

احجز مكانك واستعد للامتحان بثقة كاملة

$$F = \frac{Gm_1m_2}{r^2}$$

ملزمة العلوم الفصل الأول

Inspire 9 عام لعام 2027

$$EF = ma$$

EF

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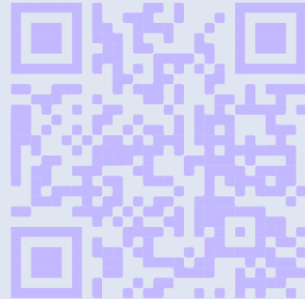
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شرح الدروس



للتواصل والحجز



انضم للقناة

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شرح لدروس الفصل
الأول كامل

بـ 99
درهم فقط

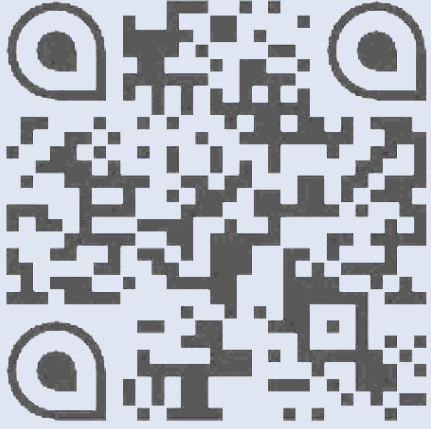
ملازم

اختبارات

Module (2): Principles of Ecology

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Module (2): Principles of Ecology

01

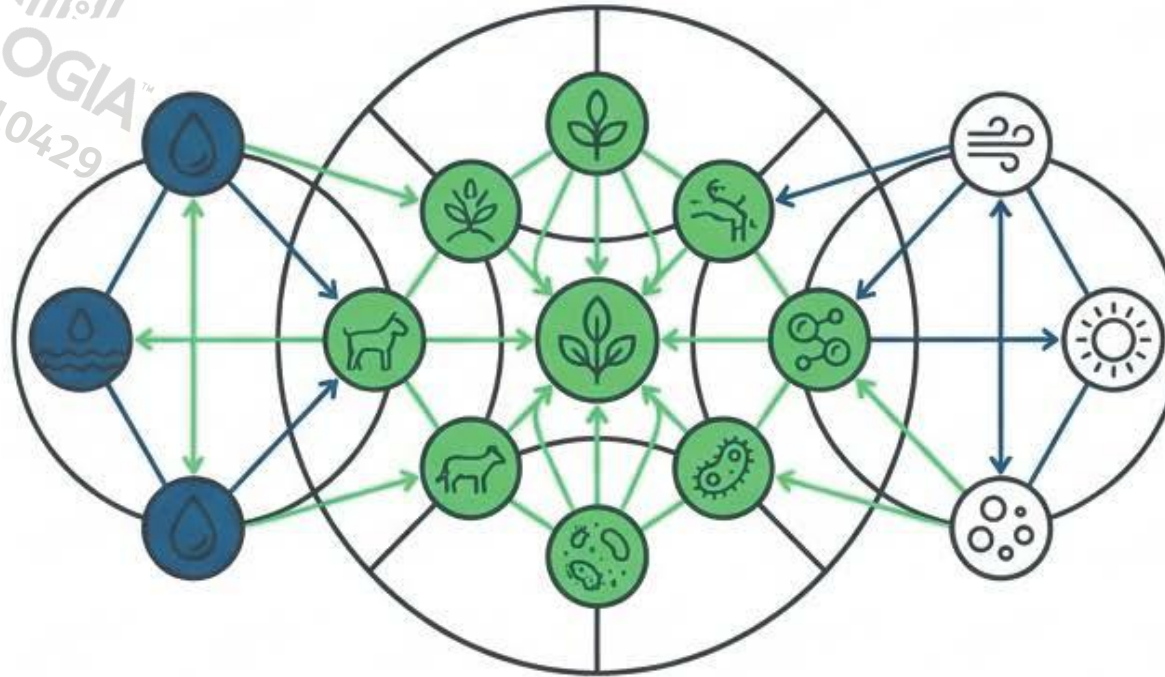
First Lesson: Organisms and Their Relationships



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Ecology: Organisms and Their Relationships

A Comprehensive Visual Blueprint to the Biosphere, Environmental Factors, and Ecosystem Interactions.

NOLOGIA Framework: Defining Ecology

Ecology is the scientific discipline in which the relationships among living organisms and the interactions the organisms have with their environments are studied.

Introduced in 1866 by Ernst Haeckel

1. OBSERVE



Focus on interactions in the field. Scientists gain insight by directly watching environments.



2. EXPERIMENT



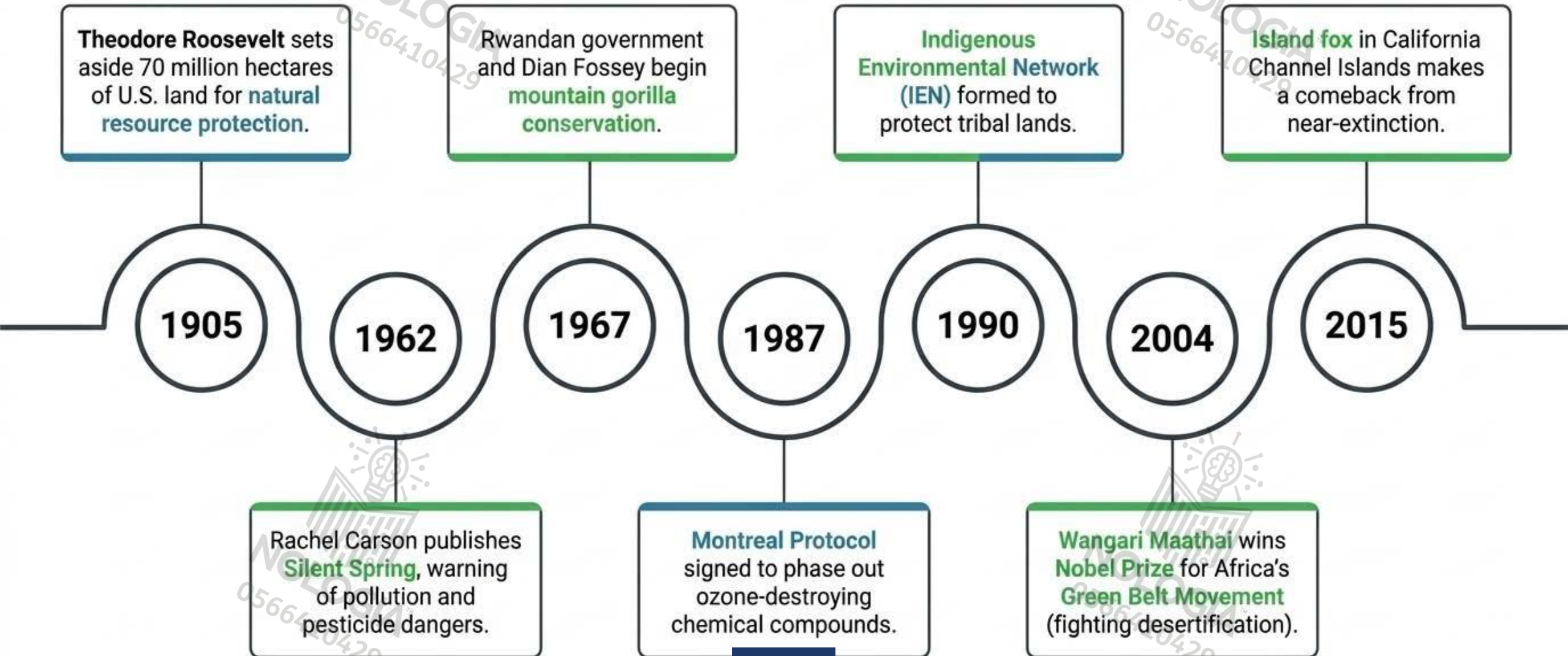
Testing variables in controlled environments to determine relationship causes, such as why organisms become ill from specific water sources.

3. MODEL



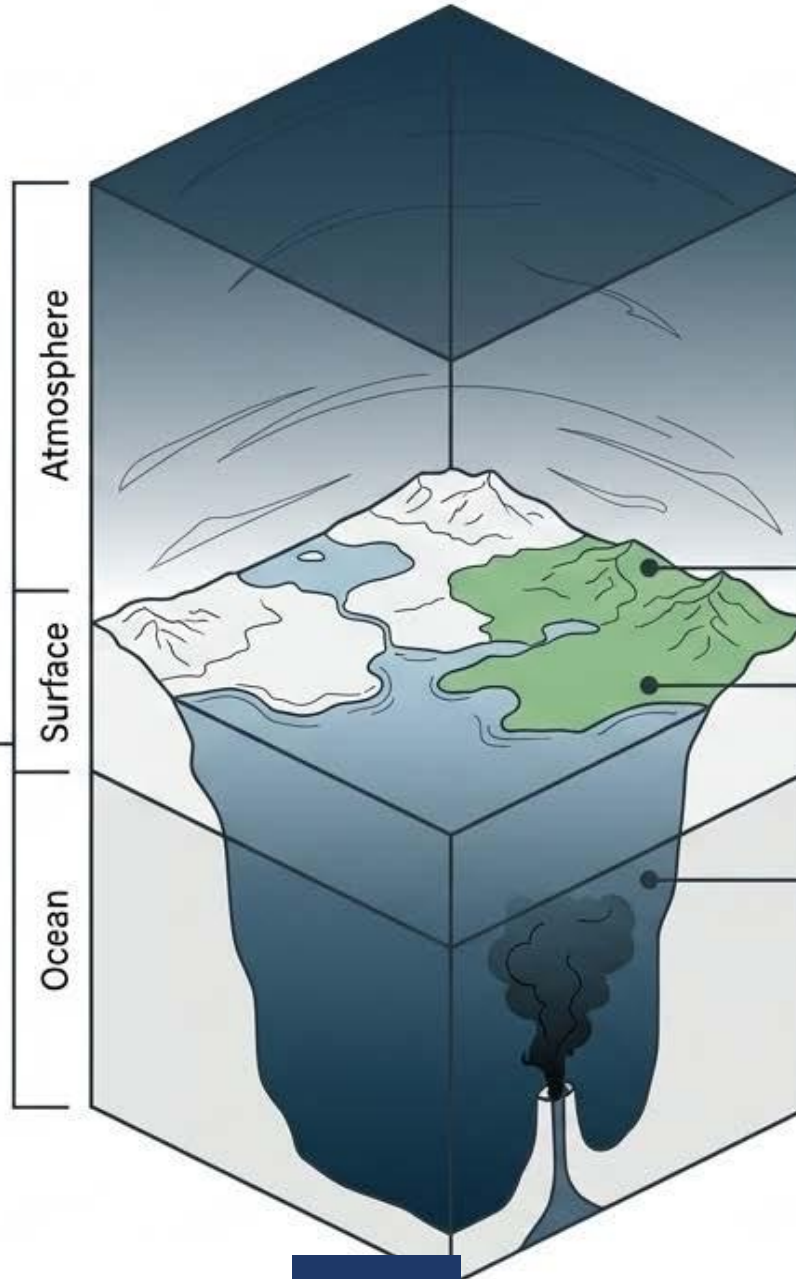
Using physical, mathematical, and computer models to simulate complex systems with too many variables without damaging the actual environment.

NOLOGIA Timeline: Milestones in Ecology (1905-2015)



NOLOGIA Canvas: Earth's Ball of Life

The biosphere includes only the portion of Earth that supports life, extending several kilometers above and below the surface.



From rainforests to deserts to deep-ocean vents, diverse organisms populate diverse locations.



NOLOGIA Matrix: Environmental Factors

BIOTIC FACTORS

The living factors in an organism's environment.

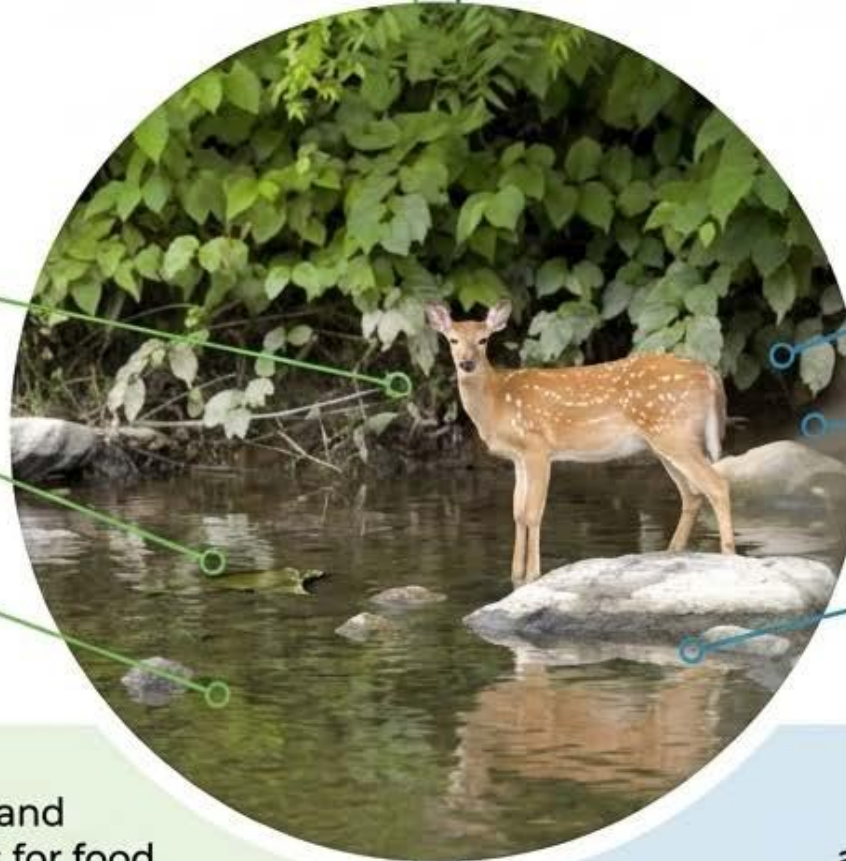
The Deer

Fish & Frogs (in water)

Microscopic
Organisms & Algae

KEY RULE:

Interactions are necessary for health and reproduction. Deer depend on others for food and are a food source for other organisms.



ABIOTIC FACTORS

The nonliving factors in an organism's environment.

Water & Air Currents

Sunlight & Temperature

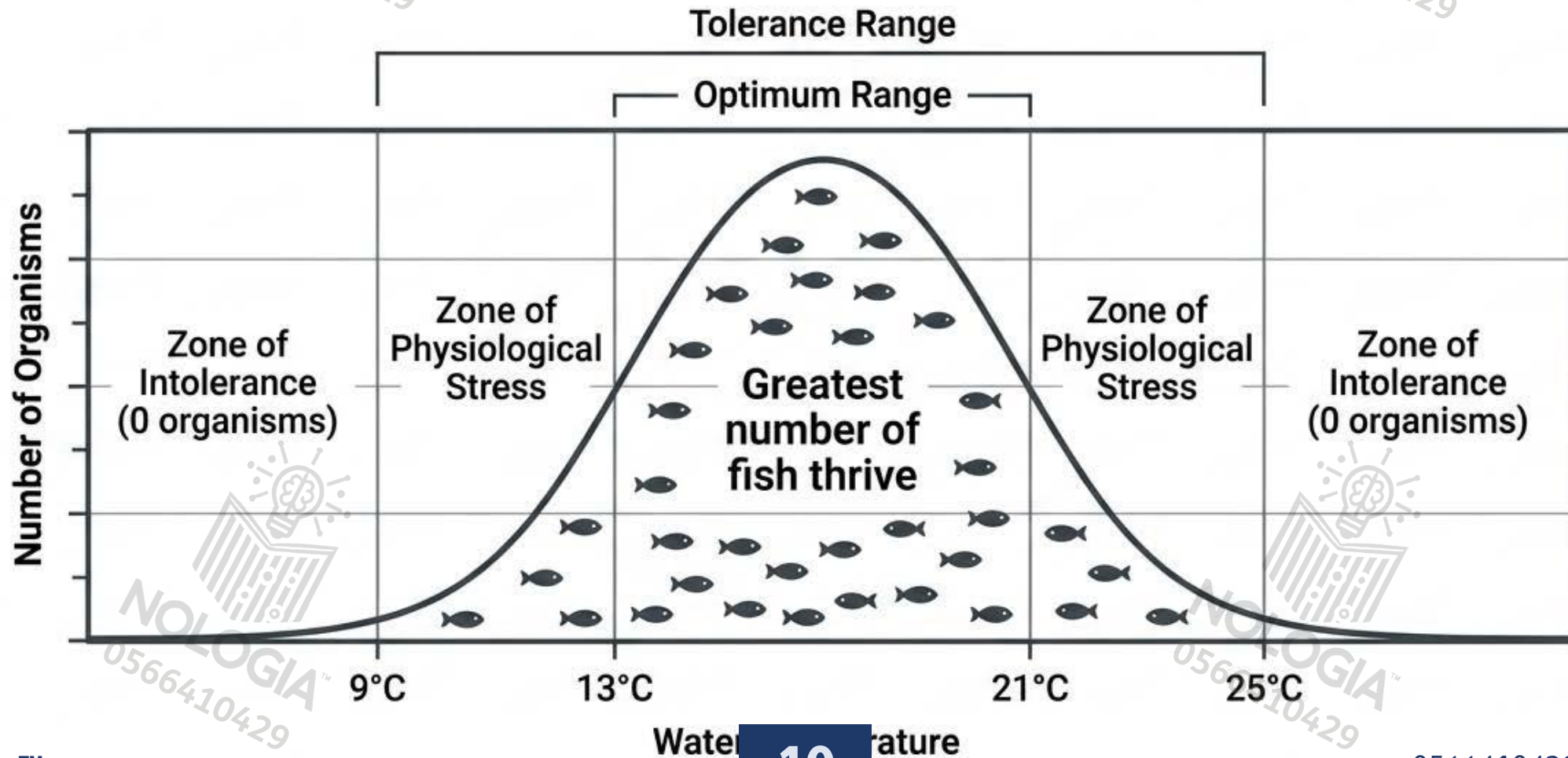
Soil Type, Rocks & Minerals

KEY RULE:

Organisms are adapted to specific abiotic factors. Transplanting a swamp plant to a dry desert will cause it to die.

NOLOGIA Data Viz: Range of Tolerance

Tolerance is an organism's ability to survive when subjected to specific abiotic or biotic factors. Limiting factors restrict numbers, reproduction, or distribution.



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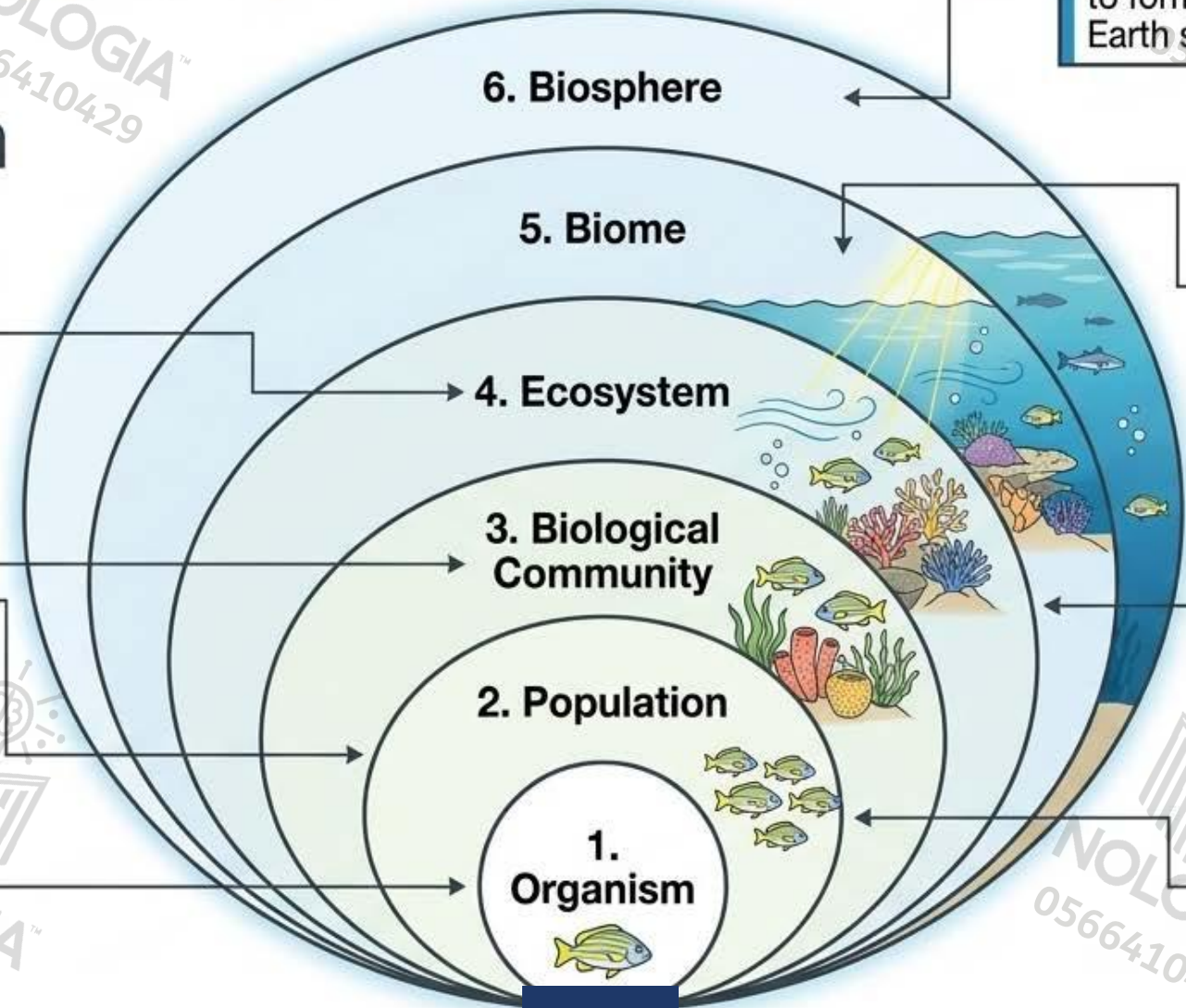
Hierarchy: Levels of Ecological Organization

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A biological community PLUS all the abiotic factors (e.g., the coral reef + sea water, temperature, light).

A group of interacting populations occupying the same area (e.g., fishes, coral, marine plants).

An individual living thing (e.g., one striped fish).



The highest level; all biomes combining to form the layer of Earth supporting life.



A large group of ecosystems sharing the same climate and similar communities (e.g., marine biome).

A group of interacting populations occupying the same area (e.g., fishes, coral, marine plants).

Organisms of a single species that share the same geographic location at the same time (e.g., a school of striped fish).

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NOLOGIA Diagnostic: Habitat vs. Niche

HABITAT (The “Where”)

An area where an organism lives.

A single tree for an insect, or a sprawling grove of trees for a moving flock of birds.



NICHE (The “How”)

The role or position that an organism has in its environment.

How an organism meets its strict needs for food, shelter, and reproduction (living space, temperature, moisture, mating conditions).

One bird species eats insects on leaves while another uses bark for nesting materials in the exact same habitat.

VS

NOLOGIA Dynamics: Community Interactions

COMPETITION (Resource Driven)

Occurs when more than one organism uses a limited resource (food, water, space, light) at the same time. The strong survive, while the weak die or relocate.



PREDATION (Consumption Driven)

The act of one organism pursuing and consuming another for food.

- **Animals:** Cats eating birds, ladybugs eating insects.
- **Plants:** Venus flytrap capturing insects with sweet, sticky substance.



NOLOGIA Synthesis: Symbiotic Relationships

Symbiosis is a close relationship when two or more species live together.

$(+ / +)$	MUTUALISM	
	Mechanism: Both organisms benefit.	
	Examples: Algae & Sloth (algae gets moisture, sloth gets camouflage); Lichens (fungi provide habitat, algae provide food).	
$(+ / 0)$	COMMENSALISM	
	Mechanism: One organism benefits, the other is neither helped nor harmed.	
	Examples: Clownfish & Sea Anemone (clownfish gets protection, anemone unaffected); Lichens on a tree.	
$(+ / -)$	PARASITISM	
	Mechanism: One organism benefits at the expense of another (host is harmed but usually not killed immediately).	
	Examples: External (ticks), Internal (tapeworms), Brood parasitism (cowbirds), Parasitic wasps on a tomato hornworm.	

NOLOGIA Module Review: Essential Checkpoints



Ecology studies interrelationships between organisms and their environments.



Biotic (living) and **Abiotic (nonliving)** limiting factors restrict population growth.



Organisms operate within a strict Range of Tolerance for survival factors.



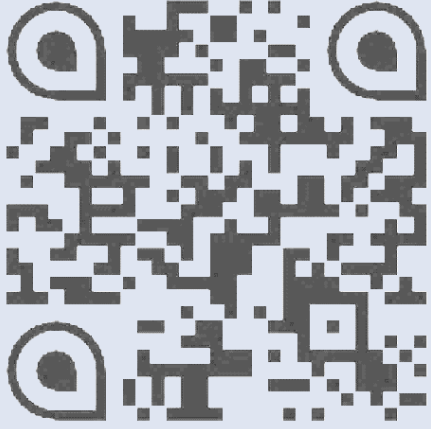
Ecological organization scales from Organism → Population → Community → Ecosystem → Biome → Biosphere.



A **Habitat** is **WHERE** an organism lives; a **Niche** is **HOW** it survives and functions.



Symbiosis includes Mutualism (+/+), Commensalism (+/0), and Parasitism (+/-).



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Module (2): Principles of Ecology

02

Second Lesson: Flow of Energy in an Ecosystem



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Flow of Energy in an Ecosystem

A Comprehensive Visual Study
Guide for Biology Students

Energy Flows, It Does Not Cycle

Focus Question: How does energy flow through an ecosystem?



