The Science of Life

Introduction to Biology
What is Biology

- “Bio” = life
- “logos” = knowledge
- many branches - different things to study in biology
Botany

- study of plants
- all types of plants - trees, flowers, grass, moss, etc.
- study growth, reproduction, development, disease - everything about plants and their environment
Zoology

- study of animals
- just like botany only with animals
Embryology

- embryo - developing organism
- studies the changes that happen to an organism from when sperm and egg fuse to full growth
Ecology

- studies how life interacts with environment
- about relationships in environment
- **biotic factors** - living part
- **abiotic factors** - nonliving part
Microbiology

- “micro” = really really small
- organisms are too small to see just with eye - need a microscope
- ex. eukaryote and prokaryote
Genetics

- study of genes in organisms - DNA
- why you look like parent(s)/brother/sister
- if your mom and dad are doctors, will you be one too?
Biotechnology

- using knowledge in biology to make products beneficial to humans
- making new medicines, new machines to help with surgery, or even changing our genes
Characteristics of Life
What is life? How is a living thing different from a nonliving thing?
Organization and Cells

- **organization** - the high degree of order within an organism’s internal and external parts

- Ex. an owl and a rock
- rock has specific shape - usually irregular
- different rocks will have different shapes and sizes
- however the owl is highly organized
owls of same species have same body parts arranged in almost the same way

they interact with environment in the same way
Cells

- all living things are made of cells
- cells are basic unit of life
- **unicellular** organisms - made of only one cell
  - example: bacteria
- **multicellular** organisms - more than one (usually many)
  - example: plant, animal, human, etc.
all living things have complex organization

each cell has **organelles** that are responsible for different functions

cells come together to form **tissues** that perform specific function

tissues come together to form **organs**

organs come together to form **organ systems**
all living things respond to their environment

Ex. what happens when you go outside in the sun?

sweat - why do we sweat?
stimulus - physical or chemical change in internal or external environment

Ex. eye dilates in response to lower levels of light
Homeostasis

- All organisms have mechanisms that allow them to maintain a stable internal environment.
- Without them, we die.
- Ex. cell’s water content controlled by taking in and releasing water.
- Cell with too much water ruptures (breaks open) and dies.
- Cell with too little water shrivels (shrinks) and dies.
- **homeostasis** - maintenance of a stable level of internal conditions even though environment is constantly changing

- organisms have regulatory systems to control things like temperature, water content, uptake of nutrients

- more than one system can be used to maintain conditions
Ex. maintaining temperature

Too cold:
- cells burn fuel to produce body heat
- hair/feathers fluff up to trap insulating layer of air next to body

too hot:
- blood vessels dilate bringing blood closer to skin to release heat
- sweat - evaporates taking heat with it
Metabolism

- all living things need energy

- energy use depends on **metabolism** - sum of all chemical reactions that take in and transform energy and materials from environment
some make their own food by using energy from sun during **photosynthesis**

other organisms need to eat food to get energy
Growth and Development

- living things grow and increase in size

- some nonliving things also grow by accumulating (building up) more of the same material
  - crystals
  - fire
living things grow through cell division and enlargement of cells

**cell division** - formation of two new cells from an existing cell
- in unicellular organisms, after cell division is cell enlargement

- in multicellular life, organisms mature through cell division, cell enlargement, and development
Development

- **development** - process by which organism becomes a mature adult

- involves cell division and cell differentiation (specialization)

- as a result, an adult organism is composed of many different types of cells specialised for different functions
Reproduction

- all organisms produce new organisms like themselves through reproduction

- unlike other characteristics, reproduction is not essential to survival

- during reproduction, organisms transmit hereditary information to their offspring (babies)
hereditary information is encoded in DNA - deoxyribonucleic acid

a short segment of DNA that contains instructions for single trait is called a gene
can be two ways:

- **asexual** - one parent
  - offspring genetically identical (exactly the same) to parent

- **sexual** - two parents
  - offspring genetically different to parents
Adaptation through evolution

- all living things evolve (change) over time
- result of adapting to changing environment
- Ex. polar bear - adapted to survive super cold temperature
  - each hair is hollow and clear
  - skin is black
  - eat fatty animals to gain fat to insulate them during winter
Themes in Biology
Diversity and Unity of Life

- The diversity (variety) of life is amazing.
- There are single-celled organisms that live in the Antarctic ice that never thaws.
- There are whales that have 1,000 trillion cells that can migrate from Alaska to Mexico every year.
Tardigrades

- these animals can survive anything!
- -272C - 150C
- 6 times the pressure at the bottom of the ocean
- ionising radiation that would kill human
- no food or water for more than 30 years
- drying out to less than 3% water
- the vacuum of outer space!!!!!!
Unity in the Diversity of Life

- life is characterised by unity - features that all living things have in common

- Ex. **genetic code** - rules that control how cells use hereditary information in DNA
“tree of life”

model of relationships by ancestry among organisms
- all living things share certain genes, but no two types have the same full set of genes
- biologists build the “tree of life” by placing organisms that have more similar sets of genes on closer branched (lineages)
- more distantly related organisms are on branches farther apart
Three Domains of life

- notice the three main branches
- **domains**
- Bacteria and Archaea have less complex cells than Eukarya
- another system of grouping is in **kingdoms**
Interdependence

- organisms interact with each other

**ecology** - branch of biology that studies these interactions between organisms and their environment

- ecologists study single species as well as **ecosystems** - communities of living species and their physical environments
Evolution of Life

- individuals change during their lifetime but their basic genetic characteristics don’t change
- populations of living things do change over time through evolution
- process in which inherited characteristics within populations change over generations
- evolution helps us understand the branches of the tree of life
Natural Selection

- this is how evolution happens

- organisms that have favourable traits are better able to survive and reproduce successfully than others without the trait
in snowy environment, which rabbit will survive more successfully?
The Scientific Method

A way to answer questions
people have been asking questions for many years about things that happen around them

- Why is the sky blue?
- What makes it rain?
- Why and when do birds sing?
The scientific method is a logical step by step way to ask and answer questions. It involves asking a question, making an educated guess and setting up an experiment to test whether or not your guess is correct.
Step 1

- Observation
- can also be called research
Step 2

- **hypothesis**

- simple statement that is what scientists think the result of their experiment will be
Step 3

- **prediction**

- statement that tells what would happen in a test situation if the hypothesis is true
Step 4

- Experiment, analysis and evaluation
- Set up experiment
- make observations during experiment - what happened?
- collect data
- analyze data
Step 5

- conclusion
- summary of results
- see if results match the hypothesis
Step 6

- communication
  - done through
  - students - lab reports
  - professionals - research publications