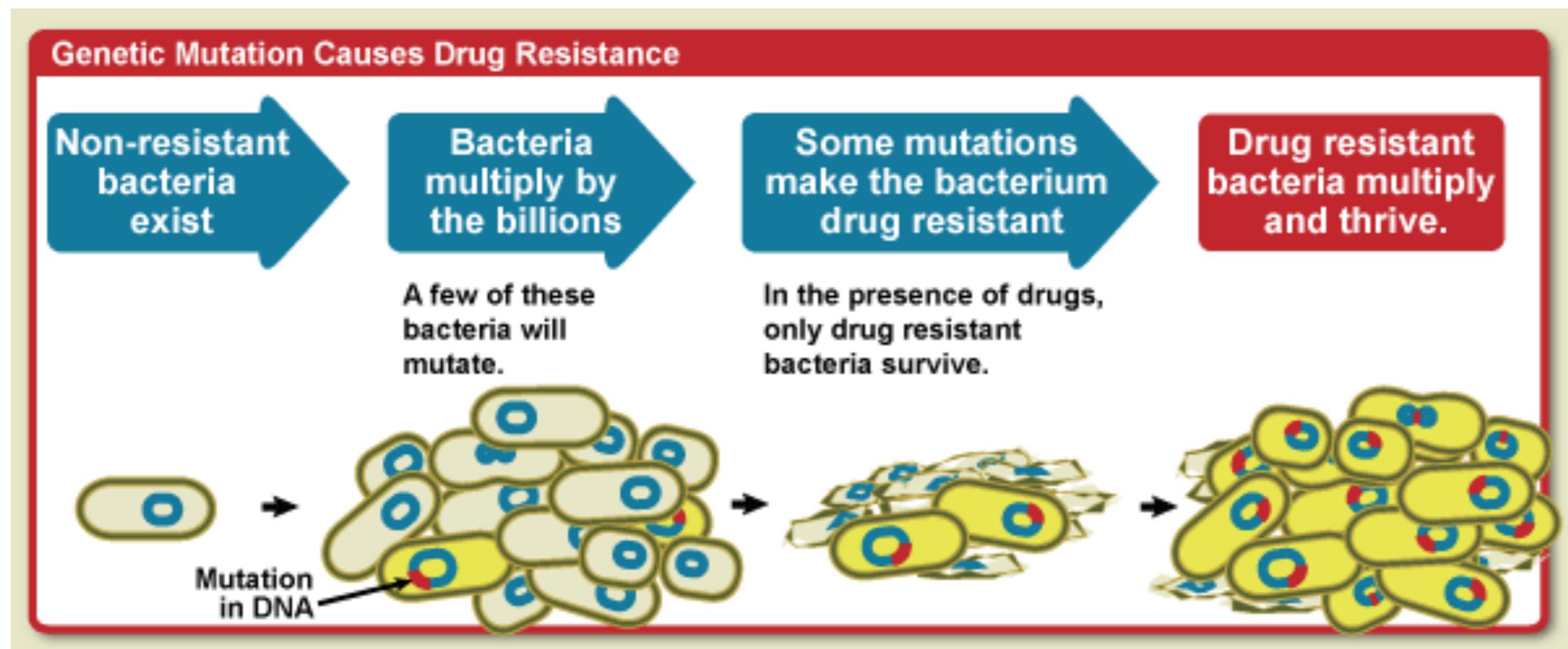
Some individuals get infected some don't due to the immunity.

Host immunity can negate virulence, as evidenced by the effectiveness of immunization that renders a microbe as deadly as the variola virus completely avirulent in individuals inoculated with the vaccinia virus.