Organisms interact primarily by passing energy to one another. One way to study ecosystem interactions is to follow this energy flow.

The classification of any organism in an ecosystem depends entirely on how they obtain their energy.

Autotrophs (Primary Producers)

Organisms that collect energy from sunlight or inorganic substances to produce their own food. They are the foundation of all ecosystems.

Photosynthesis



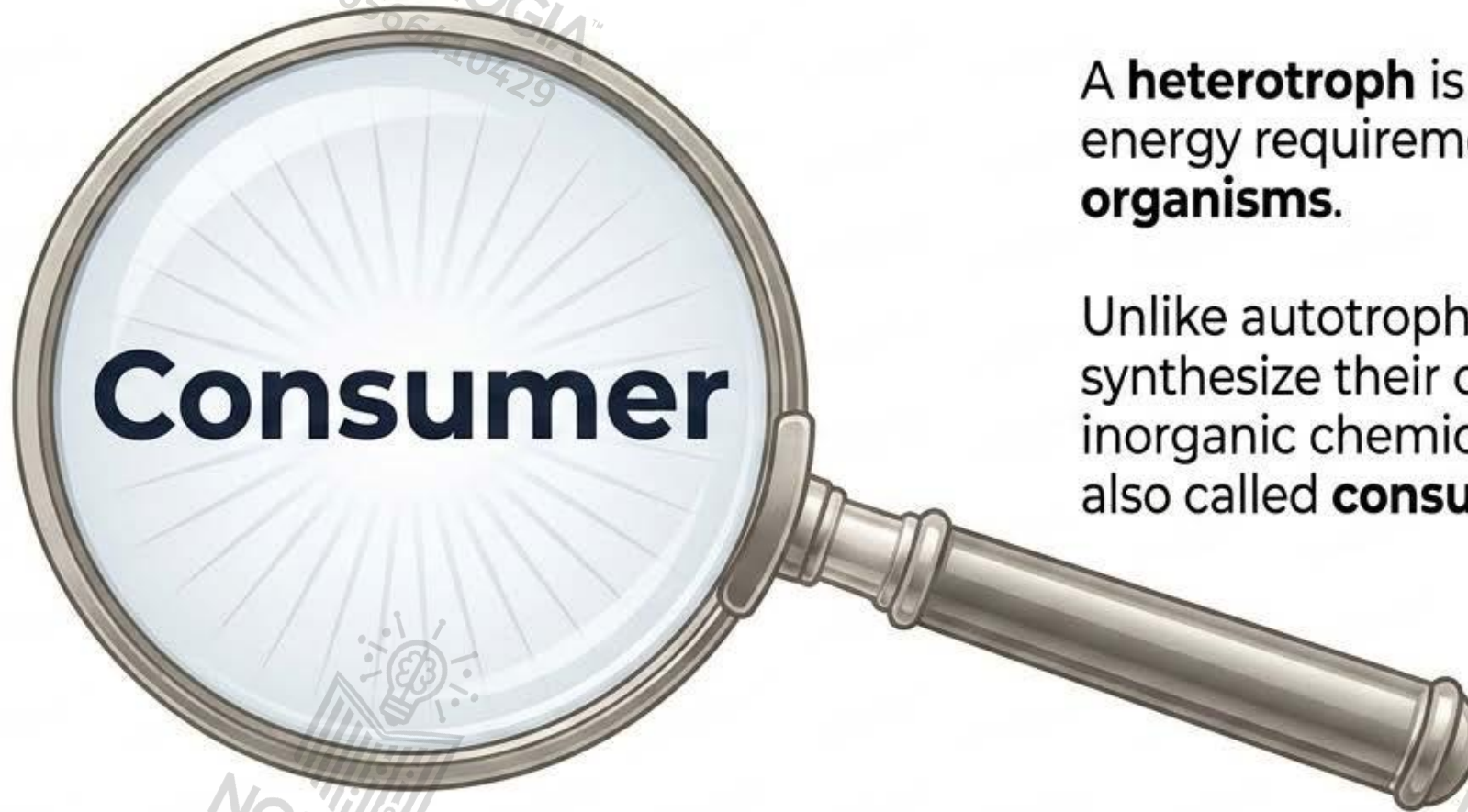
- Organisms containing chlorophyll absorb light energy.
- Converts inorganic carbon dioxide (CO₂) and water into organic molecules.
- Examples: Green plants, algae.

Chemosynthesis



- Occurs in places where sunlight is unavailable.
- Uses inorganic substances like hydrogen sulfide and CO₂ to make organic molecules.
- Examples: Certain specialized bacteria.

Heterotrophs (The Consumers)



A **heterotroph** is an organism that gets its energy requirements by **consuming other organisms**.

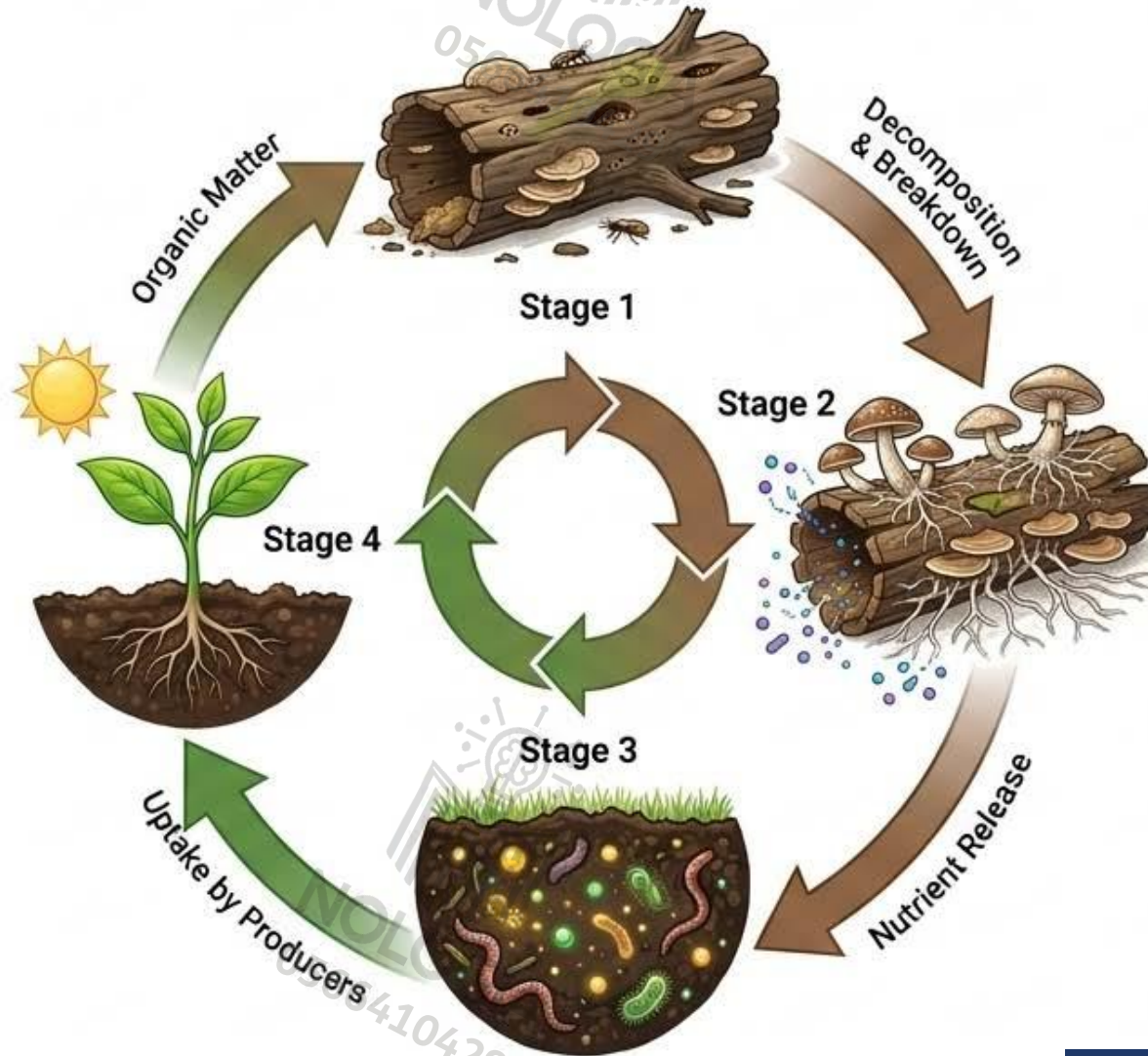
Unlike autotrophs, heterotrophs cannot synthesize their own food from sunlight or inorganic chemicals. Therefore, they are also called **consumers**.

Based on what they consume, heterotrophs are divided into 5 distinct categories...

The Consumer Matrix

Classification	Definition	Examples	Ecosystem Role
Herbivore	Eats only plants	Cow, rabbit, grasshopper	Primary Consumer
Carnivore	Preys on other heterotrophs	Wolf, lion, lynx 	Secondary/Tertiary Consumer
Omnivore	Eats both plants and animals	Bears, humans, mockingbirds	Variable Consumer
Detritivore	Eats fragments of dead matter	Worms, aquatic insects on stream bottoms	Nutrient Recycler
Decomposer	Breaks down dead organisms via enzymes	Fungi, bacteria	Chemical Recycler

The Unsung Heroes: Detritivores & Decomposers



The Decomposer Role

While all heterotrophs perform some decomposition during digestion, primary decomposers are essential to ecosystem survival.

The Mechanism

Fungi and bacteria break down dead organisms by releasing active digestive enzymes.



The Ecological Impact

They return crucial nutrients to the soil, air, and water. Without them, organic material and nutrients would remain locked away and unavailable to producers.

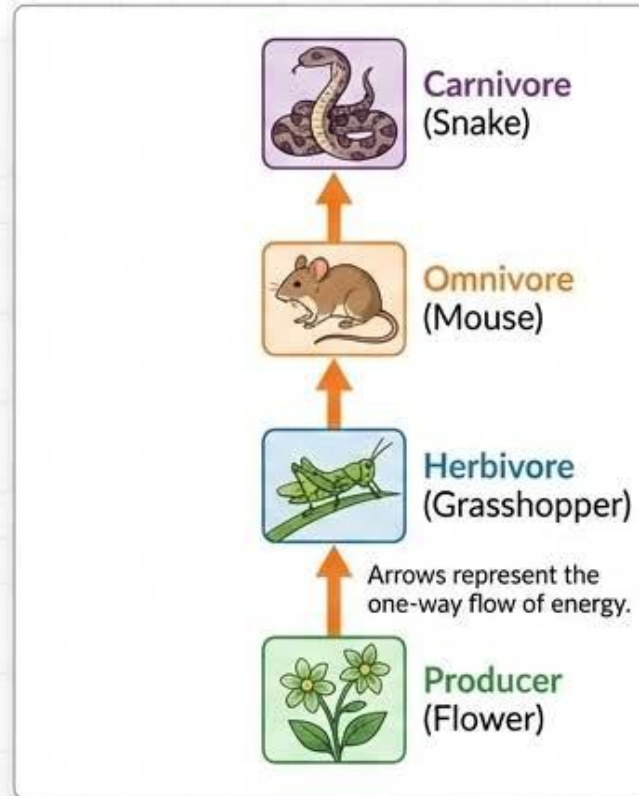
Defining Trophic Levels

Each step in a food chain or food web is called a **trophic level**.



Model 1: The Food Chain

A simplified model representing the linear transfer of energy from organism to organism.



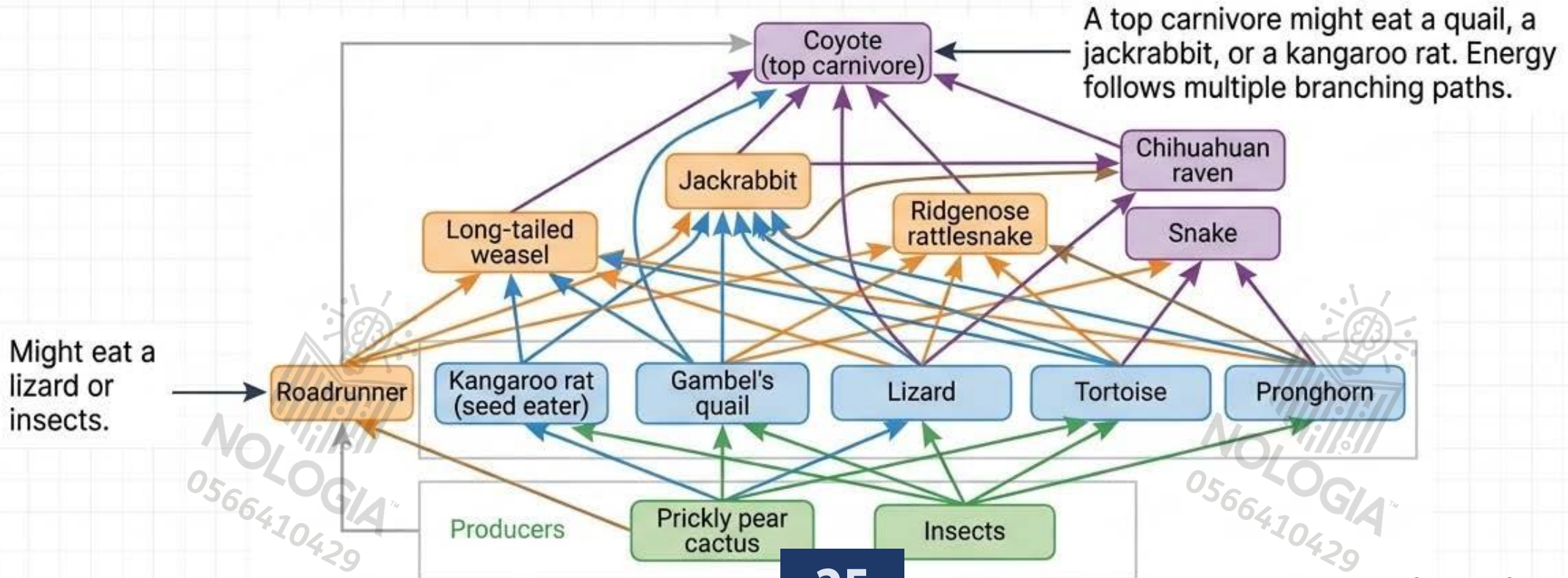
Energy Reality Check

At each step, some energy is used for cellular processes (building new cells/tissues), and some energy is released into the environment as heat.

Model 2: The Food Web

A model representing the many interconnected food chains and pathways in which energy flows through a group of organisms.

Why Chains Aren't Enough: Real feeding relationships are complex. Most organisms feed on more than one species.



Analytical Comparison: Chains vs. Webs



Food Chain

- **Structure:** Linear, single pathway.
- **Complexity:** Low (Highly simplified).
- **Ecological Reality:** Rarely exists in isolation in nature.
- **Primary Use:** Best for teaching and tracing basic trophic levels and energy loss.



Food Web

- **Structure:** Interconnected, multiple branching pathways.
- **Complexity:** High (More realistic representation).
- **Ecological Reality:** Accurately reflects how animals feed on multiple species.
- **Primary Use:** Best for mapping actual ecosystem dynamics, dependencies, and community stability.

Model 3: Ecological Pyramids

NOLOGIA Education

Core Concept

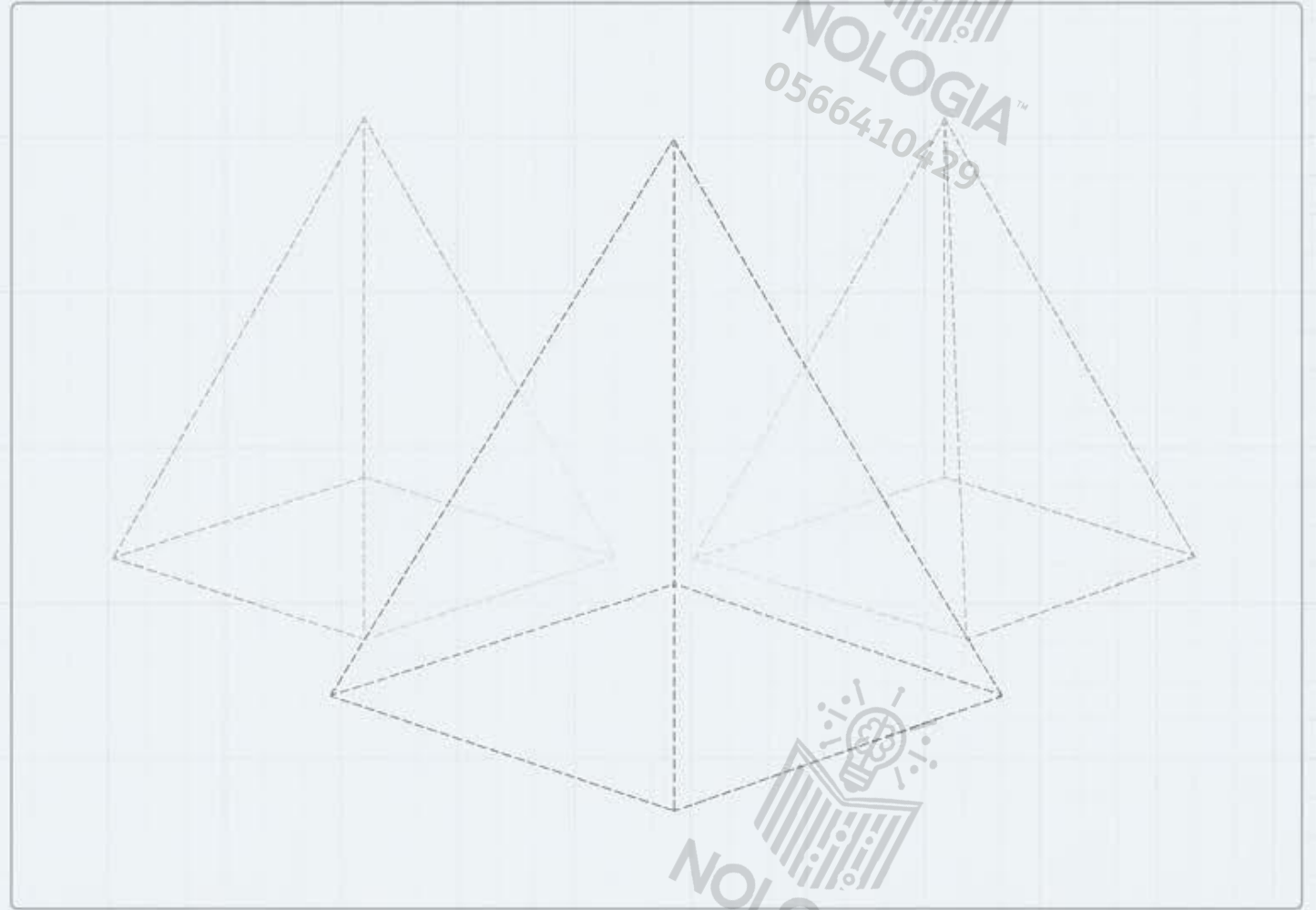
Another model ecologists use to show how energy flows through ecosystems.

Definition

A diagram that can show the relative amounts of energy, biomass, or numbers of organisms at each trophic level.

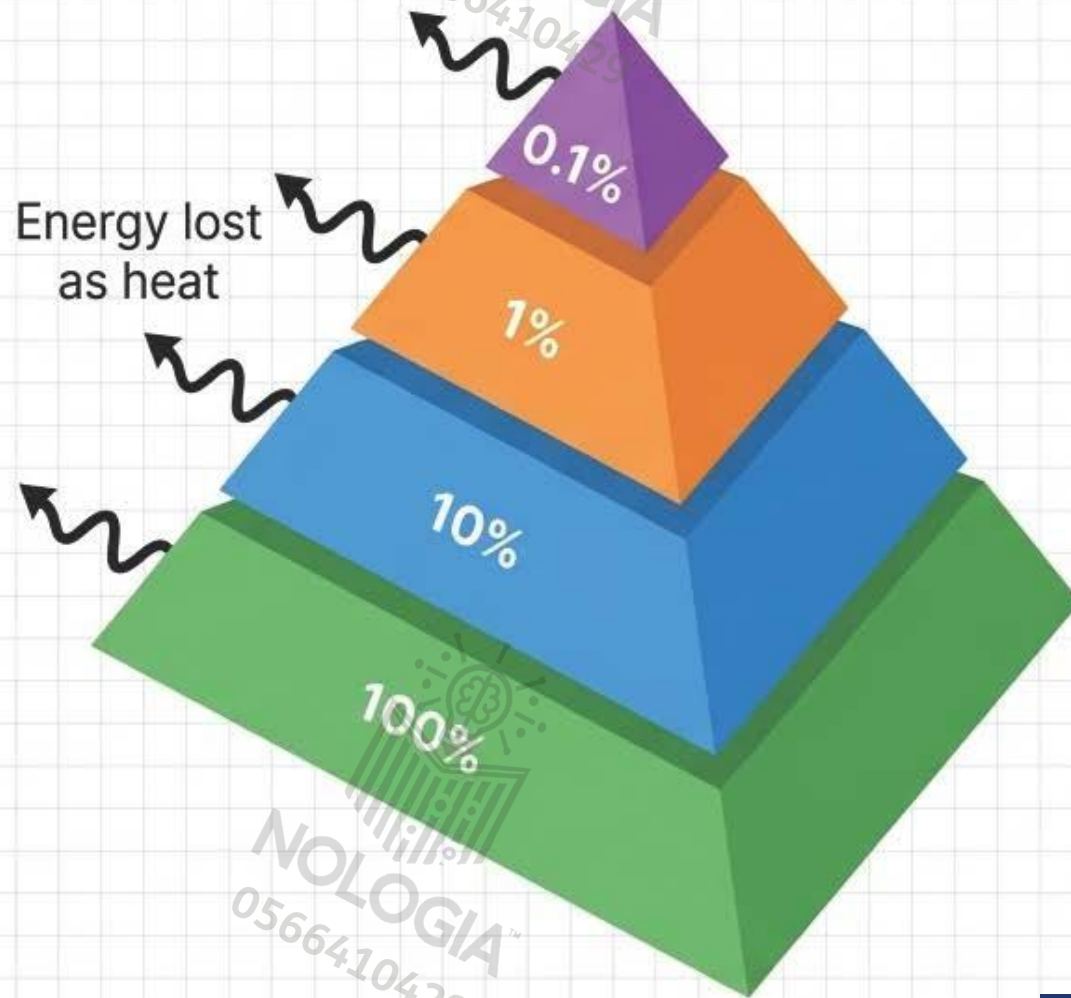
The Shape

The ecosystem itself determines the exact shape of an ecological pyramid, but they universally narrow at the top.



Ecologists use three main types of pyramids to quantify ecosystem health...

The Pyramid of Energy



The 10% Rule

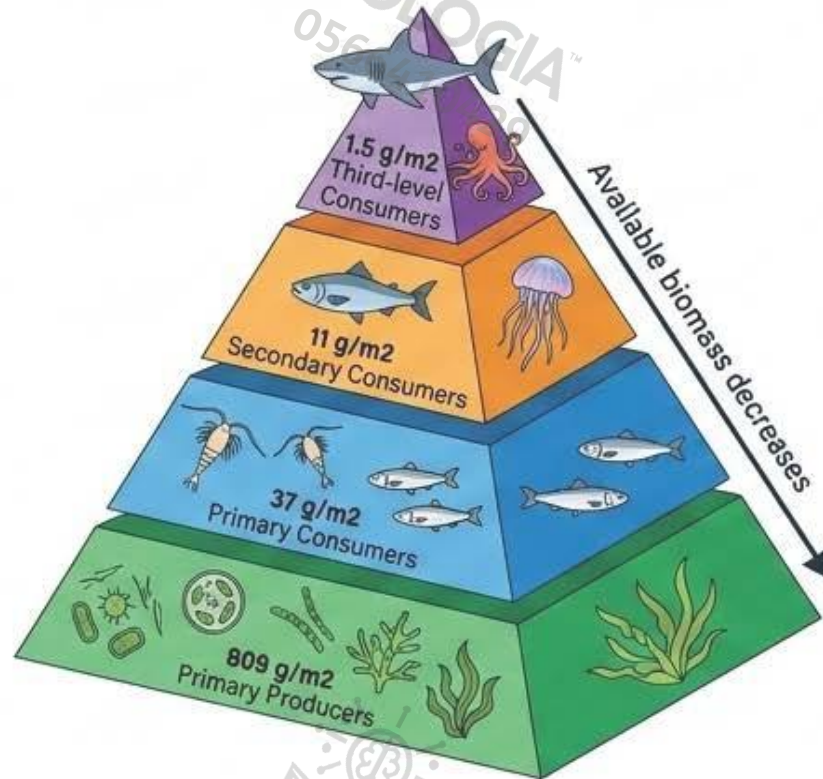
Only 10% of all energy is transferred to the level above it. (100% → 10% → 1% → 0.1%).

Where does the 90% go?

1. Consumed by the organism's cellular processes (living, growing, moving).
2. Released into the environment as heat.

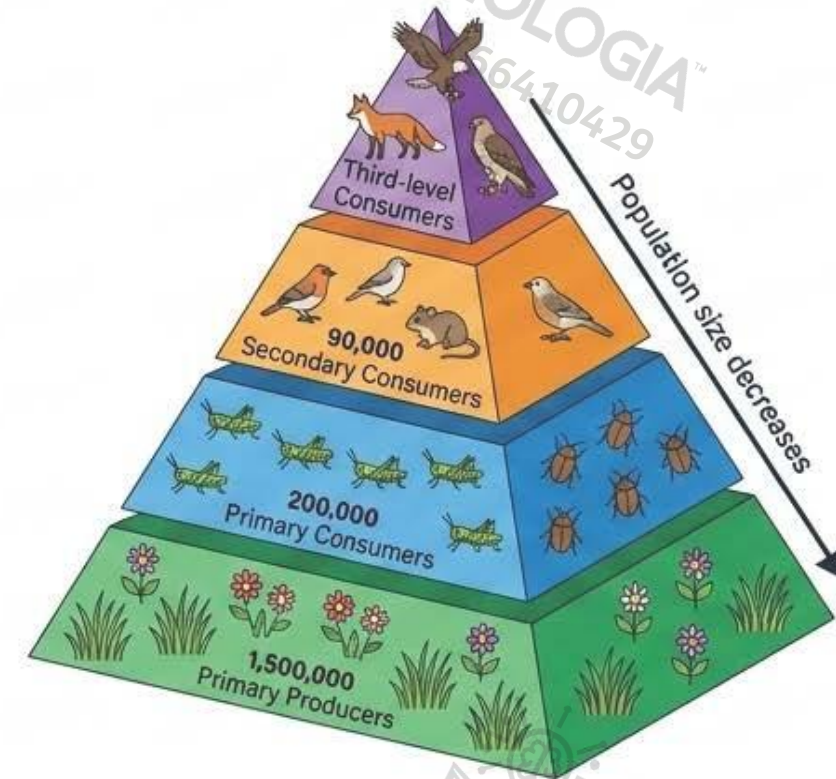
This massive energy loss is why ecosystems rarely support huge populations of top predators.

Pyramids of Biomass & Numbers



Pyramid of Biomass

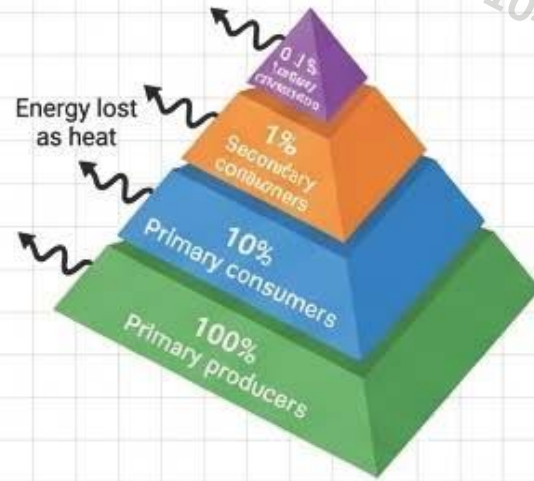
- Definition: Biomass is the total mass of living matter at each trophic level.
- Metric: Typically measured in grams per square meter (g/m²).
- Trend: Usually, the amount of biomass decreases at each higher trophic level.



Pyramid of Numbers

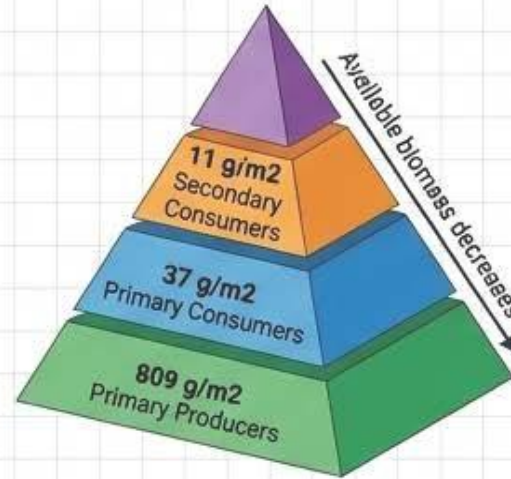
- Definition: Shows the relative number of individual organisms at each trophic level.
- Trend: Population size decreases as you move up the pyramid because there is simply less energy available to support them.

Synthesis: The Three Pyramids Compared



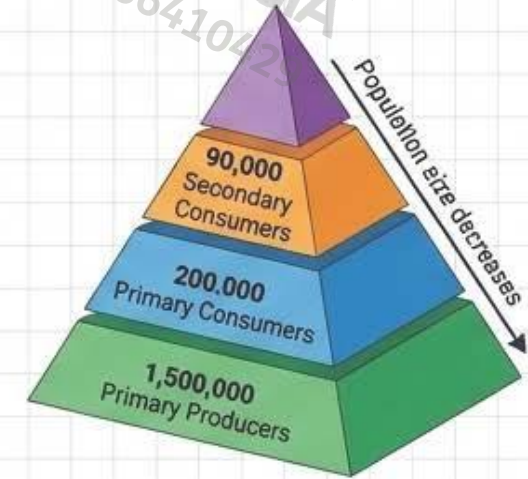
Energy Pyramid

Measures: Joules or Percentages.
Visualizes: The strict 10% transfer rule and heat loss.



Biomass Pyramid

Measures: Total physical weight (g/m²).
Visualizes: Physical mass shrinking at higher trophic levels.



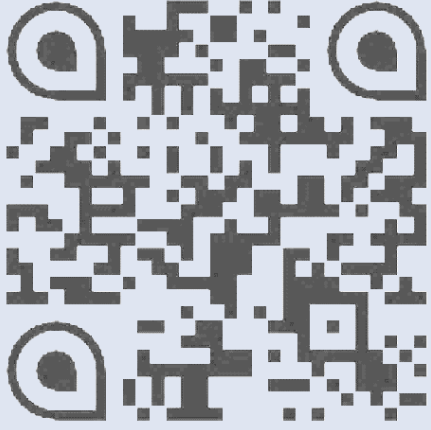
Numbers Pyramid

Measures: Population count (Individuals).
Visualizes: Fewer total individuals at the top due to energy constraints.

NOLOGIA Education

Chapter Checkpoint & Summary

-  Autotrophs capture energy from the Sun or use chemicals to make their own food (Producers).
-  Heterotrophs (herbivores, carnivores, omnivores, detritivores, decomposers) must rely on other organisms for food.
-  A trophic level represents a single step in a food chain or food web.
-  Food chains (linear) and food webs (complex) model how energy physically moves through ecosystems.
-  Ecological pyramids mathematically model energy loss (10% rule), biomass reduction, and population size decreases across trophic levels.



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Module (2): Principles of Ecology

03

Third Lesson: Cycling of Matter



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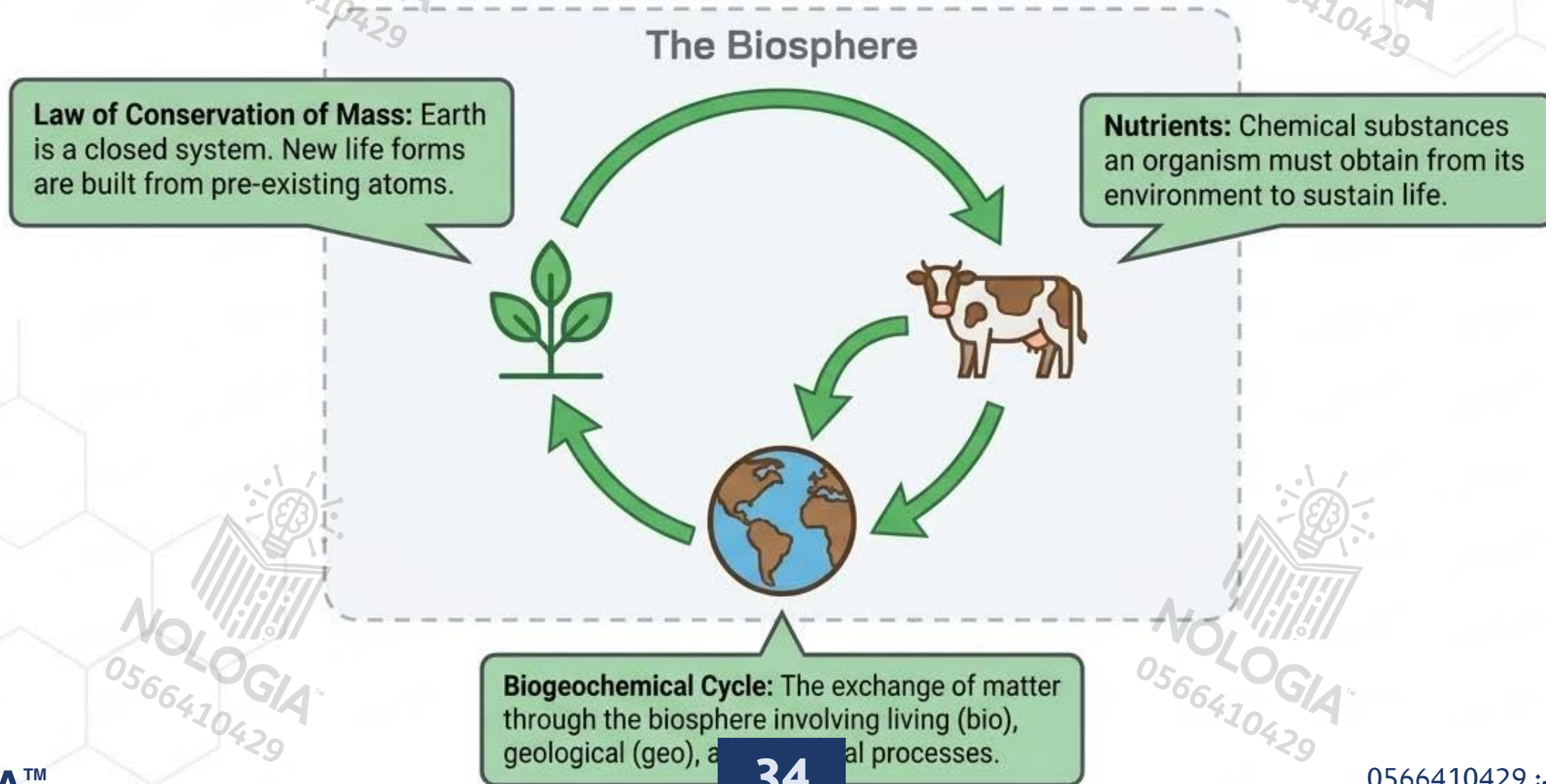
The Cycling of Matter in the Biosphere

A Comprehensive Visual Study Guide for Students

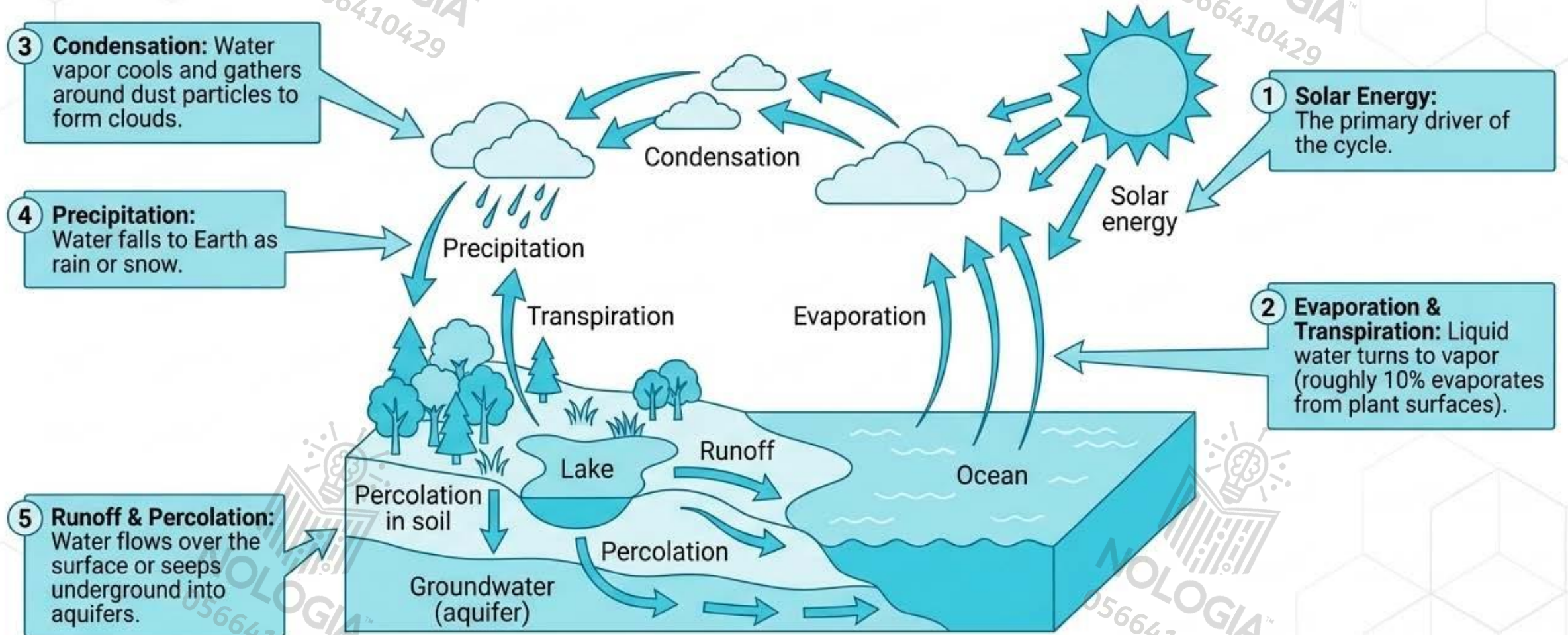


Includes: Water, Carbon/Oxygen, Nitrogen, and Phosphorus cycles

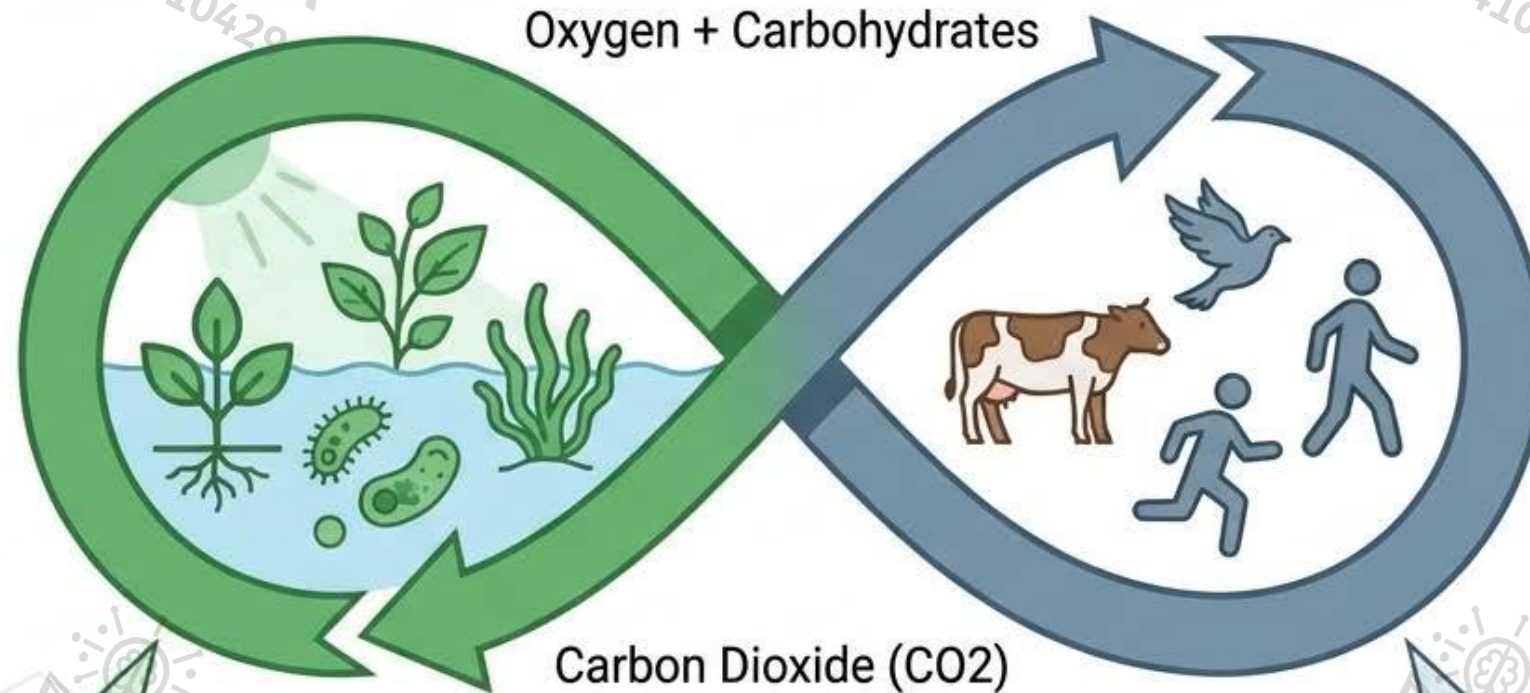
Matter is neither created nor destroyed, but continuously recycled



The Water Cycle: How solar energy drives the biosphere



The Biological Engine: The continuous interplay of Carbon and Oxygen cycles



Photosynthesis

Plants and algae convert CO₂ and water into carbohydrates and release oxygen back into the air.

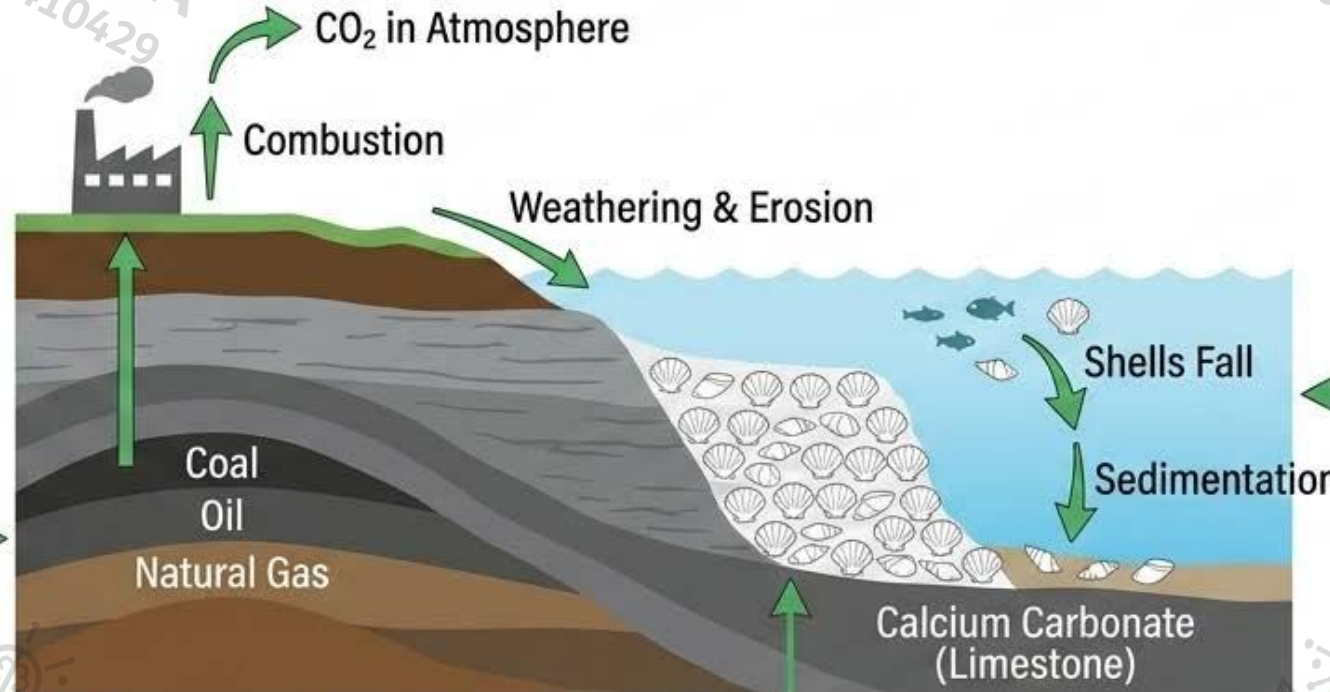
Cellular Respiration

Living organisms consume oxygen to release energy from carbohydrates, releasing CO₂ in the process.

Long-Term Carbon Storage: From fossil fuels to limestone rocks

Fossil Fuels

Organic matter is buried underground and converted into coal, oil, or gas over millions of years. Carbon returns to the atmosphere upon combustion.



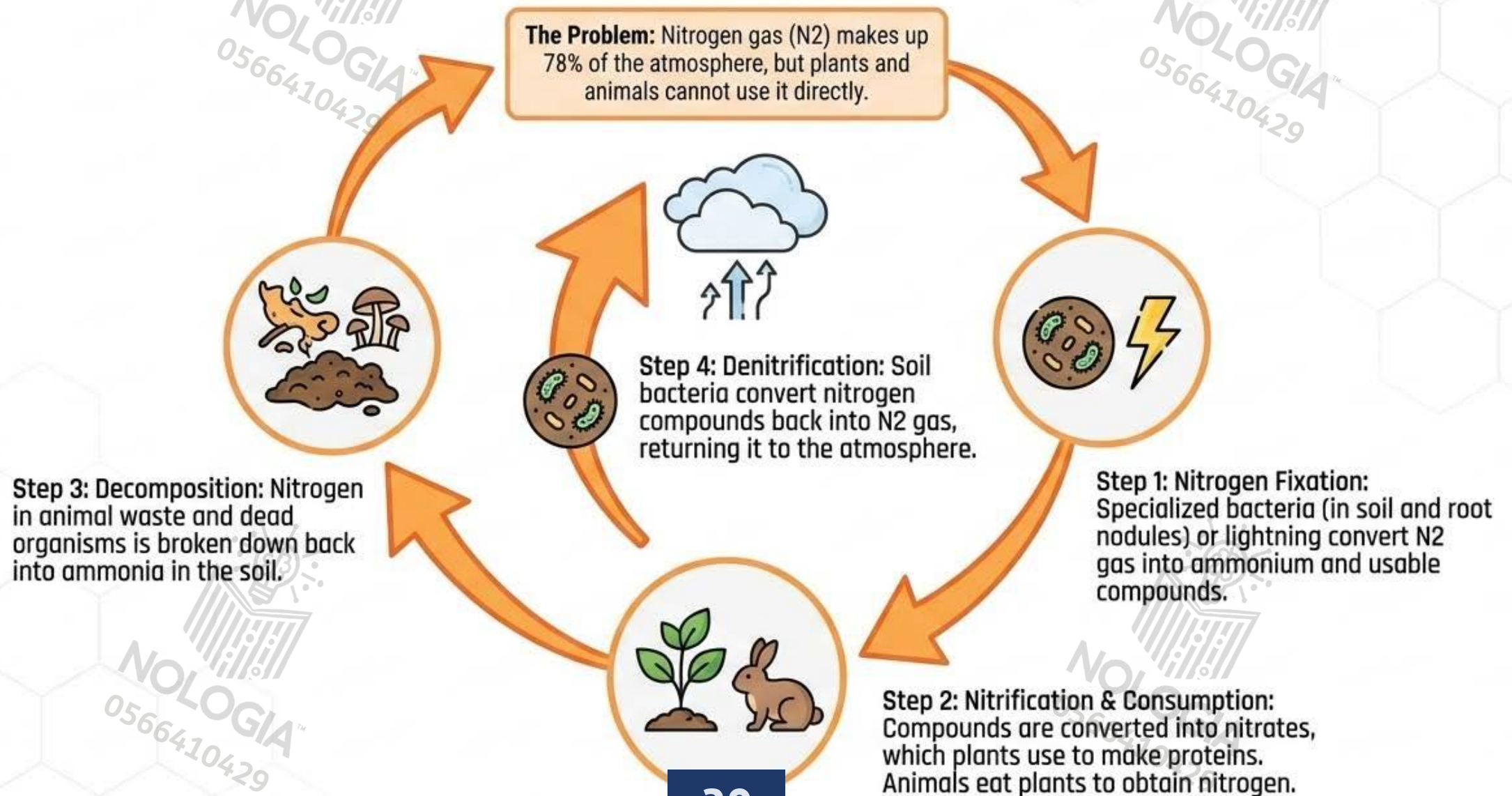
Calcium Carbonate

Shells of marine creatures fall to the ocean floor, forming massive deposits of limestone rock.

Release Mechanism

Carbon remains locked in these deposits until weathering and erosion slowly release it back into the cycle.

The Nitrogen Cycle: Converting unusable gas into vital proteins



The Phosphorus Cycle: Short biological path and long geological path

Short-Term Cycle



Soil



Plants



Animals

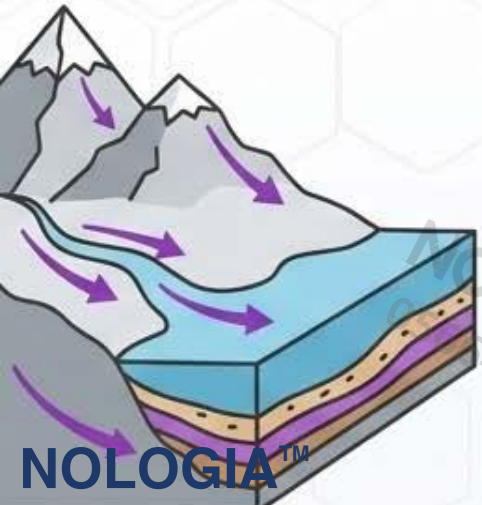


Decomposers



Short-Term: Phosphorus (essential for growth) moves from soil to producers, then to consumers. Decomposers return it to the soil upon death.