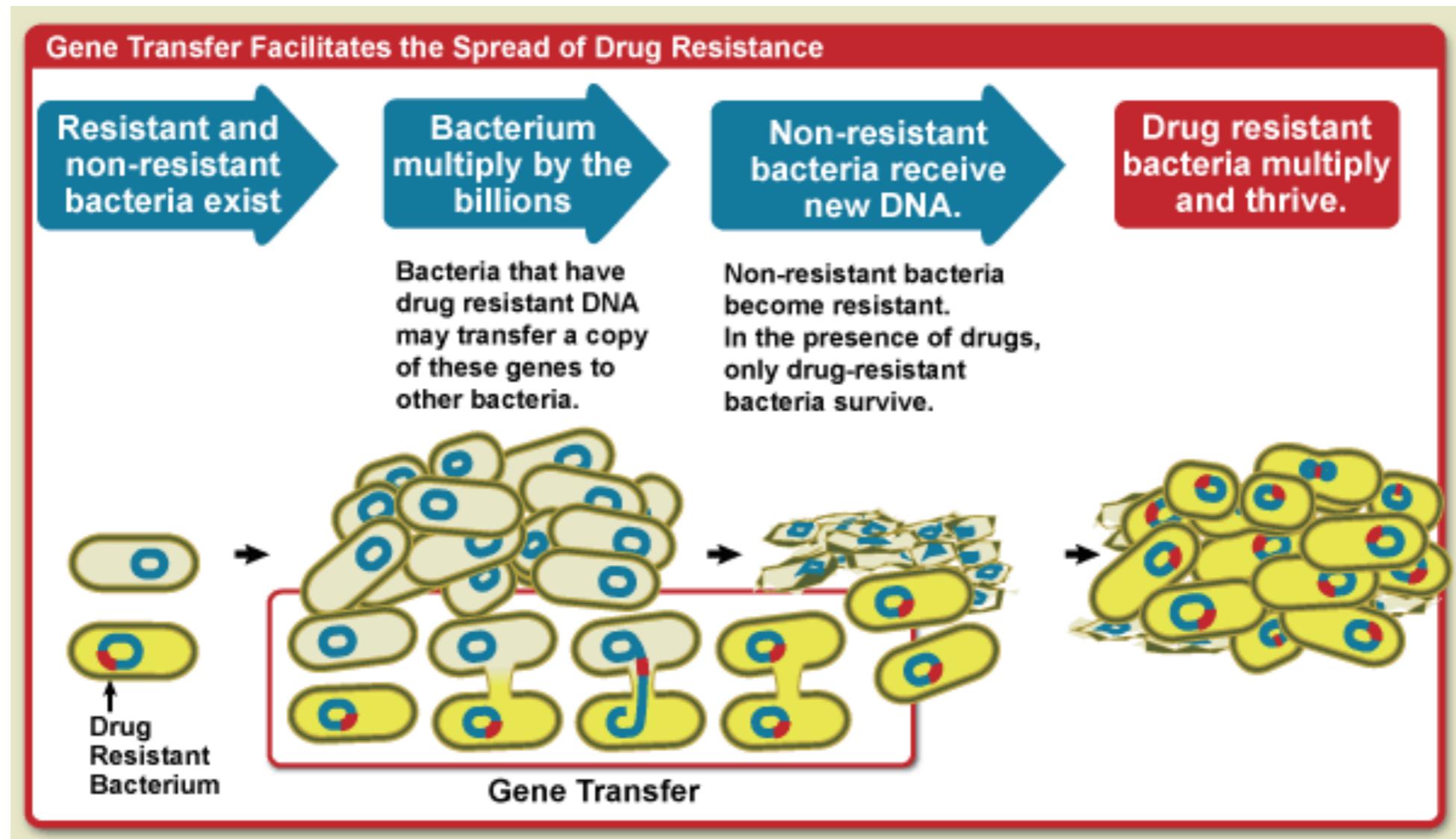
Infection with a microbe can result in diametrically opposed outcomes, ranging from the death of a host to elimination of the microbe. Hence, virulence is inherently novel, unpredictable, and irreducible to first principles.

Virulence is an emergent property

Microbes, such as bacteria, viruses, fungi, and parasites, are living organisms that evolve over time. Their primary function is to reproduce, thrive, and spread quickly and efficiently. Therefore, they adapt to their environments and change in ways that ensure their survival.