Long-Term Cycle



Ocean Sediments



Rock Uplift



Weathering/Rain



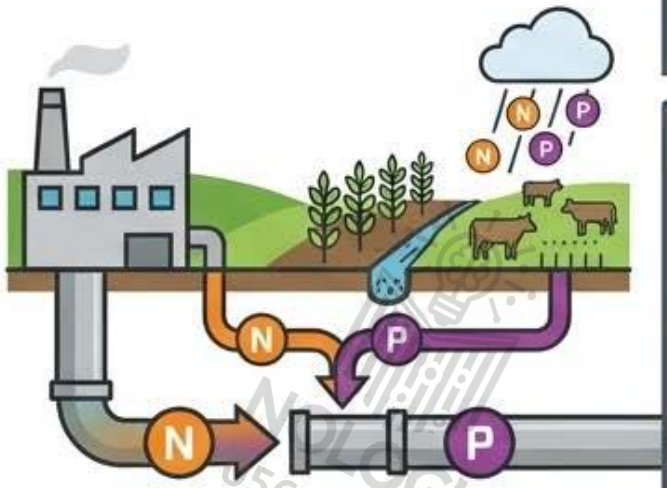
Soil

Long-Term: Phosphorus settles in aquatic environments, forming rock. Geological uplift and weathering send it back to the soil over millennia.

Human Intervention and Ecological Imbalance: Algal Blooms

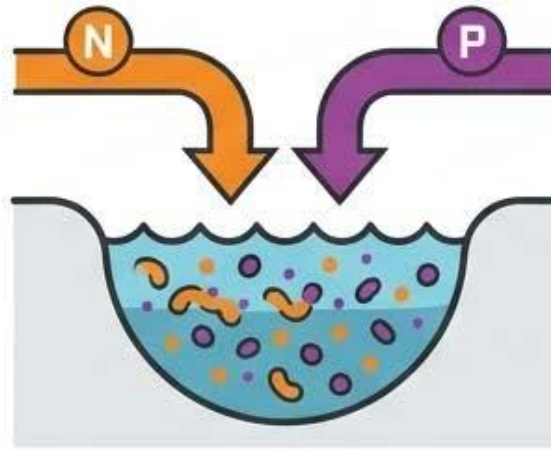
The Cause

Human activities (fertilizer use, sewage treatment, phosphate mining) introduce massive, unnatural amounts of Nitrogen and Phosphorus into runoff.



The Effect

Eutrophication: A severe nutrient overload in freshwater and marine ecosystems.



The Result

Massive algae overgrowth (blooms) upsets the ecosystem balance. Additionally, nitrogen compounds from factories cause acid rain.



NOLOGIA Comparison Matrix: Biogeochemical Cycles at a Glance

Cycle	Driver / Energy Source	Biological Role	Long-Term Reservoir
Water	Sun and Gravity	Sustaining life and transporting materials	Oceans and Groundwater
Carbon & Oxygen	Photosynthesis and Cellular Respiration	Essential molecules and energy release	Fossil Fuels and Limestone Rocks
Nitrogen	Bacterial activity and Lightning	Building proteins	Atmosphere (78%)
Phosphorus	Geological Weathering and Erosion	Cellular growth and development	Mineral Rocks and Ocean Sediments

Core Principles for Review

Biological Interconnection

The Carbon and Oxygen cycles are deeply connected through the twin processes of photosynthesis and cellular respiration.

The Power of Bacteria

The Nitrogen cycle relies almost entirely on specialized soil bacteria to convert atmospheric gas into a form usable by the food web.

Geological Time

Carbon and Phosphorus both have long-term geological cycles where matter is locked in rock, sediment, or fossil fuels for millions of years.

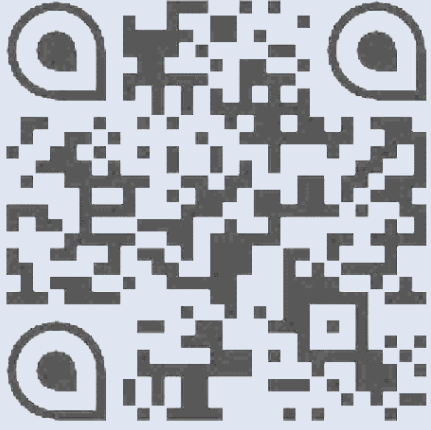
Conservation Law

Regardless of how matter changes form or moves between living and non-living environments, it is perfectly conserved within the biosphere.

Module (5): Biodiversity and Conservation

	Lesson Title	Page
5-1	Biodiversity	44
5-2	Threats to Biodiversity	58
5-3	Conserving Biodiversity	74

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Module (5): Biodiversity and Conservation

01

First Lesson: Biodiversity



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The Biosphere's Blueprint: A Master Guide to Biodiversity

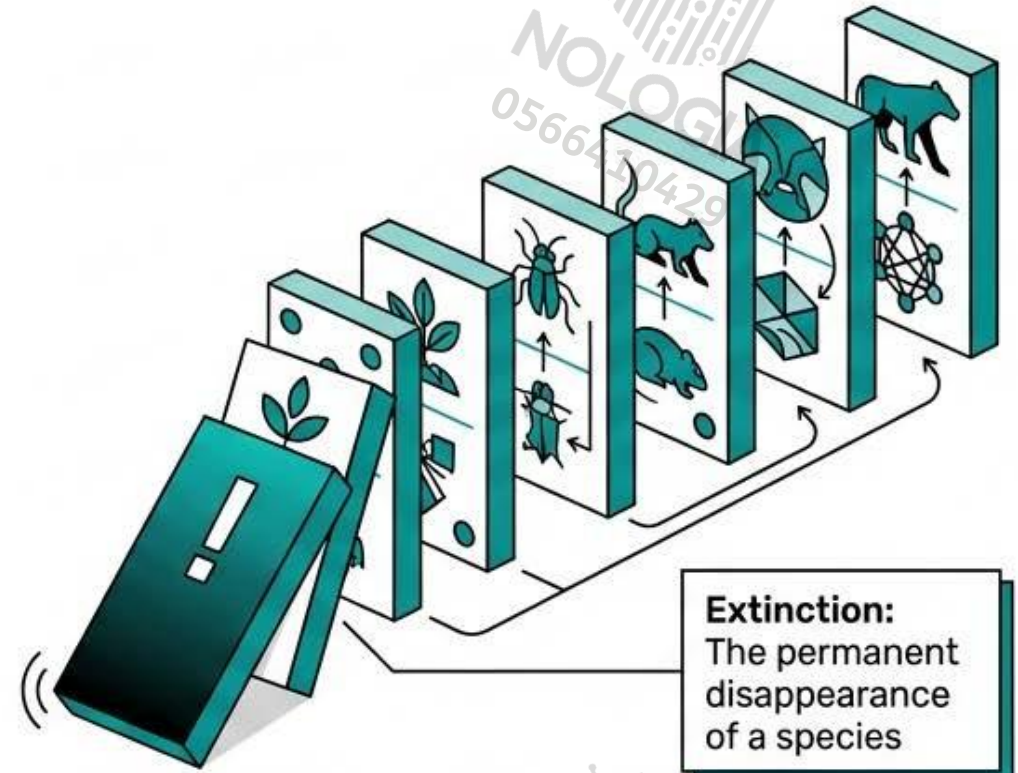
NOLOGIA Complete Study Guide | Essential Concepts,
Scales of Life, and Ecosystem Economics

Optimized for Print & Review

What is Biodiversity?

The variety of life in an area, determined by the number of different species.

**HIGH BIODIVERSITY =
HIGH ECOSYSTEM STABILITY**

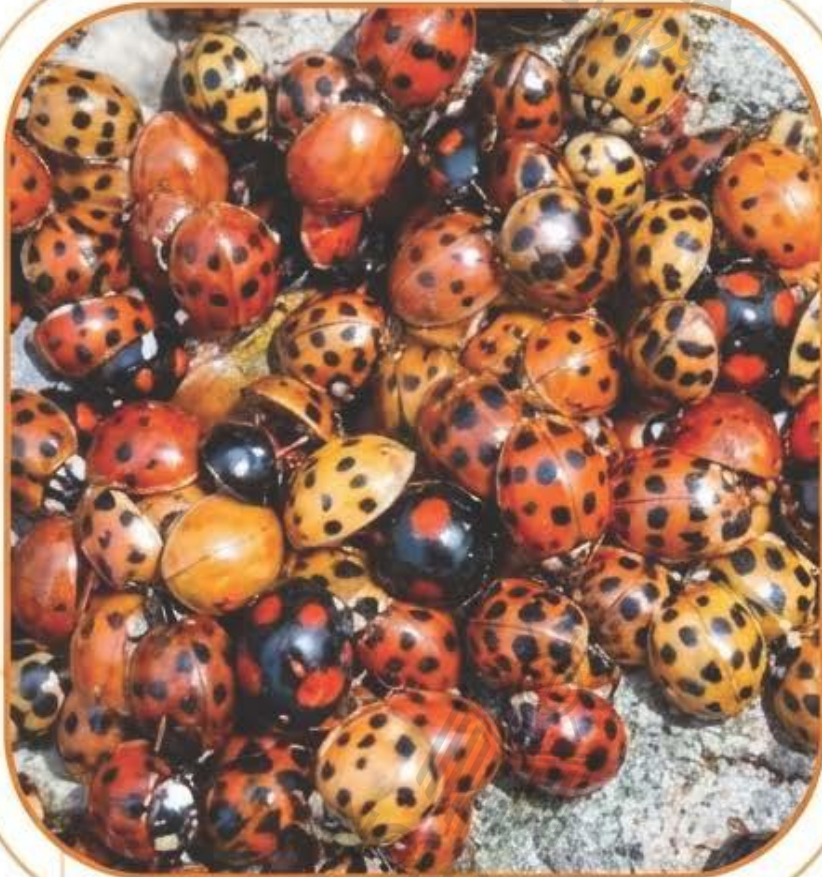


When the last member of a species dies, the health and stability of the entire biosphere decreases.

The Three Scales of Biodiversity

1. Genetic Diversity 	2. Species Diversity 	3. Ecosystem Diversity 
Variety of inheritable characteristics or genes within a population.	Number of different species and their relative abundance in a community.	Variety of ecosystems present in the biosphere.
 Key Benefit: Resistance to disease, adaptability to changing environments. 	 Key Benefit: Creates rich, complex food webs and habitats. 	 Key Benefit: Provides diverse abiotic factors that support entirely different types of life. 

Scale 1: Genetic Diversity in Action



Outbreak of
disease
OR
environmental
change

High
Genetic
Diversity

Some
individuals
possess
resistant
traits →
Population
survives and
reproduces

Variety isn't just about color. Invisible genetic traits dictate the ability to resist diseases or find new food sources.

Scale 2: Species Diversity & The Equator Effect

Distribution of Bird Species



Number of species



Species diversity is not evenly distributed. As you move geographically from polar regions toward the tropics (equator), the number of species dramatically increases.



Example: A habitat rich in species diversity.

Scale 3: Ecosystem Diversity

How Abiotic Factors Shape Life



ARCTIC TUNDRA

- **Location:** Alaska
- **Abiotic Factors:** Cold temperatures, ice, specific daylight patterns.
- **Supports** highly specialized organisms.



TROPICAL RAINFOREST

- **Location:** South America
- **Abiotic Factors:** High humidity, dense canopy, year-round warmth.
- **Supports** massive webs of interacting populations.

Ecosystem Diversity = Interacting Populations + Abiotic Factors

Phase 2: The Value of the Biosphere

Sustaining biodiversity is essential to supporting human life on Earth. Nature provides an incalculable return on investment through three primary value streams:



Direct Economic Value

Resources humans extract directly.



Indirect Economic Value

Services healthy ecosystems perform for free.



Aesthetic & Scientific Value

Recreational, inspirational, and research benefits.

Direct Value: The Agricultural Gene Bank



Wild Relative (Teosinte)

Contains genes resistant to viral diseases.

Genetic Engineering /
Cross-Breeding



Commercial Crop

Vulnerable to disease,
lacks genetic diversity.

Wild species serve as reservoirs of desirable genetic traits. If teosinte went extinct, the ability to develop disease-resistant corn would be lost forever.

Direct Value: The Pharmaceutical Pharmacy

Case Study

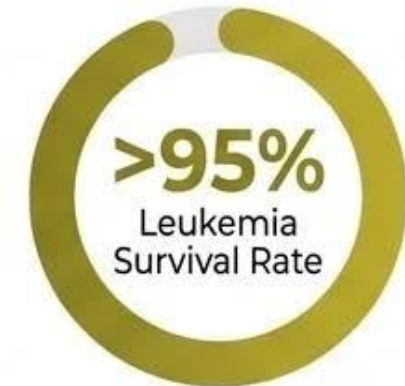


Madagascar Periwinkle
(*Catharanthus roseus*)

Before extract



After extract



- Many current medicines are derived from nature (e.g., Penicillin from mold, Aspirin from willow tree).
- The Madagascar periwinkle (*Catharanthus roseus*) yields an extract crucial for treating certain leukemias.

Warning: Countless unknown, highly useful extracts remain undiscovered in remote regions—unless

Indirect Value: Nature's Free Services

A healthy biosphere provides processes that sustain all life.



Green plants provide oxygen and remove carbon dioxide.



Natural processes provide safe, clean drinking water.



Substances are cycled to provide nutrients for all living things.



Ecosystems provide protection against floods and droughts.



Nature generates and preserves fertile soils.



Detoxifies wastes and regulates local climates.

Healthy ecosystems provide these services at a fraction of the cost of human technology.

The Economics of Nature: NYC Watershed Case Study



**Preserve
Natural
Watershed**



**\$1.5
Billion**

**Build Tech
Filtration
System**



**\$6
Billion**

In the 1990s, NYC proved that preserving a healthy ecosystem is significantly less expensive than using human technology to perform the same service.



Aesthetic Value

Sustaining biodiversity preserves landscapes like Lake Tahoe for their incredible recreational, inspirational, and cultural value.

Scientific Value

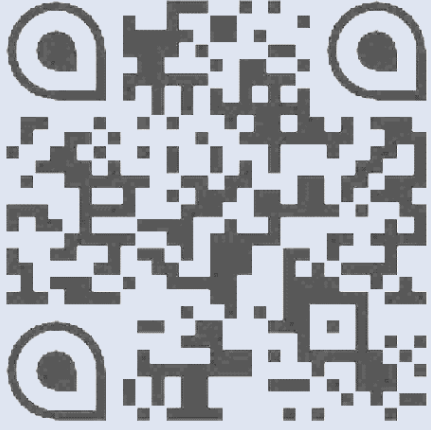
Studying the environment benefits humanity. Attempting to solve ecological problems brings diverse groups and cultures together, often leading to the development of new technologies.

NOLOGIA Master Synthesis: Biodiversity at a Glance

NOLOGIA
Ultimate
Cheat Sheet

Scale	Definition	Example	Primary Value
Genetic	Genes within a population	Ladybird Beetle colors / Teosinte	Direct Value (Disease resistance, medicine)
Species	Variety of species in an area	High diversity near the equator	Indirect/Ecosystem stability
Ecosystem	Variety of habitats in biosphere	Rainforests vs. Arctic regions	Indirect Value (Water filtration, climate regulation)

Biodiversity is the ultimate reservoir of life. Extinction is a permanent loss of biological, economic, and scientific potential.



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Module (5): Biodiversity and Conservation

02

Second Lesson: Threats to Biodiversity



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THREATS TO BIODIVERSITY

Understanding the Anthropogenic Disruption of Ecosystems



The Extinction Spectrum: Natural Process vs. Global Crisis



Matrix 1: The Extinction Spectrum - NOLOGIA

Background Extinction

Definition

The gradual process of species becoming extinct.

Causes

Stable ecosystem changes, climate shifts, natural disasters.

Characteristics

Gives species opportunity to adjust or evolve; part of the natural biological cycle.

Mass Extinction

Definition

An event where a large percentage of all living species go extinct in a relatively short period.

Causes

Drastic, rapid environmental changes.

Characteristics

Species cannot adjust to changes that occur too fast; prevents the evolution of new coping traits.

Fundamental Rule: Species become extinct because they can no longer survive and reproduce in their environment.



The Geological Baseline: Five Recent Mass Extinctions

Geological Timeline Graphic

Ordovician Period

~444 million
years ago



Example: Graptolites

Devonian Period

~360 million
years ago



Example: Dinichthys

Permian Period

~251 million
years ago



Example: Trilobite

Triassic Period

~200 million
years ago



Example: Cynognathus

Cretaceous Period

~65 million
years ago



Example: Ammonite

The Modern Crisis: Accelerated Anthropogenic Change



Scientists estimate the current rate of extinction is about 1000 times the normal background extinction rate. Predictions suggest 1/3 to 2/3 of all plant and animal species will go extinct in the second half of this century.

Anthropogenic Changes

Changes to the environment induced by human activity.

Natural Resources

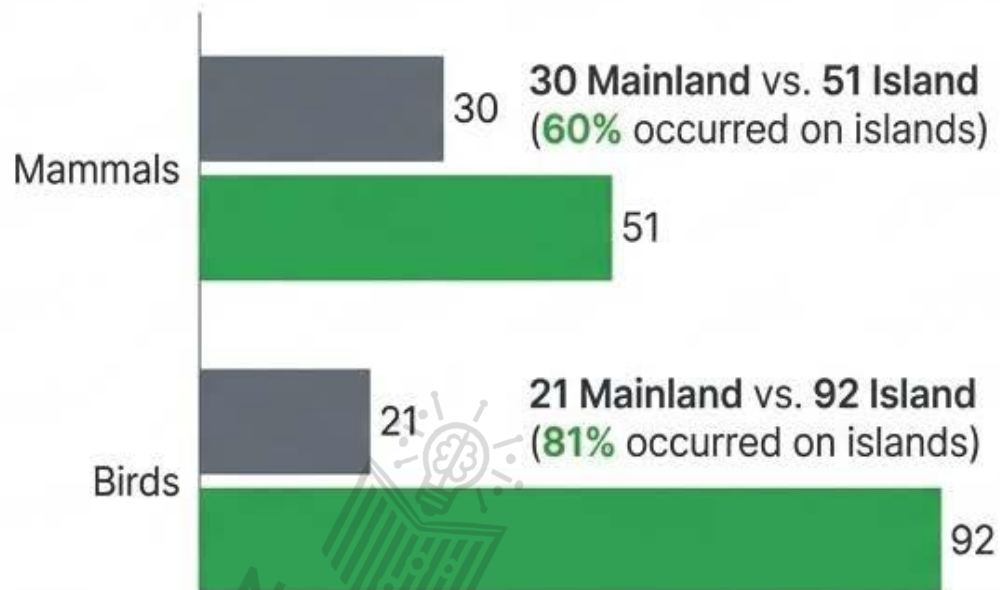
Materials and organisms found in the biosphere (minerals, fossil fuels, plants, animals, soil, clean water, clean air, solar energy).

Geographic Note: Most modern extinctions will occur near the equator, affecting highly vulnerable tropical species. (NOLOGIA Dossier)



Ecosystem Vulnerability: The Island Effect

Matrix 3: Vulnerability Data (Extinctions Since 1600)



Why Island Species Fail to Adapt

- ⚠ Evolved without natural predators (defenseless against introduced dogs, cats, rats, humans).
- ⚠ Carriers of new diseases (native populations have zero resistance).
- ⚠ Small population sizes.
- ⚠ No escape routes (individual animals rarely travel between islands).

Threat #1: Overexploitation

Overexploitation is the excessive use of species that have economic value (hunted for meat, hides, sport, fur, horns, or timber). Historically, this was the primary cause of extinction.

Mahogany Trees

Valued for beauty and durability. Takes ~100 years to mature. Illegal logging pushes varieties to extinction.

North American Bison

Hunted for meat, hides, and sport. Dropped from 50 million to <1,000 by 1889.

Passenger Pigeons

Once darkened skies with massive flocks; overhunted to extinction by the early 1900s.

Ocelot & White Rhino

Hunted today for commercial fur value and medicinal horn purposes.



Threat #2: Habitat Loss (The Leading Cause)

Matrix 2: Habitat Degradation
Profiles | NOLOGIA

Destruction of Habitat

Completely clearing a natural area, forcing native species to relocate or die.

Example: Clearing tropical rainforests (which contain more than half of all species on Earth) for agricultural crops or grazing land.



Disruption of Habitat

The habitat remains **physically intact**, but the delicate, interconnected **food web** is broken from within.

Often caused by **removing a crucial species**.

(See detailed mechanism in next section).

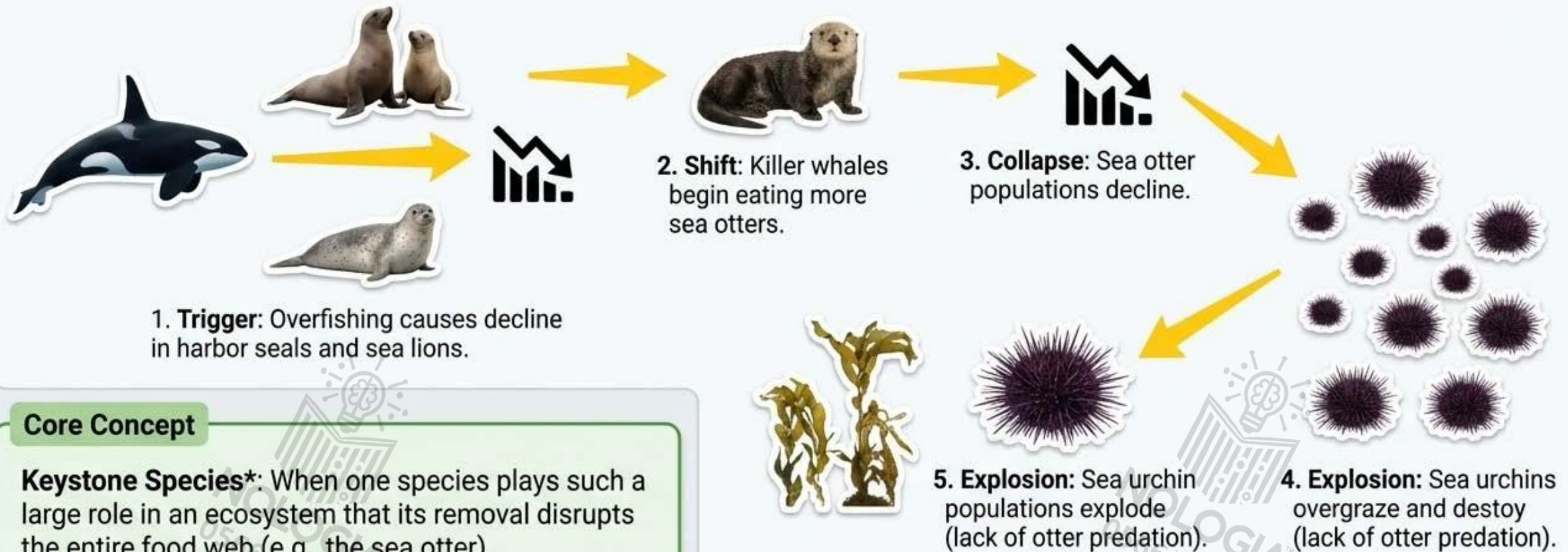
Fragmentation of Habitat

Separating a large continuous ecosystem into **small, disconnected pieces** of land via roads or fences.

(See detailed mechanism in next section).

Habitat Disruption: The Keystone Domino Effect

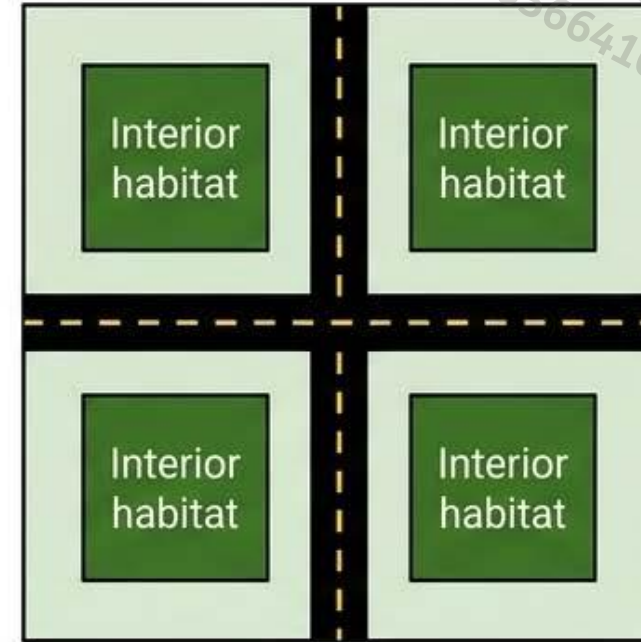
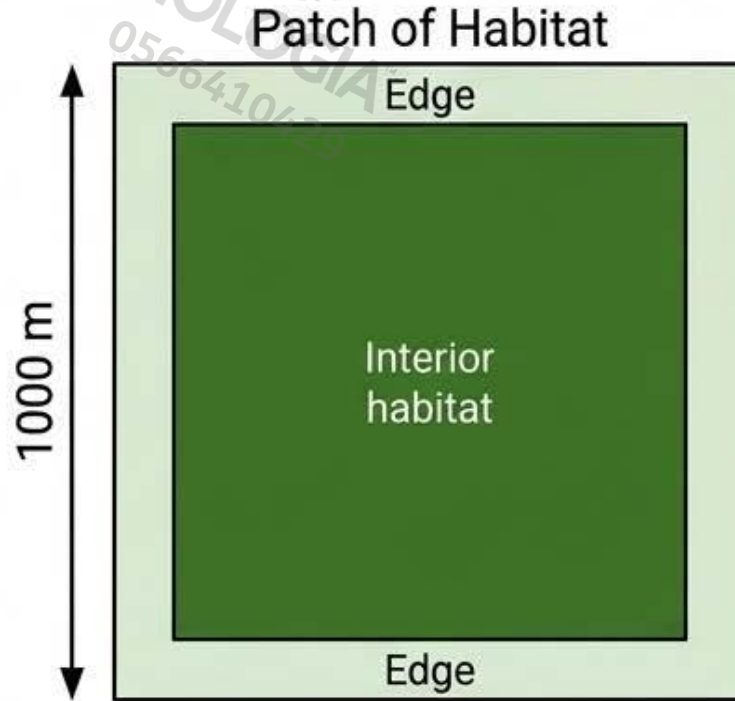
Domino-Effect Flowchart



Core Concept

Keystone Species*: When one species plays such a large role in an ecosystem that its removal disrupts the entire food web (e.g., the sea otter).
- NOLOGIA Definition

Habitat Fragmentation & The Edge Effect



The Problem: Smaller parcels support fewer species and reduce genetic diversity (making it harder to resist disease or respond to change).

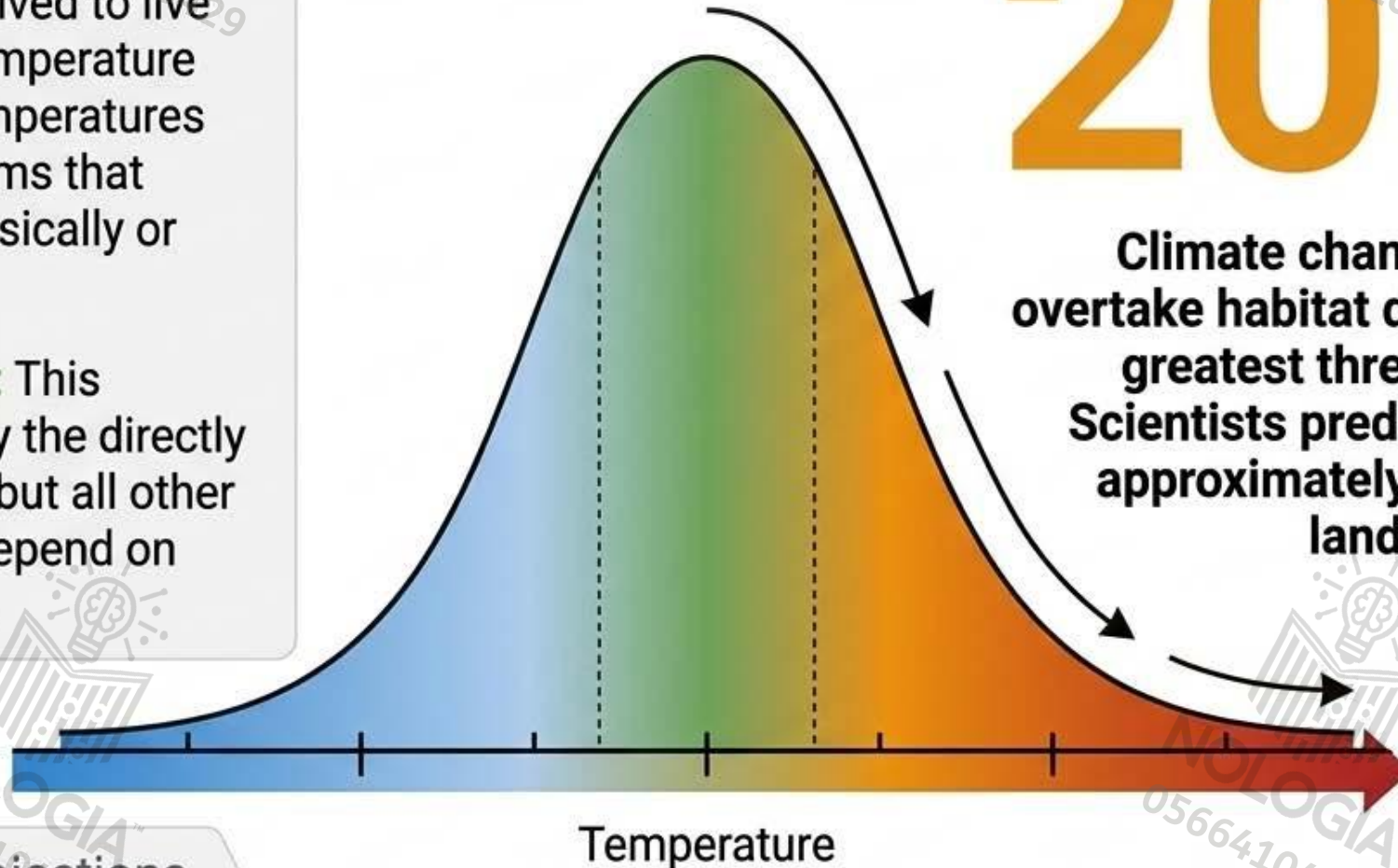
Edge Effects: Different abiotic factors (temperature, wind, humidity) exist at boundaries. Predators and parasites thrive here, making native interior species highly vulnerable to attack. NOLOGIA Framework.

Threat #3: Climate Change

Core Mechanism:

Species have evolved to live within specific temperature ranges. When temperatures increase, organisms that cannot adapt physically or migrate will die.

Systemic Impact: This threatens not only the directly affected species but all other organisms that depend on them for survival.



Threat #4: Pollution (Changing the Composition)

Pollution and atmospheric changes threaten global stability by changing the chemical composition of air, soil, and water with substances not found in nature.

Biological Magnification

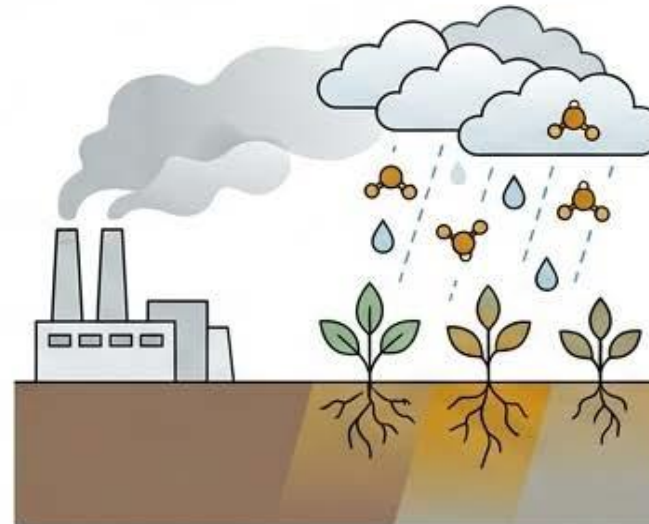
The accumulation of toxic substances in organisms as they move up the food chain (e.g., DDT, PCBs).



↙ Detailed in next panel

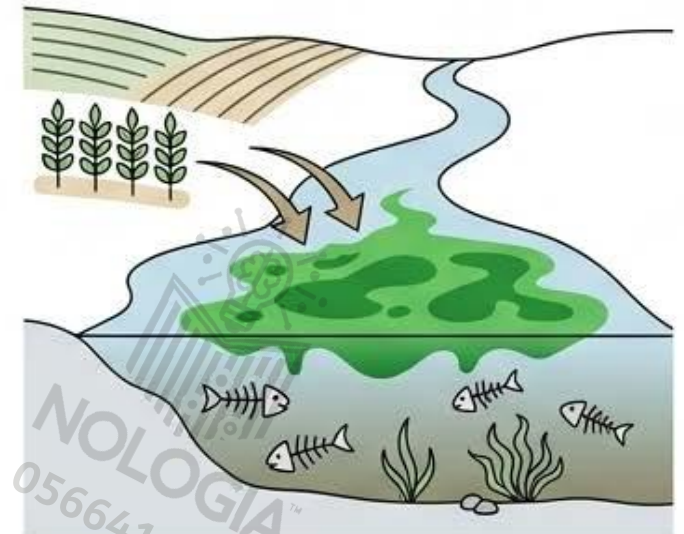
Acid Precipitation

Fossil fuel emissions reacting with atmospheric water to form sulfuric and nitric acid, fundamentally altering soil chemistry.



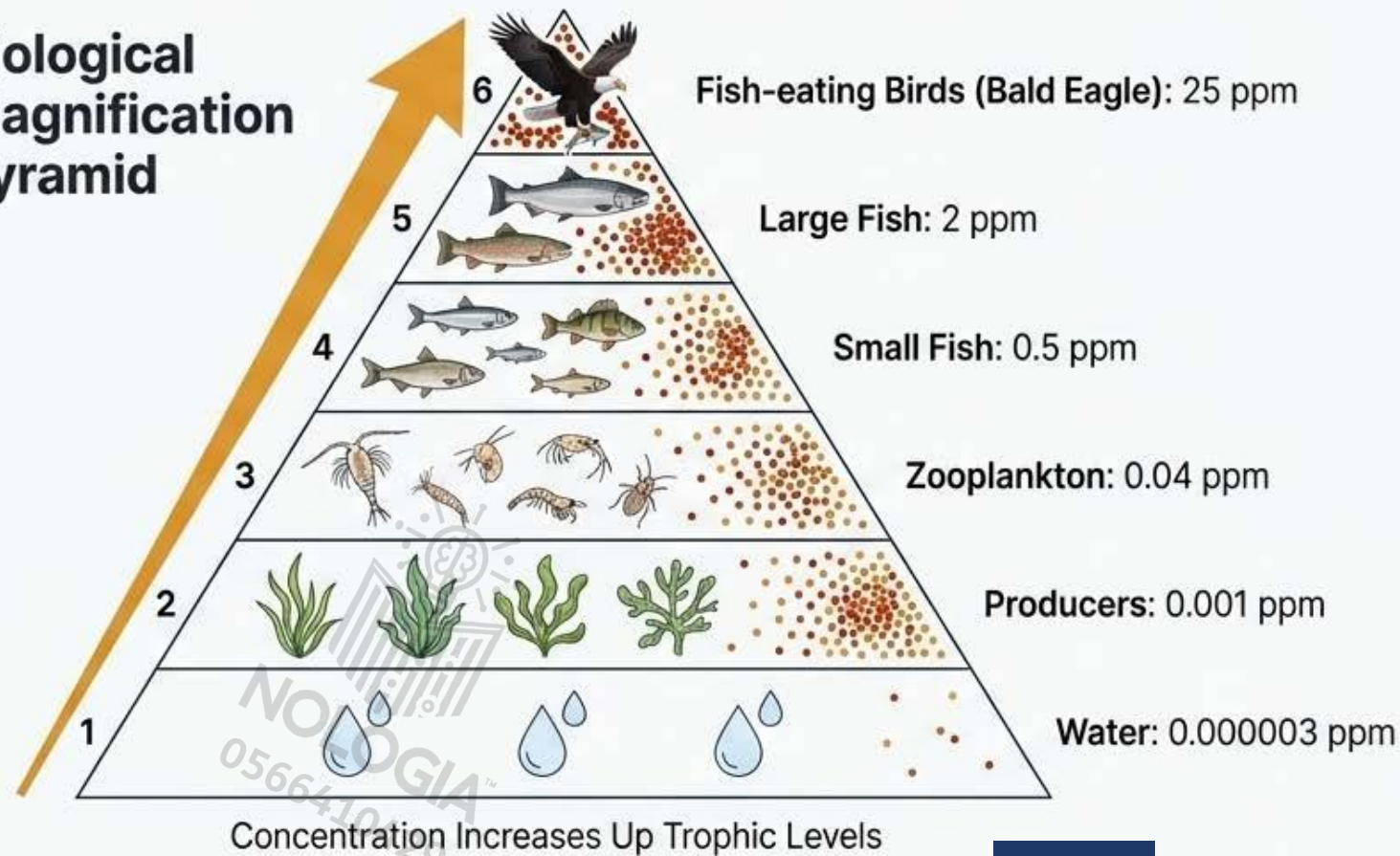
Eutrophication

Nitrogen and phosphorus runoff accelerating algae growth, ultimately suffocating underwater habitats.



Biological Magnification: The Toxic Multiplier

Biological Magnification Pyramid



Real-World Impact: DDT

Focus on DDT: Once used to control crop-eating insects, it concentrated in top predators like the Bald Eagle. The high toxicity caused fragile, thin eggshells, leading to the death of developing birds and near extinction before DDT was globally banned.
(NOLOGIA Case File)

Pollution Mechanisms: Acidification & Eutrophication



Acid Precipitation

- **Source:** Burning fossil fuels releases sulfur dioxide and nitrogen oxides.
- **Reaction:** Combines with water in the air to form sulfuric and nitric acids.
- **Impact:** Falls to Earth and removes vital nutrients (calcium, potassium) from the soil. Damages plant tissues, slows growth, and suffocates fish.



Eutrophication

- **Source:** Fertilizers, animal waste, and sewage rich in nitrogen and phosphorus flow into waterways.
- **Reaction:** Causes rapid, extensive algae growth.
- **Impact:** Algae use up the oxygen supply during growth and decay. Other aquatic organisms suffocate. Some algae also release lethal toxins.

Threat #5: Invasive Species

Definition

Nonnative species intentionally or unintentionally transported to a new habitat. Because they are relocated without their natural controlling factors (predators, parasites, and native competition), they reproduce in massive numbers and disrupt the ecosystem.

40%

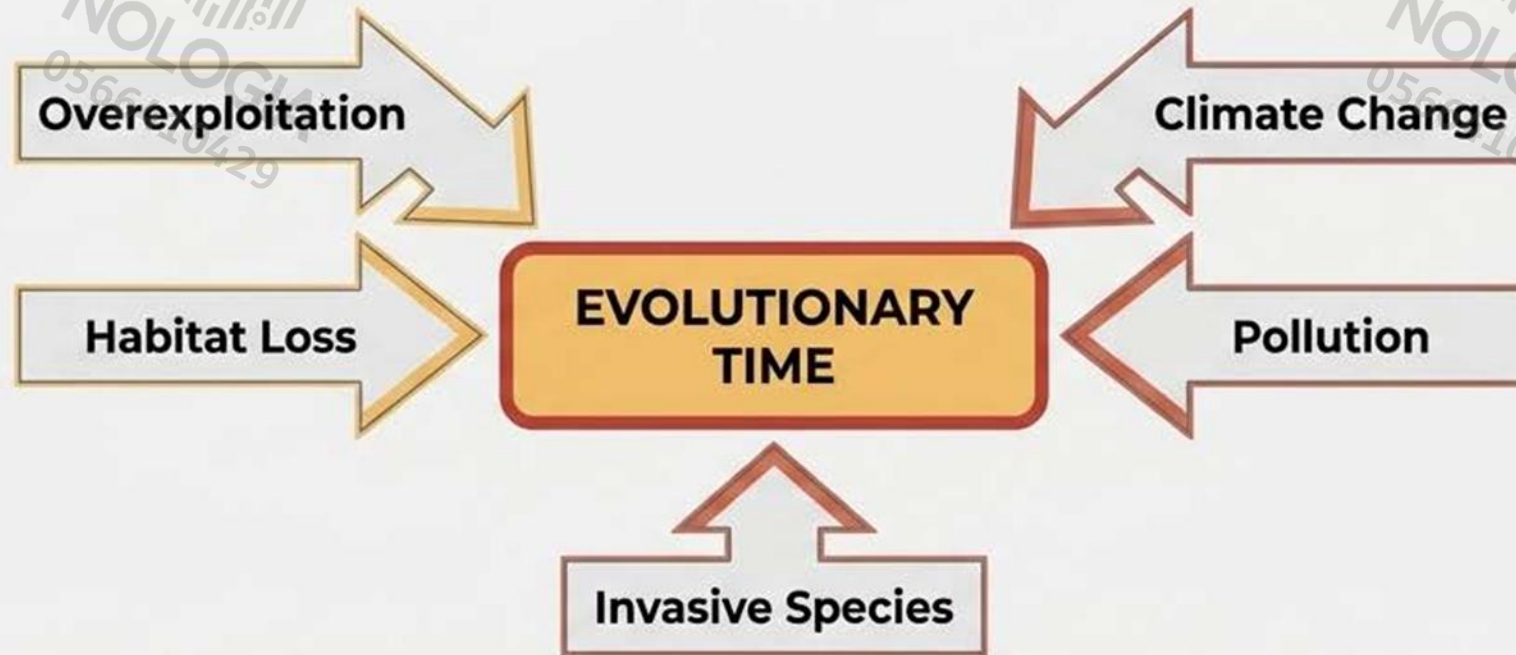
Invasive species are responsible for an estimated 40% of all extinctions since 1750, costing billions annually in cleanup and control.

Case Study



The Imported Fire Ant: Accidentally introduced to Mobile, Alabama in the 1920s via cargo ships from South America. Lacking natural predators, they spread rapidly, attacking native wildlife like newborn deer and ground-nesting birds. (NOLOGIA Biological Record)

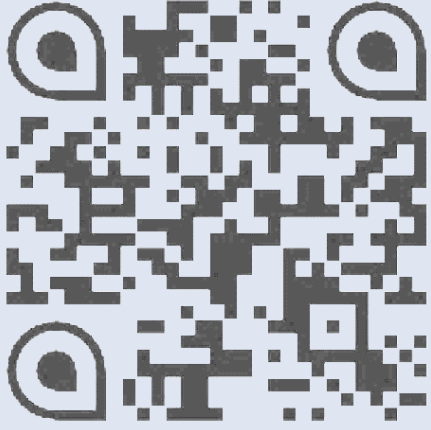
Synthesis: The Speed of Anthropogenic Change



Why is today's high rate of extinction different from past mass extinctions?

After historical extinctions, biodiversity recovered slowly over millions of years as new species evolved. Today, humans are changing environmental conditions faster than new traits can evolve to cope with them.

The problem is not just *what* is changing, but the unprecedented *speed* at which the baseline of survival is being altered.



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Module (5): Biodiversity and Conservation

03

Third Lesson: Conserving Biodiversity



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Conserving Biodiversity

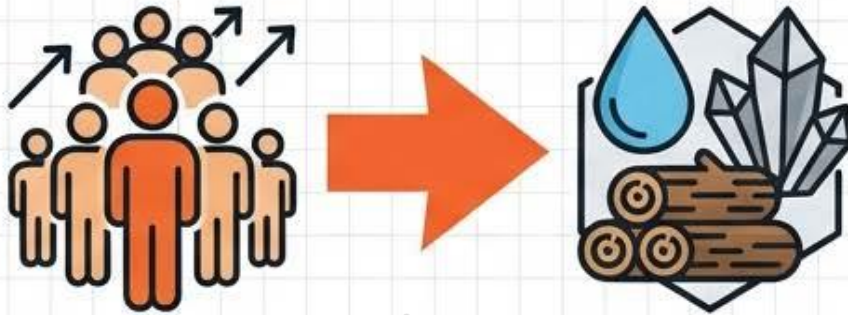
The NOLOGIA Official Study Playbook: Protection, Restoration, and Sustainable Use.



Grade 09 Science | Comprehensive Visual Review

The NOLOGIA Master Blueprint: Pressures & Actions

The Pressure



The Root Cause:

A growing human population of over 6 billion drives a massive demand for natural resources to supply basic needs.

The Toolkit



Sustainable Use
(Balancing consumption and replacement)



Protection
(Reserves, Hotspots, Laws)



Restoration
(Bioremediation, Biological Control)

The Resource Pressure: Global Consumption Gap



Developed Countries



- Much higher per capita consumption.
- High standard of living powered by heavy industry and high goods consumption.

Developing Countries



- Lower per capita consumption.
- Historically reliant on agriculture for income rather than industry.
- The Future Shift: As developing nations increase industry to raise living standards, their consumption rate must increase, making long-term conservation plans globally critical.

The Resource Matrix: Renewable vs. Nonrenewable

Renewable Resources

Replaced by natural processes faster than they are consumed. Supply appears endless but is not unlimited.

- Examples: Solar energy, agricultural plants, animals, clean water, clean air.

Nonrenewable Resources

Found in limited amounts or replaced over extremely long periods of time.

- Examples: Fossil fuels (coal, oil, gas), mineral deposits (uranium), extinct species (lost forever).

Context Changes Everything!



A single tree is renewable because it grows back from seeds. A completely cleared forest is nonrenewable because the entire habitat is destroyed, resident organisms die, and local extinction occurs.

The Goal: Sustainable Use

Sustainable use means using resources at a rate at which they can be replaced or recycled while preserving the long-term environmental health of the biosphere.



- ✓ 1. Reduce the amount of resources consumed.
- ✓ 2. Recycle resources that can be reused.
- ✓ 3. Preserve ecosystems and use them responsibly.



Protection Strategy 1: Nature Reserves

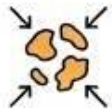
Traditional Protected Areas



The US established the world's first national park (Yellowstone) in 1872 to protect geological features and biodiversity.



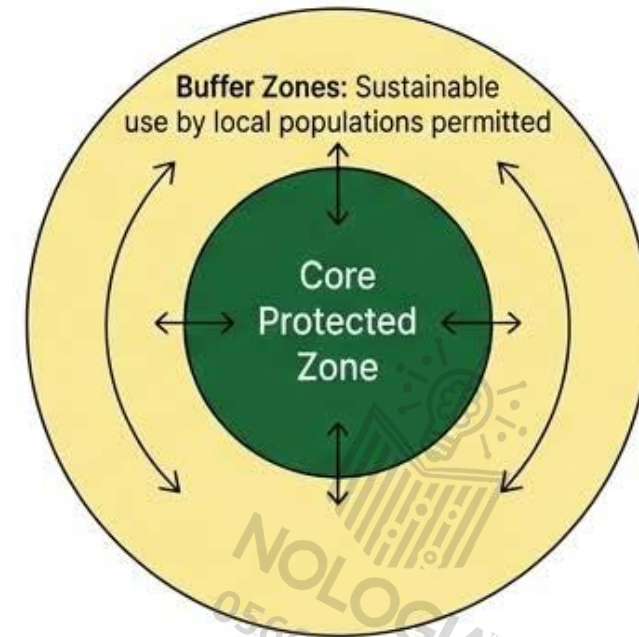
Currently, 10-15% of the world's land is set aside as reserves.



The Problem: Historically, these have been small "islands" of habitat entirely surrounded by damaging human activity.

Megareserves (The Costa Rica Model)

Large managed areas that integrate human populations rather than banish them.



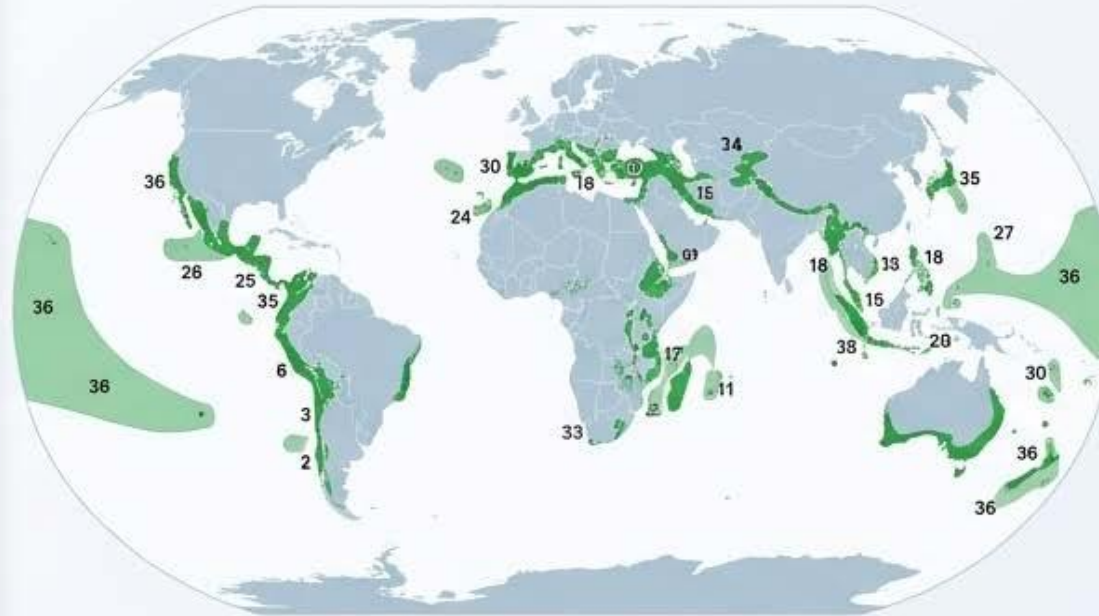
Protection Strategy 2: Biodiversity Hotspots

The Hotspot Formula

To be designated as one of the 36 globally recognized hotspots, a region **MUST** meet two criteria:

- ✓ **Exceptional Endemism:** At least 1,500 species of vascular plants that are endemic (found **ONLY** in that specific geographic area).
- ✓ **Critical Threat:** Must have lost at least 70% of its original habitat.

Impact: They originally covered 17% of Earth, now only 1/10th remains, yet they hold ~half of all plant/animal species.



The Funding Debate

Save the Hotspots

Concentrating funds here saves the absolute greatest number of species from immediate extinction.

Spread the Funds

Focusing only on hotspots ignores vital ecosystem services elsewhere (e.g., wetlands filter water and regulate floods globally, despite having fewer total species).

Protection Strategy 3: Habitat Corridors

Passageways between fragmented habitats allowing organisms to move safely.



Advantages

- Provides safe travel for animals across human-made barriers.
- Effectively creates a larger contiguous piece of land supporting a wider variety of species.
- Increases genetic variation by mixing separated populations.



Disadvantages

- Does NOT completely solve the core problem of habitat destruction.
- Allows diseases to pass easily from one infected area to the next.
- Increases edge effect (a single, intact large habitat is mathematically superior to connected small fragments).

The Legislative Shield

During the 1970s, global attention pivoted toward environmental destruction. Governments responded with powerful legal frameworks designed to act as structural shields for ecosystems.

1973 (United States)

Endangered Species Act (ESA)

Designed to legally protect species becoming extinct or in danger of extinction within the US.