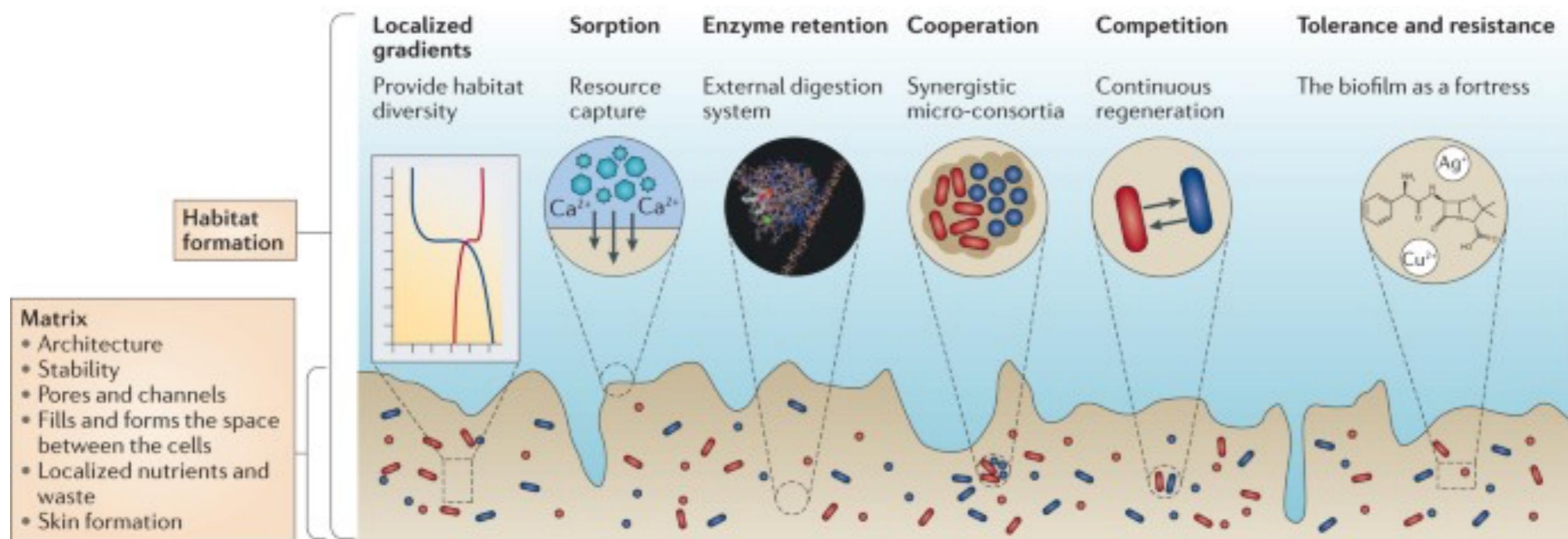
Microbes also may get genes from each other, including genes that make the microbe drug resistant. Bacteria multiply by the billions. Bacteria that have drug-resistant DNA may transfer a copy of these genes to other bacteria. Non-resistant bacteria receive the new DNA and become resistant to drugs. In the presence of drugs, only drug-resistant bacteria survive. The drug-resistant bacteria multiply and thrive.



Microbial resistance is an emergent property

Biofilm formation is an emergent property

Emergent properties of bacterial biofilms include social cooperation, resource capture and enhanced survival following exposure to antimicrobials, and cannot be understood and predicted through the study of free-living bacterial cells.



It is an exciting era to study Biology. Why?

- We are closer to understanding many interesting things like how cell works, how plants convert light into energy, how human brain functions, how the great diversity of life came about etc..**
- Any one can study Biology!! Biology is a field that requires a good understanding of all the other sciences. If you have a good high school level foundation in biology, chemistry, and mathematics, you can go for Biology as your major.**
- If you see that some part of the natural world is in danger of being destroyed by human activity, and if you want to be in a position to effect change in the way people live and use the environment**
- If you would like to work on improving human health, food production, population dynamics, epidemics, biology would be the best choice.**
- If you like exploring neurosciences and understand how it connects to sociology or psychology, biology training would be helpful.**