1973 (International)

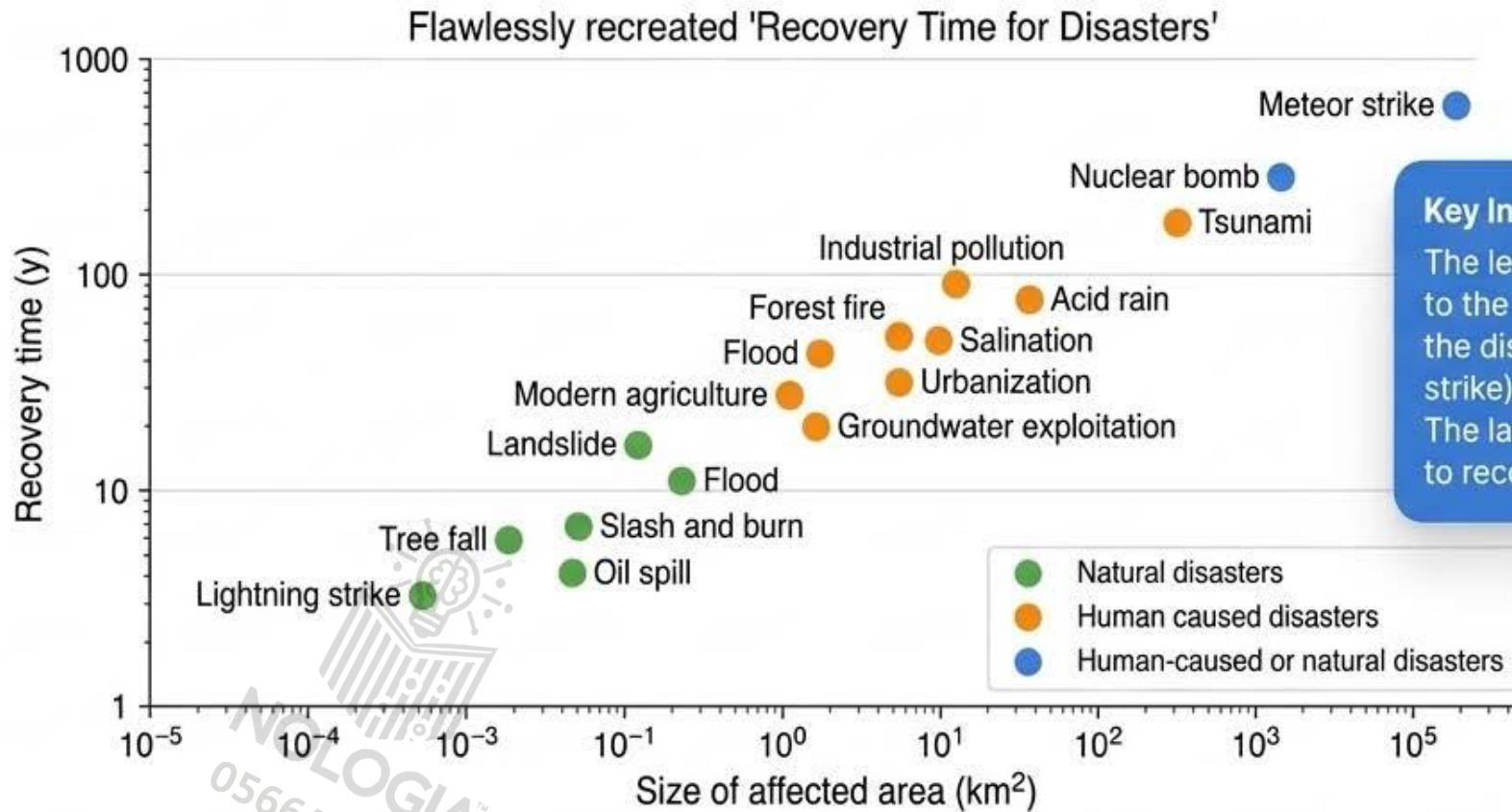
CITES Treaty

Convention on International Trade in Endangered Species of Wild Fauna and Flora. Outlawed the global trade of endangered species and animal parts (e.g., ivory elephant tusks, rhinoceros horns).

Takeaway: Legislation ensures the preservation of biodiversity for future generations by severely penalizing destructive behavior.

Restoring Ecosystems: The Recovery Curve

Sometimes biodiversity is destroyed so completely (mining, oil spills, toxic chemicals) that native species simply cannot survive.



Key Insight: Size Determines Time

The length of time for recovery is directly tied to the size of the affected area, NOT whether the disaster was a natural event (meteor strike) or human-made (industrial pollution). The larger the affected area, the longer it takes to recover.

Restoration Tech 1: Bioremediation

The use of living organisms (prokaryotes, fungi, plants) to detoxify a polluted area.

Flowchart A: Microorganisms (The Kerosene Spill)

1975, South Carolina: 80,000 gallons of jet fuel leak into sandy soil and groundwater.



Jet fuel leak, contaminated groundwater

Scientists add targeted nutrients to the affected soil.



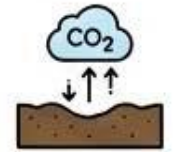
Nutrients added for microorganisms

Naturally occurring microorganisms accelerate the breakdown of carbon-based fuels.



Microbes breakdown fuels

Toxins are successfully converted into harmless carbon dioxide.



Toxins converted to harmless CO2

Flowchart B: Plants (Heavy Metals)

Plants (e.g., reed beds) are planted in soils heavily contaminated with zinc, lead, nickel, or organics.



Contaminated soil with heavy metals

Plants actively absorb and store the toxic metals in their plant tissues as they grow.



Plants absorb toxic metals

Plants are safely harvested, completely removing the heavy metal toxins from the ecosystem



Harvested plants remove toxins

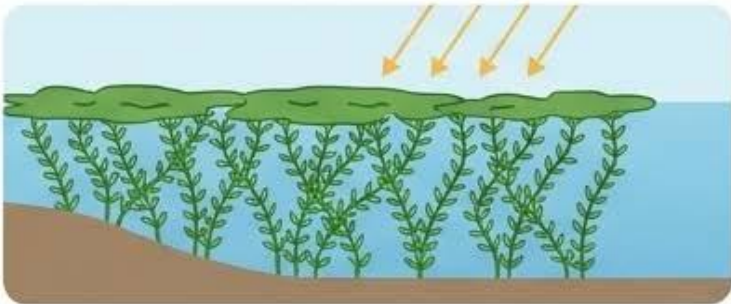


Restoration Tech 2: Biological Control

Definition

Introducing a natural predator or competitor to safely control an invasive species population.

The Threat



Hydrilla (an invasive plant in Florida) grows rapidly, forms dense surface mats, and completely blocks light from reaching bottom-dwelling native plants.

Cause & Effect



The Solution



Ecologists introduced the Asian grass carp in the early 1970s. The carp eat massive amounts of Hydrilla, effectively controlling the population and restoring water light penetration.

The Catch / Risk

If too many carp are present, they will destroy natural vegetation and ruin the overall water quality. Ecologists must carefully monitor the exact number of carp introduced into each body of water.

NOLOGIA Quick-Scan: Exam Prep Cheat Sheet

Core Terms

Sustainable Use

Balancing consumption rate with replacement rate.

Endemic Species

Species found naturally in only one specific geographic area.

Hotspot

Geographic area with $\geq 1,500$ endemic plants AND $\geq 70\%$ habitat loss.

Resource Types

Renewable

Replaced naturally faster than consumed (e.g., Solar, clean water, single tree).

Nonrenewable

Exists in limited amounts, extremely long replacement time (e.g., Fossil fuels, cleared forests).

Conservation Tools

Protection

Megareserves (uses buffer zones), Habitat Corridors (connect fragments).

Legislation

ESA (Protects US species), CITES (Bans global trade of animal parts).

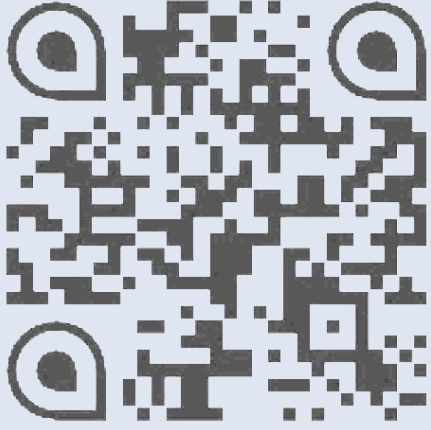
Restoration

Bioremediation (Organisms detoxify soil), Biological Control (Predators introduced to eat invasive species).

Module (1): The Nature of Science

	Lesson Title	Page
1-1	The Methods of Science	89
1-2	Standards of Measurement	100
1-3	Communicating with Graphs	114

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Module (1): The Nature of Science

01

First Lesson: The Methods of Science



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MASTER BLUEPRINT

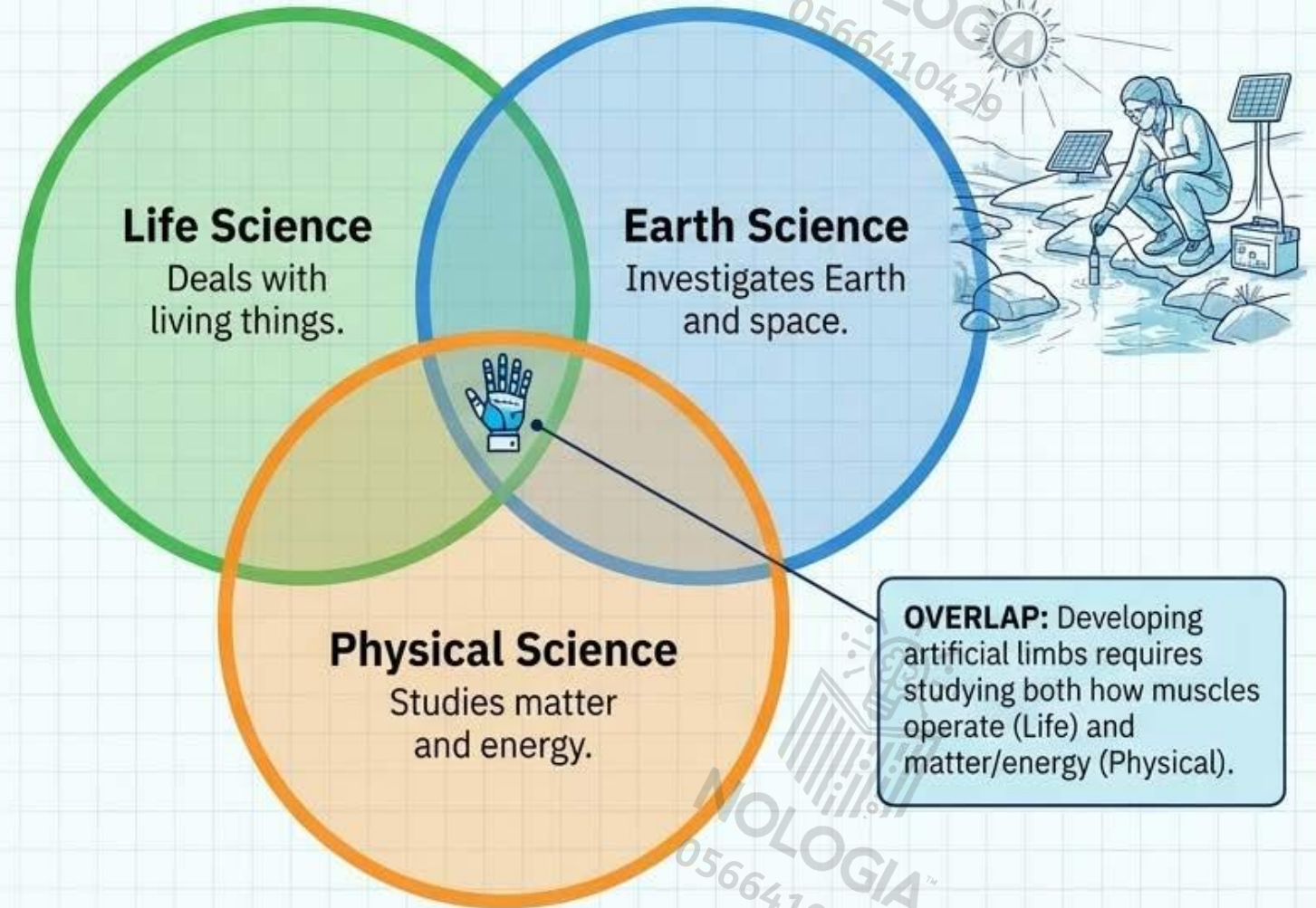
The Methods of Science

A comprehensive visual study guide for
understanding scientific inquiry, variables, and models

Defining the Realm of Science

What is Science?

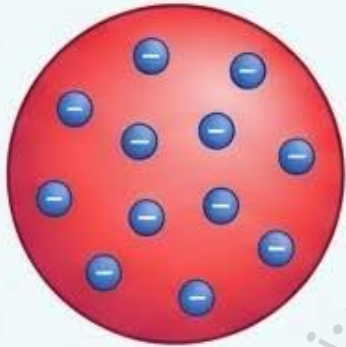
Science comes from the Latin word *scientia*, meaning "knowledge." It is a process based on inquiry that helps develop explanations about events in nature.



Science Changes: The Evolution of Knowledge

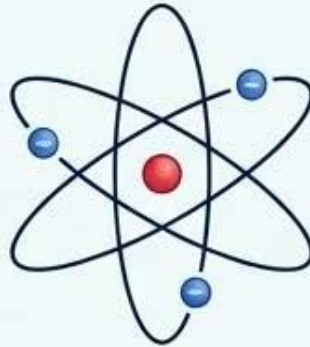
Scientific explanations must sometimes be modified. As more is learned, earlier explanations might be found incomplete, or new technology provides more accurate answers.

1904
Thomson Model



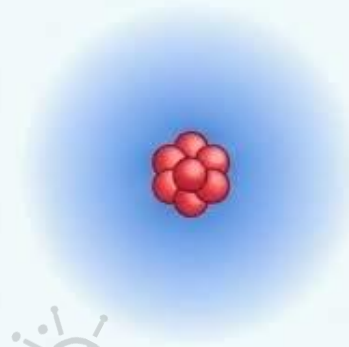
Solid ball of evenly distributed positive charge with electrons embedded inside.

1911
Rutherford Model



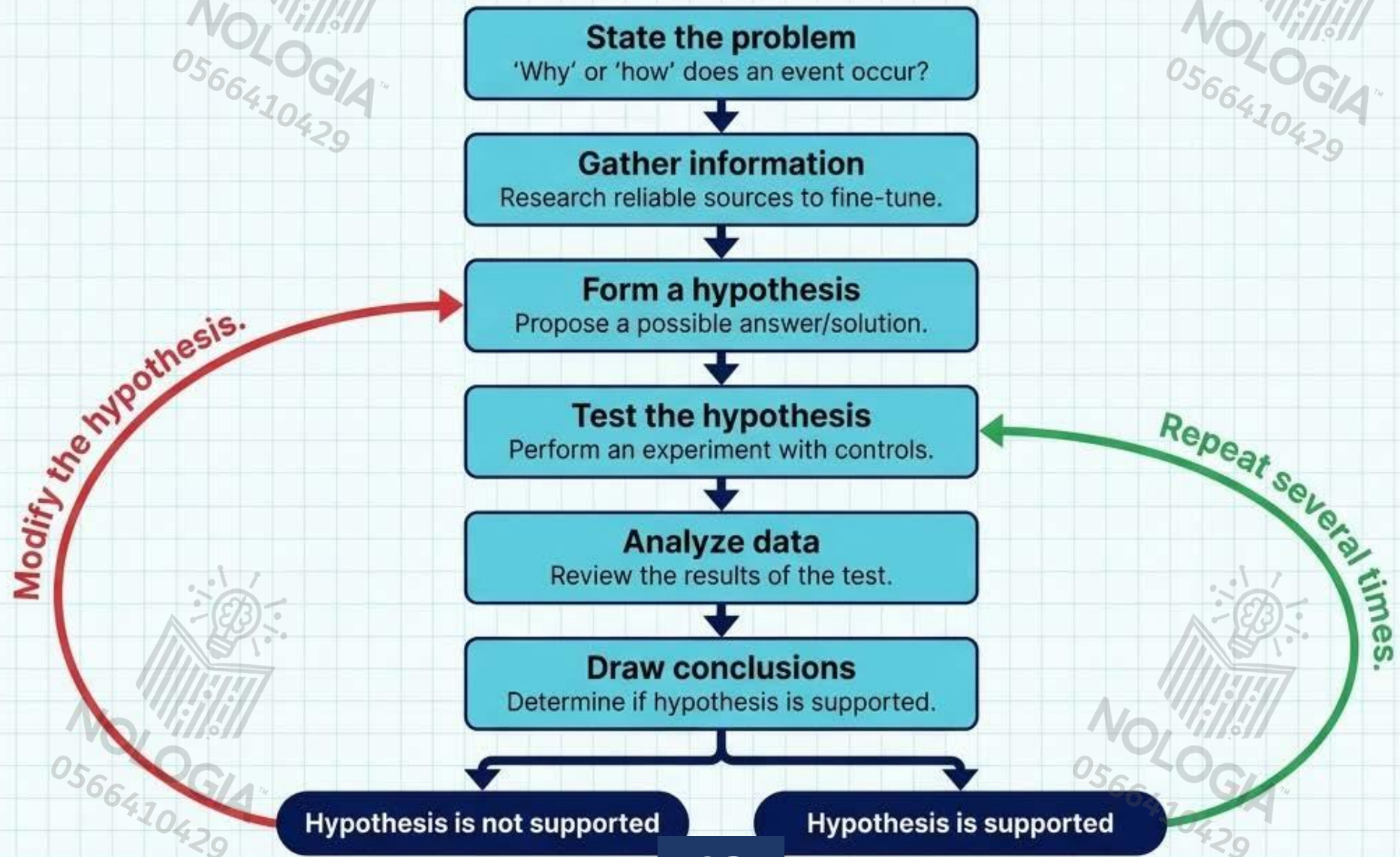
Based on new research, features a positively charged nucleus with electrons orbiting like planets around the Sun.

Present-Day
Electron Cloud Model



Nucleus of protons/neutrons surrounded by a cloud representing the space containing rapidly moving electrons.

The Scientific Method Engine



The Hypothesis Reality-Check

The Concept

The Hypothesis

A possible answer to a question or a possible solution to a problem based on what you know and observe.

The Experiment

A procedure that tests the effect of one thing on another using a control.

The Real-World Application

Step 1

The Problem

Space shuttle tiles need protection from intense heat.

Step 2

The Observation

Ceramic coatings solved a similar problem on guided missiles.

Step 3

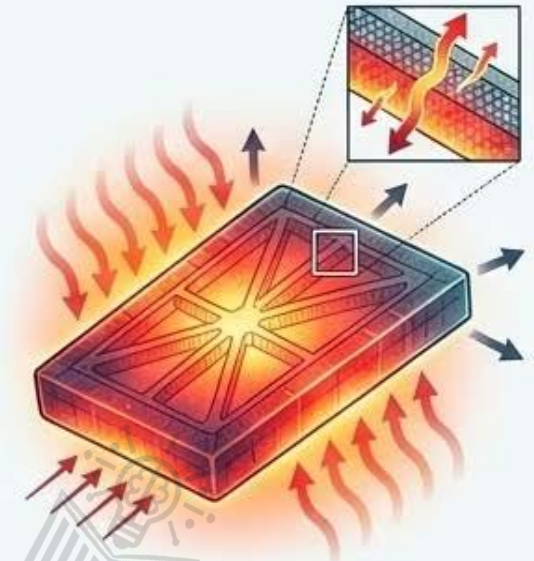
The Hypothesis

A ceramic material might also work to protect the space shuttle.

Step 4

The Reality Check

If testing shows it fails, the hypothesis is rejected and a new material must be theorized.



The Variable Diagnostic Matrix

An experiment tests the effect of one thing on another.

Example: Studying the effects of microgravity on plant growth aboard the ISS.



Independent Variable

The variable that is changed to test the effect on the dependent variable.

ISS Example: Microgravity

Dependent Variable

Changes according to the changes of the independent variable.

ISS Example: Plant Growth

Constant

A factor that does not change when other variables change.

ISS Example: Soil, light, water, temperature

Control

The standard by which the test results can be compared.

ISS Example: Earth-gravity plant group

Visualizing with Models: Past & Future

NOLOGIA

Why use models? To **visualize** things that are **too large**, **too small**, take **too much time**, or are **too hazardous** to observe directly.

Physical Analogies



In the 1800s, Lord Kelvin placed balls into a bowl of jelly to model how light moves through space.

Use: Visualizing abstract or invisible concepts through tangible objects.

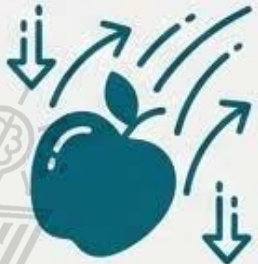
Computer Simulations



Flight simulators mimic real-world processes safely.

Use: Pilots practice harsh weather conditions or in-flight challenges without ever leaving the ground or risking lives.

Structural Distinctions: Scientific Law vs. Theory

Scientific Theory (The “Why”)	
Definition	An explanation based on knowledge gained from many observations and investigations. It is NOT a guess.
Flexibility	Can be modified as new information becomes available.
Example	Theories explain how the law of gravity works. 

Scientific Law (The “What”)	
Definition	A statement about what happens in nature that seems to be true all the time. Describes a pattern.
Limitation	It does not explain why or how something happens.
Example	The Law of Gravity dictates that any one mass will attract another mass. 

Crucial Rule: A theory can be used to explain a law, but theories do NOT become laws.

The Limitations of Science

SUBJECTIVE DATA

Science can help explain many things, but it cannot explain or solve every question.

It is a scientist's job to develop hypotheses that can be tested and verified.

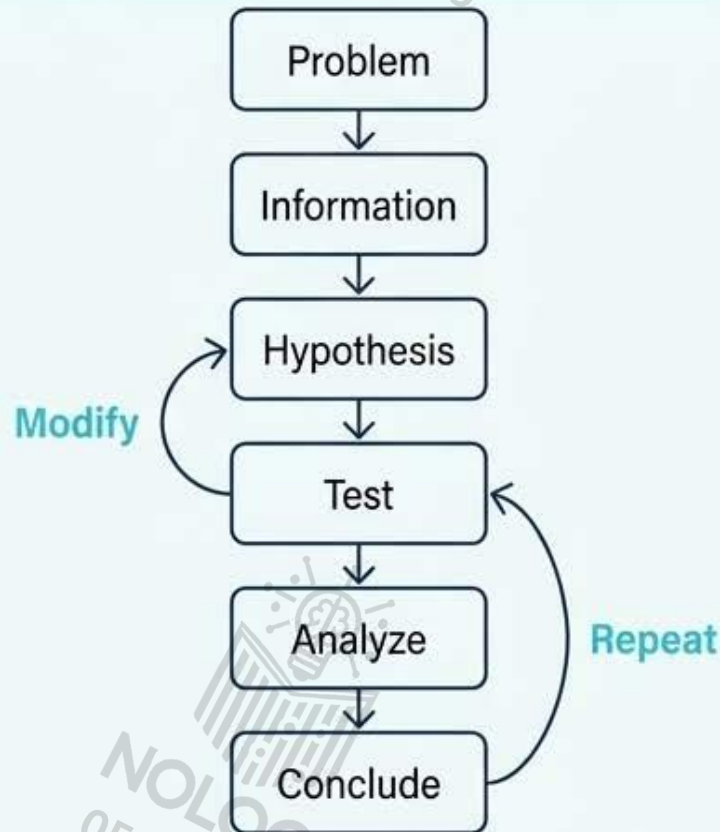
Questions about opinions and values cannot be tested scientifically. They are not scientific questions.



You might survey people about whether this painting is beautiful, but science cannot prove that opinion to be true or false.

NOLOGIA Ultimate Cheat Sheet: Methods of Science

The Method Loop



Variable Quick-Check™

Independent:

I change it.

Dependent:

It changes in response.

Constant:

Stays exactly the same.

Control:

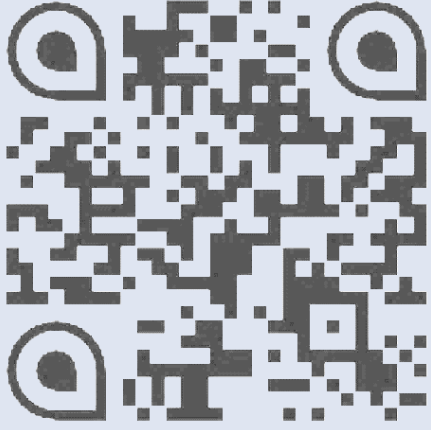
Standard for comparison.

The Rules of Science

Theory: Explains why based on evidence. Can change.

Law: Describes what happens always. Doesn't explain why.

Model: Visualizes the extreme (too big, small, fast, dangerous).