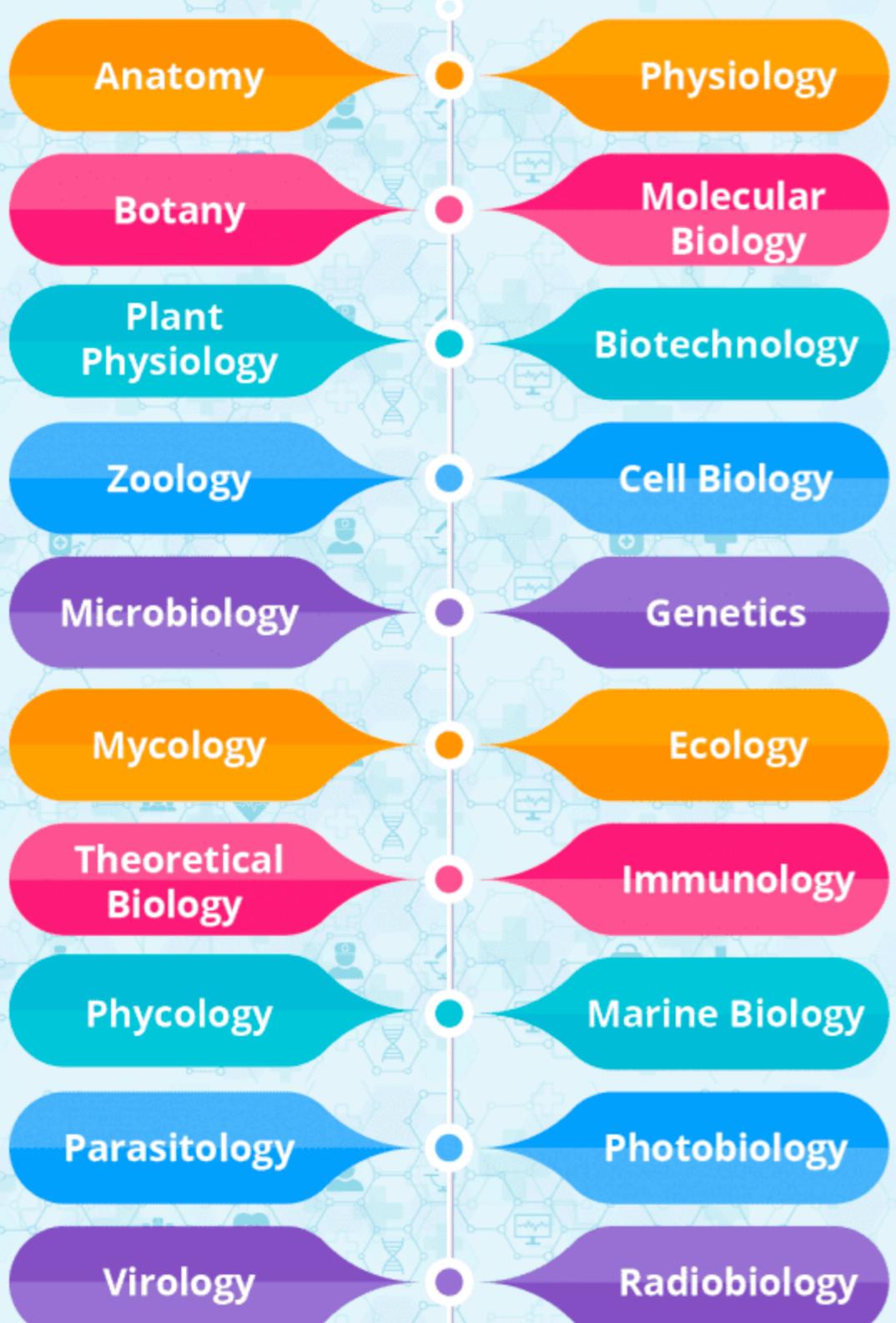
“There is no greater wonder, no bigger question and no deeper thought than that which focuses on the beauty, mystery and miracle that is life”.

- Job opportunities with good salaries
- Bio-entrepreneurships
- A blend of lab-field(outdoor)-office work

The more we learn about life, the more fascinating it becomes, as progress in one question leads to even more questions that will captivate curious minds for decades to come. More than anything else, biology is a quest, an ongoing inquiry about the nature of life.

The world needs biologists like never before to solve many of the challenges it faces today.

Specialisations in Biology



There is enormous scope for biology and this keeps growing!

Top 200 Highest Impact Factor Journals (2022)

1. CA: A Cancer Journal for Clinicians – Impact Factor: 286.13
2. Lancet – Impact Factor: 202.731
3. New England Journal of Medicine – Impact Factor: 176.079
4. JAMA: Journal of the American Medical Association – Impact Factor: 157.335
5. Nature Reviews Molecular Cell Biology – Impact Factor: 113.915
6. Nature Reviews Drug Discovery – Impact Factor: 112.288
7. Nature Reviews Immunology – Impact Factor: 108.555
8. Lancet Respiratory Medicine – Impact Factor: 102.642
9. BMJ: British Medical Journal – Impact Factor: 93.333
10. Nature Medicine – Impact Factor: 87.241
11. Lancet Microbe – Impact Factor: 86.208
12. World Psychiatry – Impact Factor: 79.683