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Module (1): The Nature of Science

02

Second Lesson: Standards of Measurement

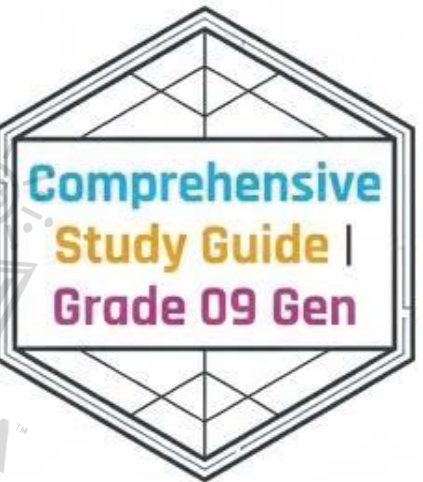
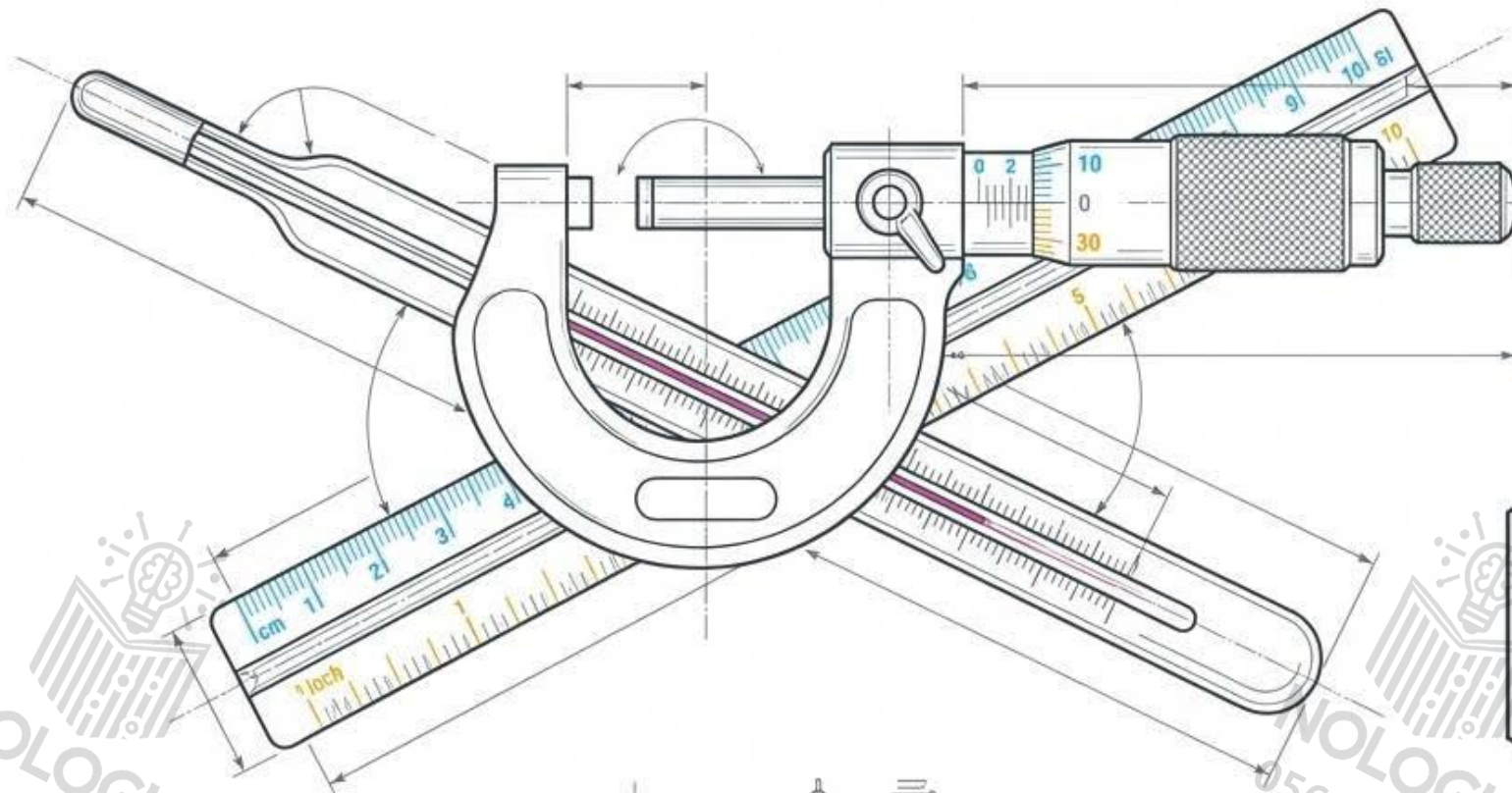


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Standards of Measurement

The NOLOGIA Master Reference File



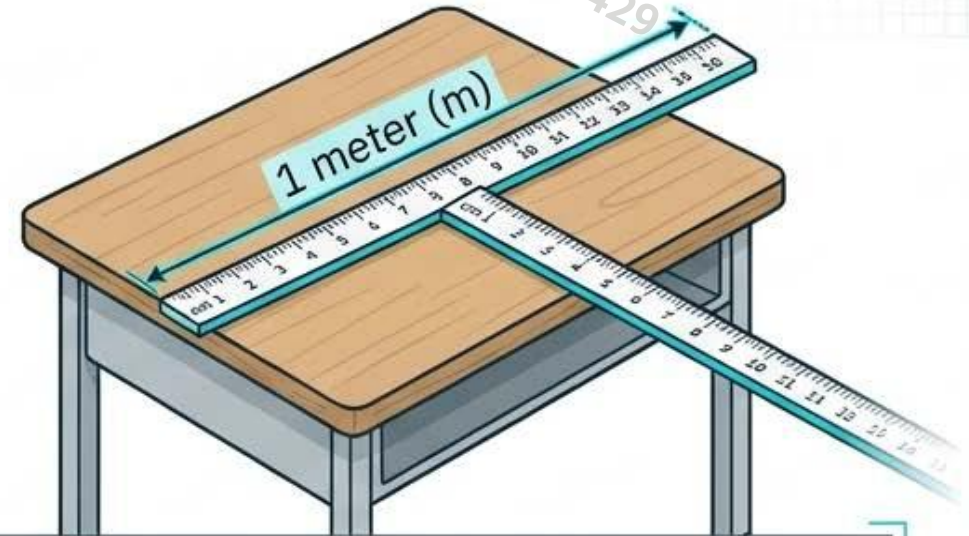
The Measurement Problem: Subjective vs. Objective

The Problem



Subjective: Without a standard, you cannot compare results.

The Solution



Objective: A standard is an exact quantity that people agree to use.

Standard: An exact quantity that people agree to use to compare measurements.

The Core System: SI Base Units

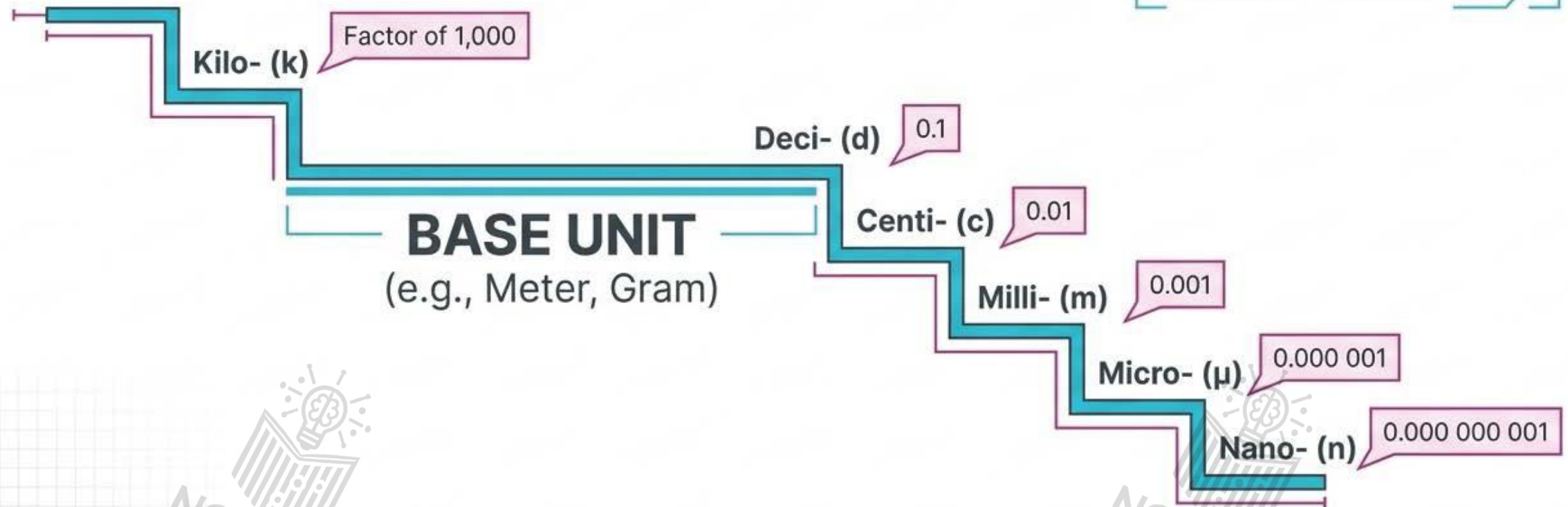
	Length	meter (m)
	Mass	kilogram (kg)
	Time	second (s)
	Electric current	ampere (A)
	Temperature	kelvin (K)
	Amount of substance	mole (mol)
	Intensity of light	candela (cd)

Fun Fact

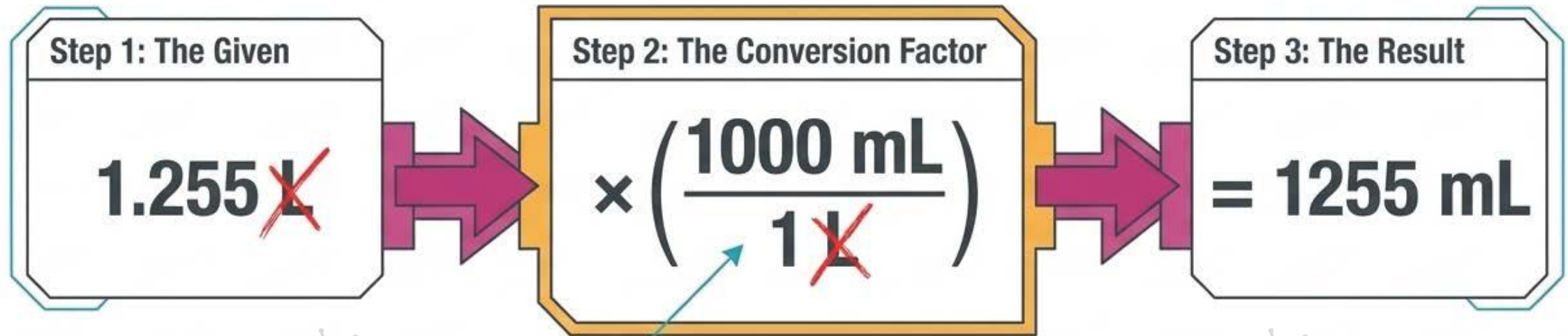
SI standards are based on **universal constants**. The standard meter equals the exact distance light travels in a vacuum in **1/299,792,458 seconds**.

The Scale Engine: SI Prefixes

The SI system is based on multiples of ten. Prefixes indicate what multiple of ten should be used with the units.



The Math Mechanic: Converting Between Units



Dimension 1: Measuring Length

By choosing an **appropriate unit**, you avoid large-digit numbers. It is **easier to read 21 km** than 21,000 m.

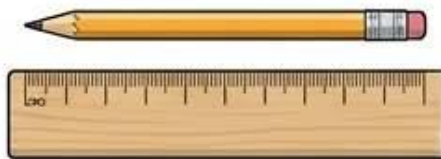
Spectrum of Scale

Zone 1
Micro Scale



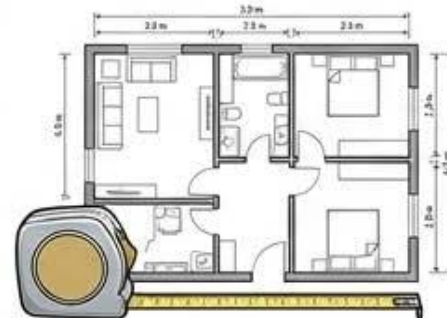
Appropriate unit: micrometers

Zone 2
Small Scale



Appropriate unit: centimeters

Zone 3
Human Scale

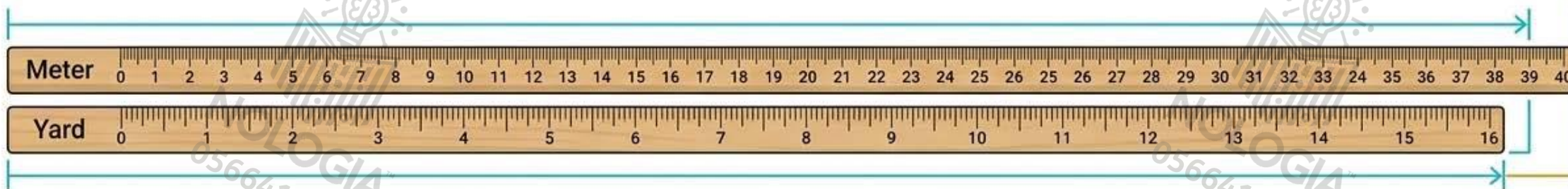


Appropriate unit: meters

Zone 4
Macro Scale



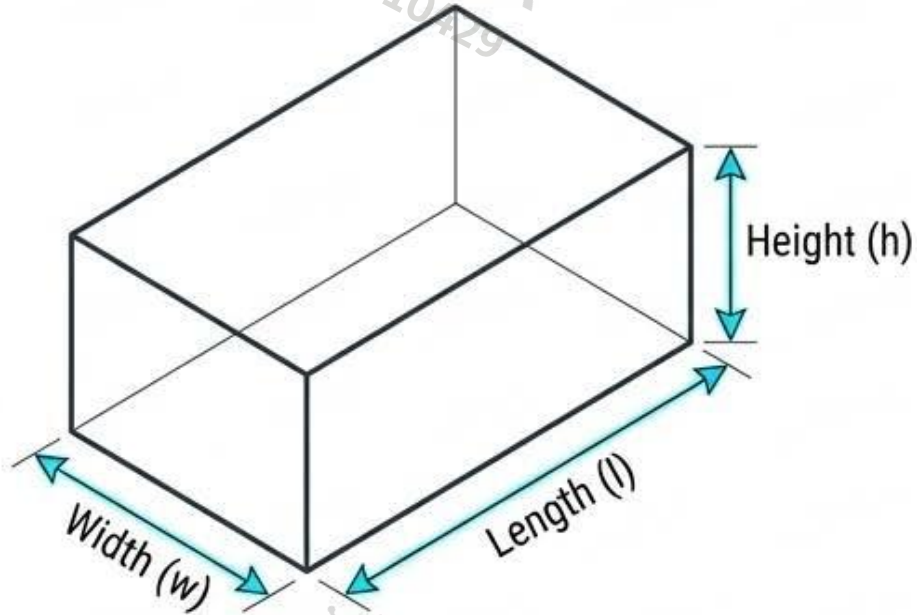
Appropriate unit: kilometers



1 Meter (SI Base Unit) > 1 Yard (Imperial Unit)

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The Formula

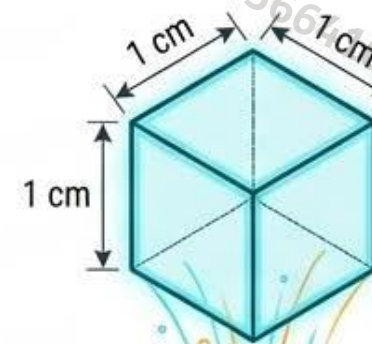


$$V = l \times w \times h$$

Units result in cubic centimeters (cm³) or cubic meters (m³).

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The Liquid-Solid Bridge



$$1 \text{ cm}^3 = 1 \text{ mL}$$



One cubic centimeter and one milliliter occupy the exact same amount of space.

Dimension 3: Mass vs. Volume

Definition

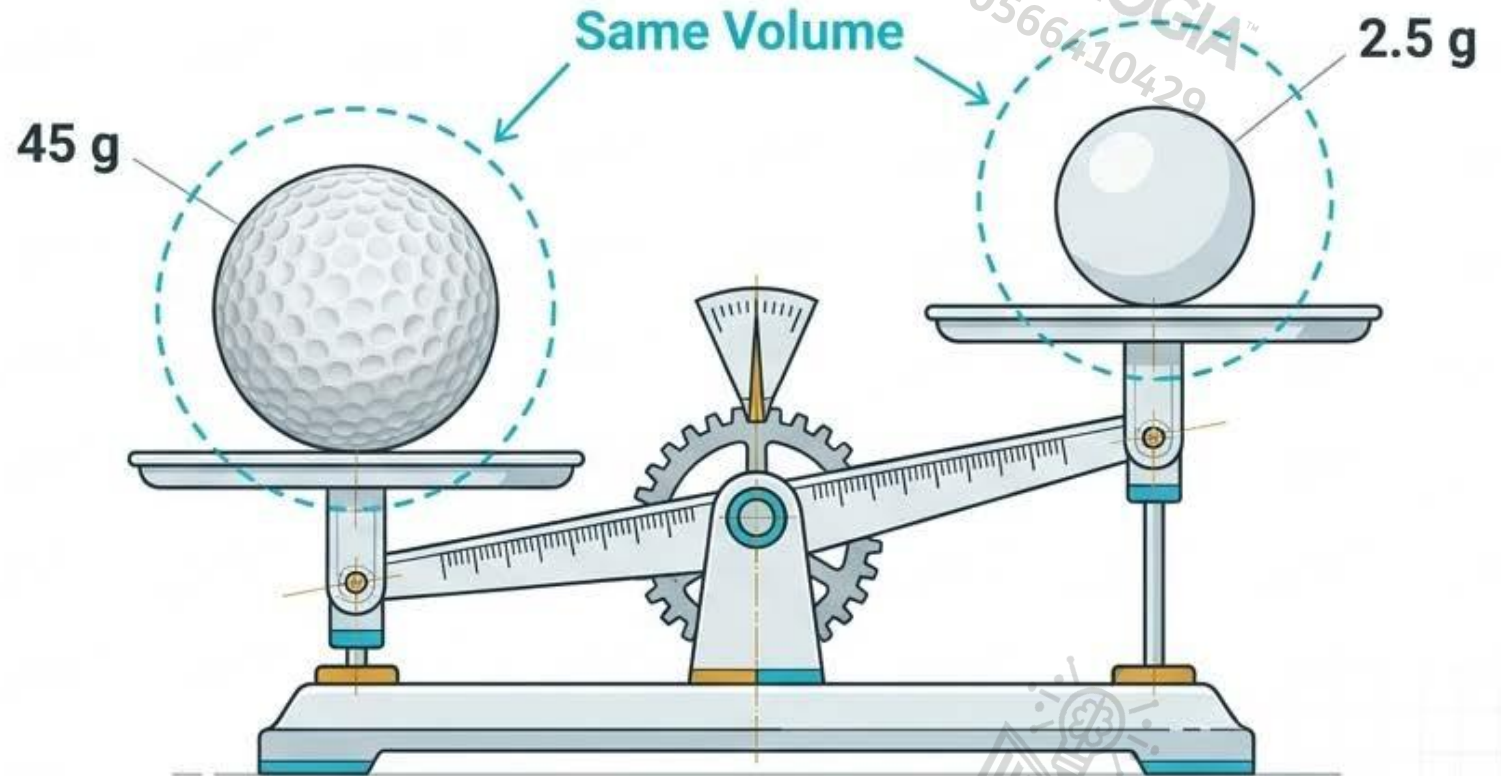
1

Matter: Anything that takes up space and has mass.

Box 2

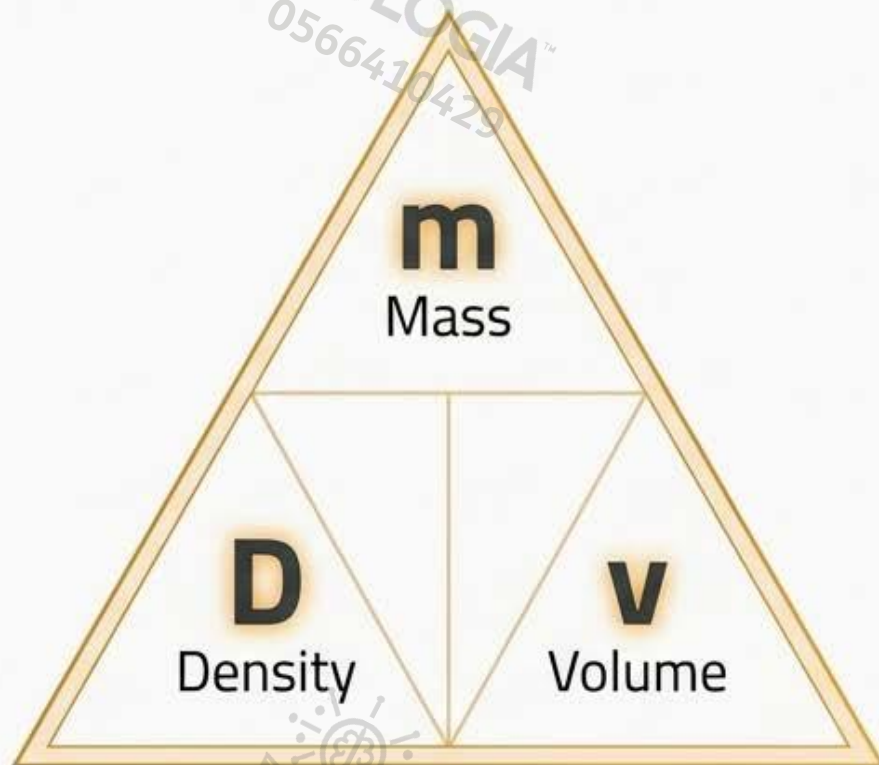
2

Mass: A measurement of the quantity of matter in an object.



The golf ball has almost **18 times the mass** of the **table-tennis ball**, despite occupying the same space.

The Density Equation



Material Densities (g/cm³)

Hydrogen	0.00009
Oxygen	0.0014
Water	1.0
Aluminum	2.7
Iron	7.9
Gold	19.3

Density is the mass per unit volume of a material. A cube of aluminum and a cube of silver the exact same size will have different masses because their densities differ.

Base Units vs. Derived Units

Base Units (The Building Blocks)

Based on universal physical constants.



Meter



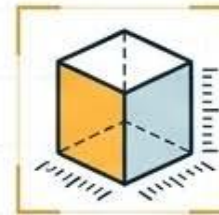
Kilogram



Second

Derived Units (The Combinations)

Obtained by combining different SI units.



m³ (unit multiplied by itself)



g/cm³ (mass divided by volume)



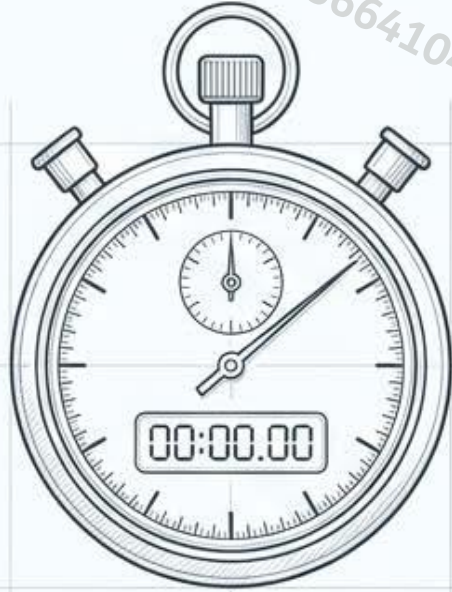
Liter

You measure Base Units. You calculate Derived Units.

Dimensions 4 & 5: Time and Temperature

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Time

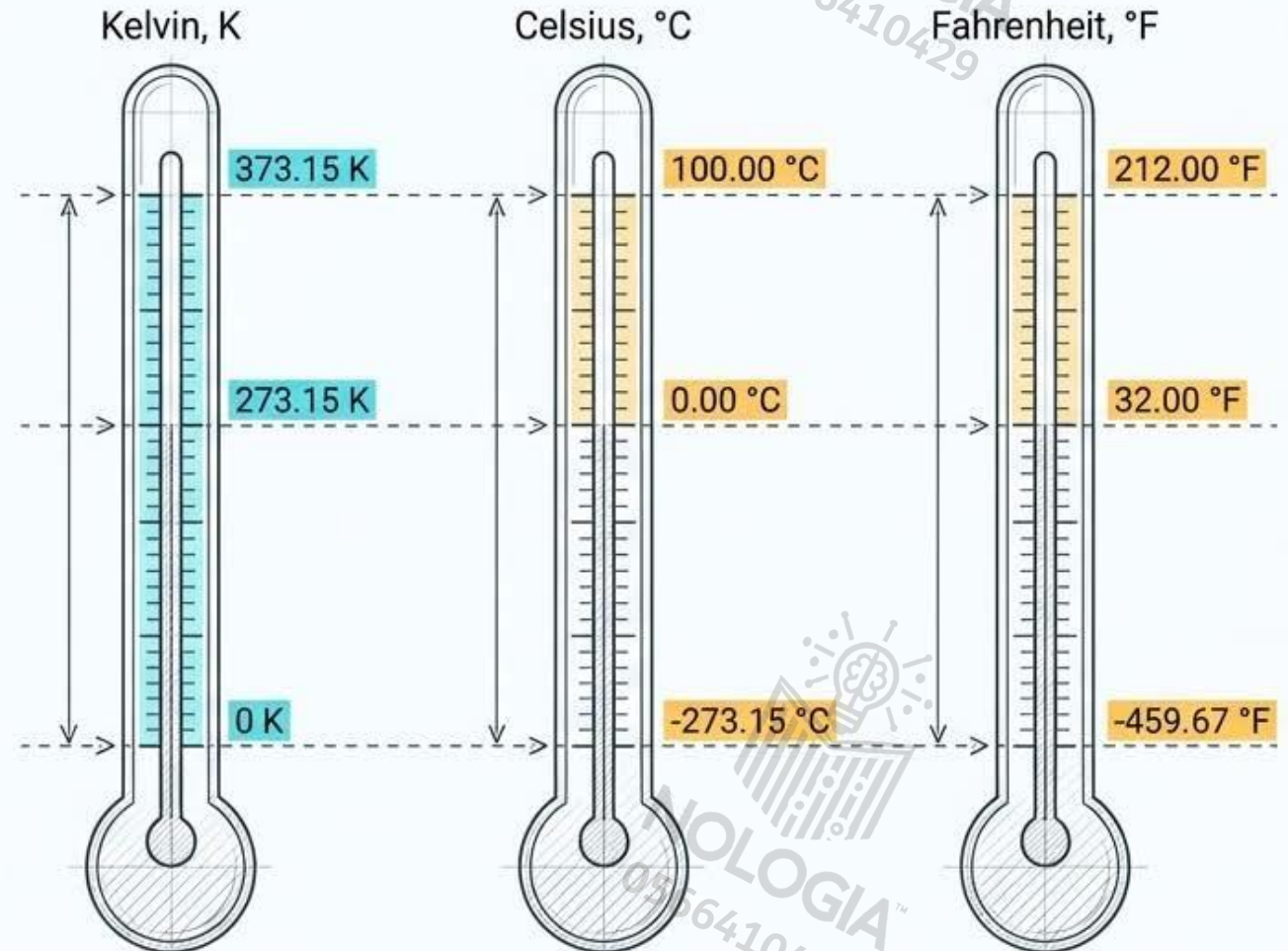


Time is the interval between two events.
SI Unit: **second (s)**.

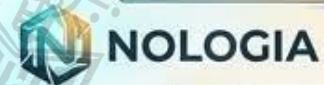
Critical Note

Kelvin is the SI unit. Zero on the Kelvin scale (0 K) is Absolute Zero, the coldest possible temperature.
Note: Degree symbols are NOT used with Kelvin.

Temperature



The NOLOGIA Scale Matrix: SI Units in the Real World

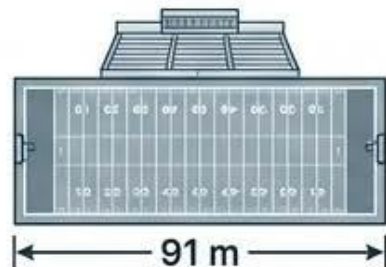


Millimeters



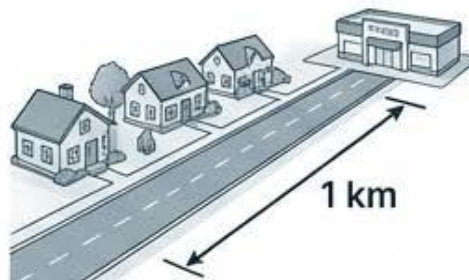
A dime is about 1 mm thick.

Meters



About 91 m long.

Kilometers



Distance to a store.

Milliliters



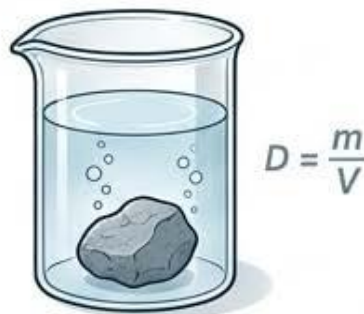
A teaspoon is about 5 mL.

Liters



Holds 1.89 L.

Grams/cm³



Denser than water.

Kelvin



Water boils at 373 K.

Grams



Mass of a paperclip.

NOLOGIA Master Reference: Study Cheat Sheet

The 7 Base Units



m (meter)



K (kelvin)



kg (kilogram)



mol (mole)



s (second)



cd (candela)



A (ampere)

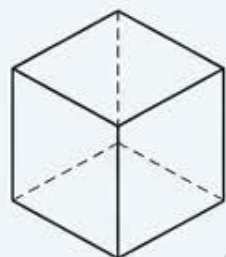
Core Formulas

Volume: $V = l \times w \times h$

Density: $D = m / v$

Temp: $K = ^\circ C + 273$

Key Equivalencies



$1 \text{ cm}^3 = 1 \text{ mL}$



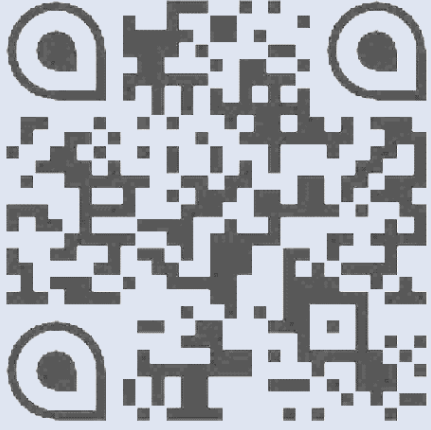
Prefix Quick Guide

Kilo (1000)

Centi (0.01)

Milli (0.001)





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Module (1): The Nature of Science

03

Third Lesson: Communicating with Graphs



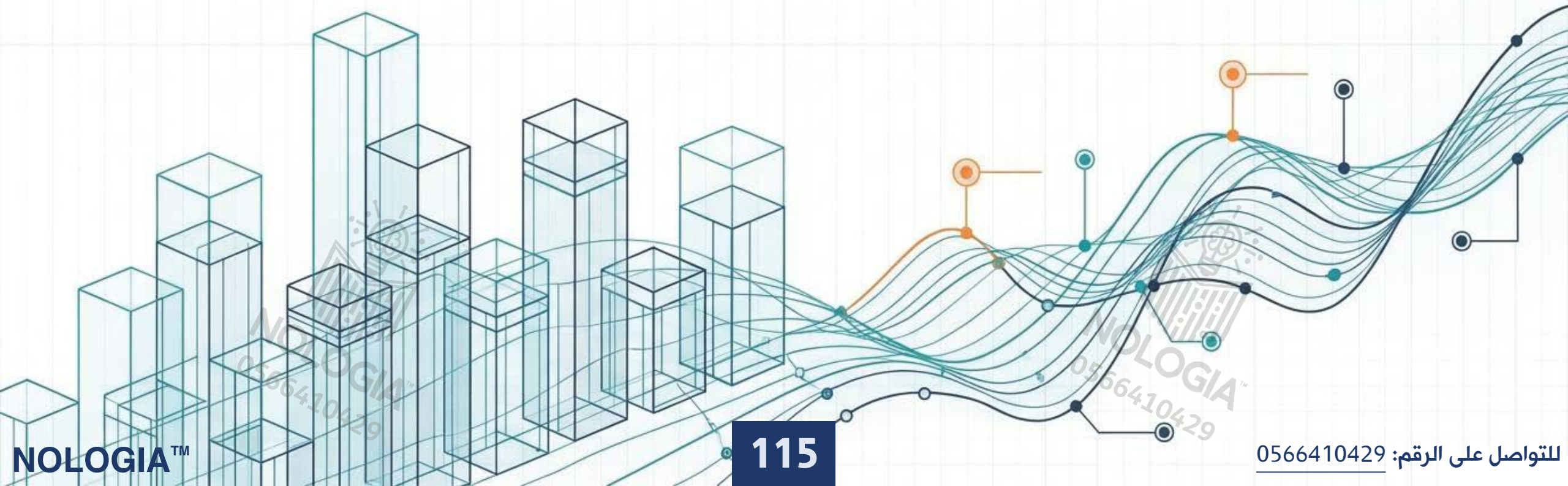
لحجز مقعدك قم بالتواصل معنا
اضغط هنا: 0566410429



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Communicating with Graphs

The Comprehensive NOLOGIA Study Guide for Data Visualization



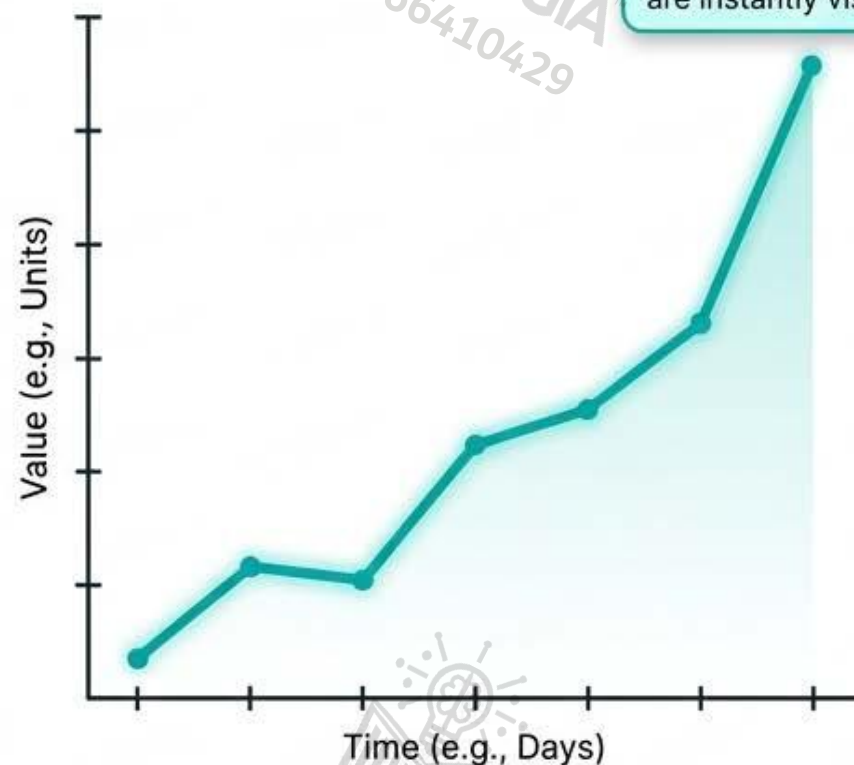
Raw Data

38.95	102.4	0.0054	25.66	88.12	0.951	1.089	...	0.1279	17.45
17.88	67.45	0.123	45.32	45.32	198.7	1.0045	...	0.0738	17.97
45.32	198.7	1.0045	31.82	198.3	199.9	1.0037	...	0.4623	58.85
38.95	101.7	0.0070	17.88	67.45	409.8	0.6461	...	0.1243	22.36
37.61	88.1	0.0063	6.12	57.67	579.1	0.8495	...	0.0961	21.28
18.37	119.9	0.1015	16.89	88.12	599.9	1.0025	...	0.1287	29.13
45.32	198.7	1.0076	56.3	12.17	98.1	1.0002	...	0.3631	45.04
37.85	102.4	1.0045	25.66	76.53	38.82	0.1006	...	0.0728	28.50
28.99	85.3	0.0092	27.45	88.12	169.7	0.9511	...	0.1032	29.25
28.24	98.7	0.0003	25.88	77.45	435.9	1.1028	...	0.0288	57.32
40.55	94.6	0.0250	17.88	84.73	483.9	1.035	...	0.0729	28.08
18.98	131.5	0.0074	25.66	89.68	509.0	1.063	...	0.4797	47.07
47.04	131.3	1.0023	12.78	26.3	376.4	1.0519	...	0.0798	15.18
45.32	198.7	1.0045	45.32	196.7	249.3	1.0056	...	0.0637	30.31
28.91	101.4	0.0086	17.88	68.12	83.49	1.0302	...	0.3703	38.94
28.21	139.0	0.0083	47.32	54.32	289.7	1.0004	...	0.0353	88.12
36.23	101.6	0.0592	36.52	68.19	46.88	1.0004	...	0.1223	10.09
37.81	108.5	0.0082	40.52	64.92	188.9	0.7233	...	0.0283	38.47
38.95	102.4	0.0056	25.66	88.12	225.6	1.0246	...	0.0788	36.43
25.56	94.7	0.0067	25.66	88.12	573.4	1.9517	...	0.0783	19.86
17.88	88.9	0.0799	26.81	67.45	63.71	1.0045	...	0.3185	47.34
54.34	103.4	0.0043	48.31	95.81	304	1.0358	...	0.0731	12.16
17.88	11.3	0.0593	17.88	75.8	453.2	1.0255	...	0.1089	36.54
45.32	198.7	0.0223	45.32	46.24	198.7	1.0045	...	0.0223	17.63
38.95	102.8	0.0056	25.66	88.12	198.7	1.0045	...		

Raw Data:
Hard to detect
hidden patterns.

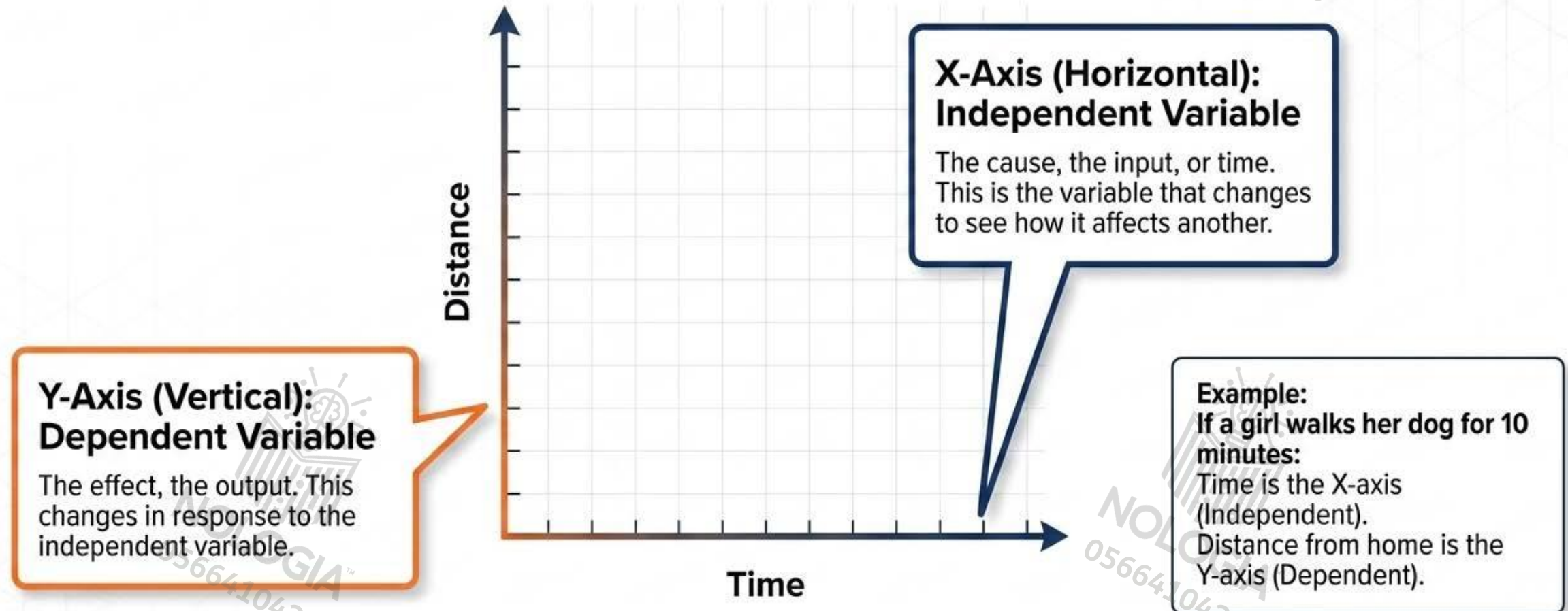
Transformation

Visual Display



Key Takeaway: Graphs are visual displays of information used by scientists to detect patterns that would not be evident in a standard table.

The Anatomy of a Graph



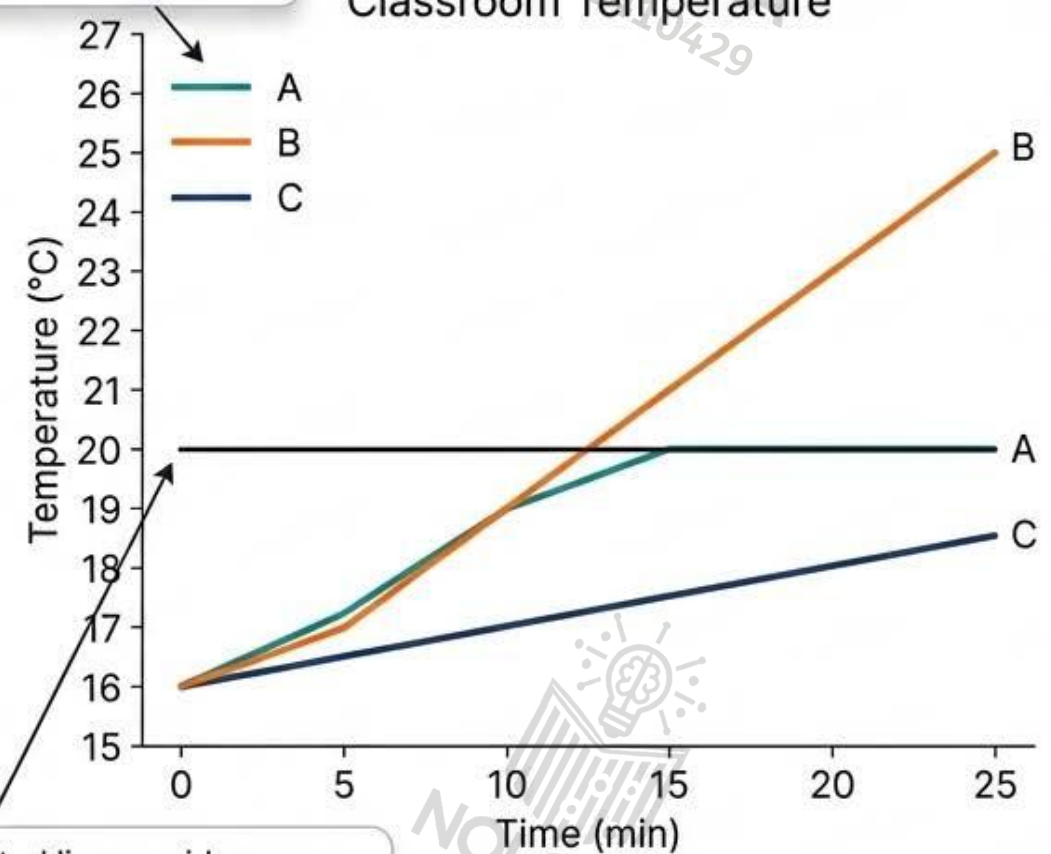
Time

Distance

Line Graphs: Visualizing Continuous Change

Used to show relationships where the dependent variable changes due to a change in the independent variable. Most commonly used to track changes over time.

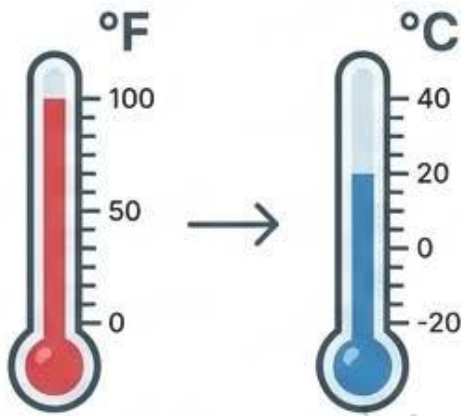
You can compare multiple identical events on one graph.



A control line provides a baseline (e.g., the thermostat setting) to measure efficiency.

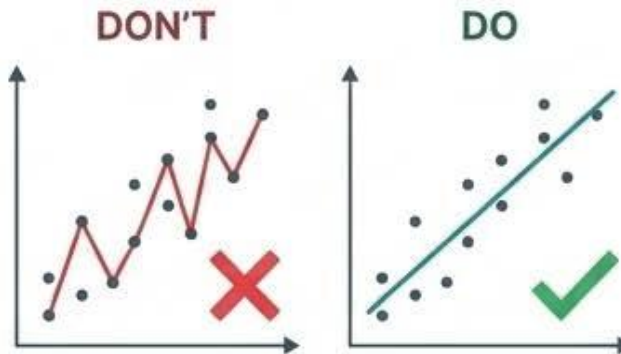
Constructing Line Graphs: NOLOGIA Pro-Tips

Rule 1: Consistent Units



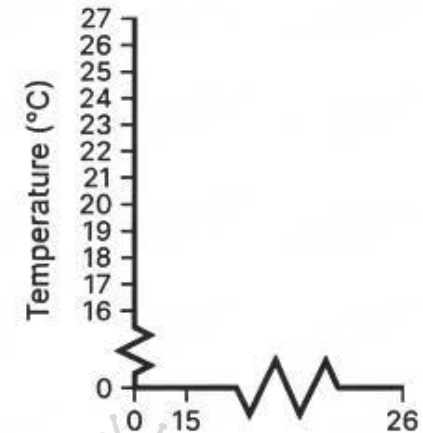
Always use consistent units. Convert all measurements before plotting.

Rule 2: The Best-Fit Line



Never play connect-the-dots. Draw a smooth best-fit line or curve among the points.

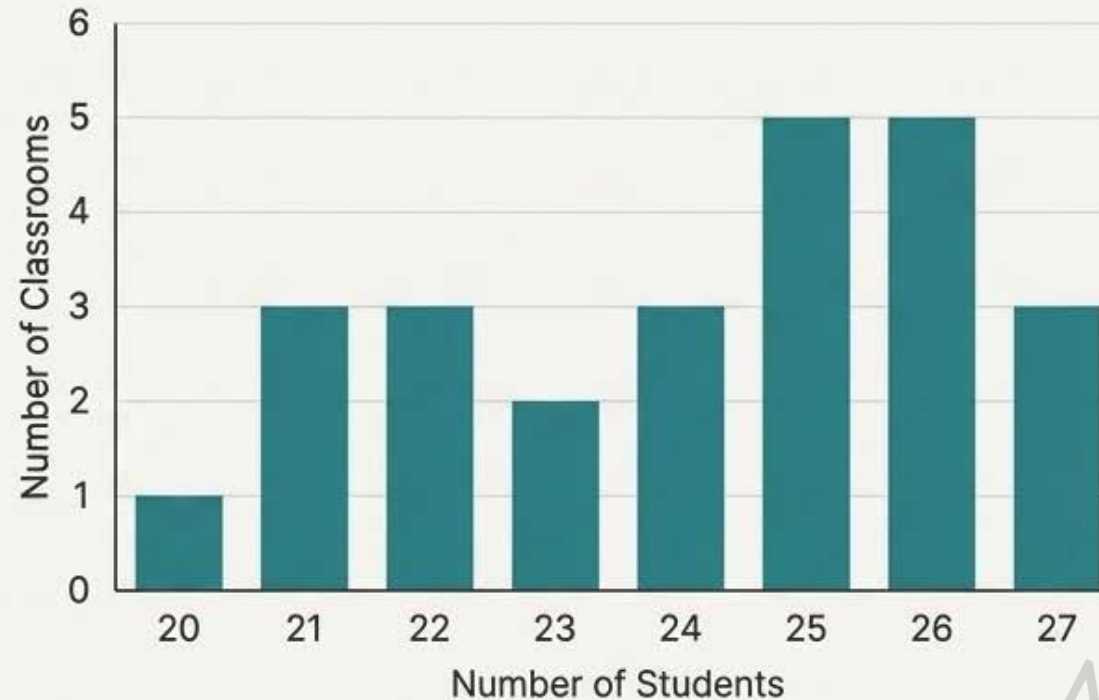
Rule 3: Scale Breaks



Use a scale break (zigzag) to skip empty space and spread out data points, making the graph readable.

Bar Graphs: Comparing Categories

Classroom Size



Primary Use

Comparing information or displaying data that is collected by counting and does not change continuously.

Structure

X-axis = Independent Variable (Distinct Categories).
Y-axis = Dependent Variable (Count/Quantity).

Circle Graphs: Parts of a Whole

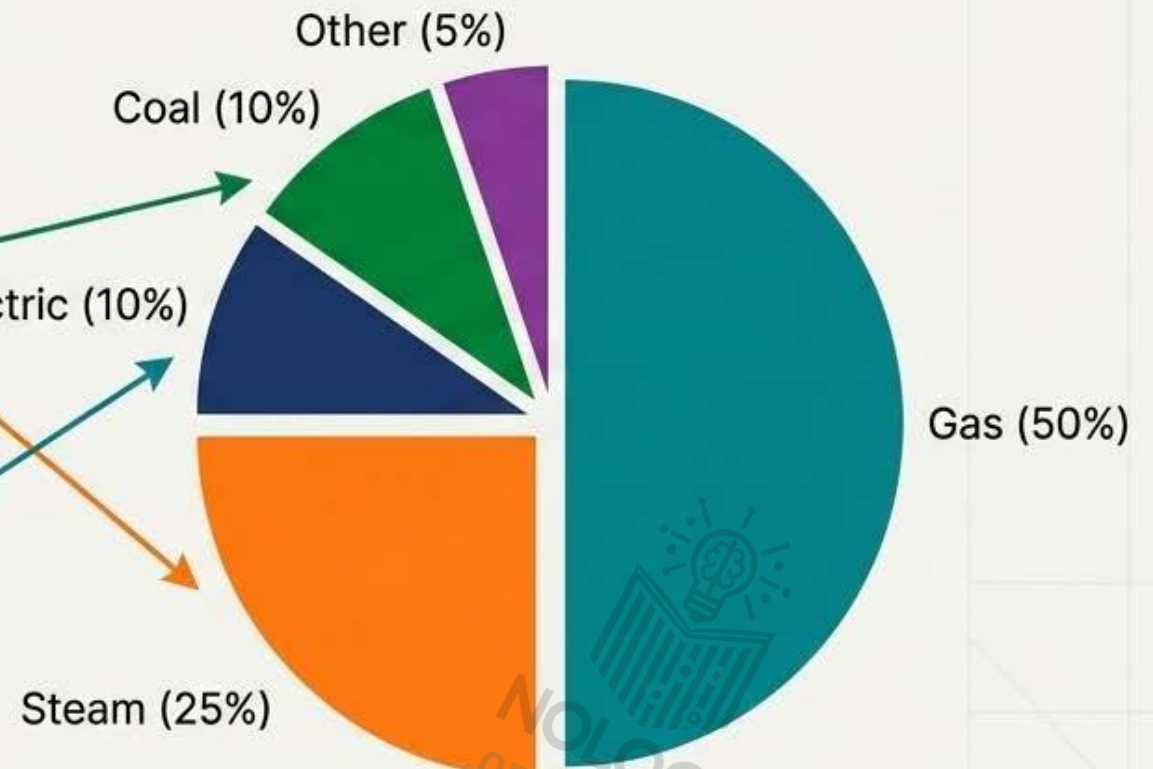
Core Concept Box

Used to show how a fixed, total quantity is broken down.

The entire circular pie represents the absolute total (100%).

The slices represent the individual parts, typically displayed as percentages.

Sources of Heat



The Math Connection: Calculating Circle Graph Angles

Step 1: Part ÷ Total = Decimal

$$\begin{array}{ccc} \mathbf{18} & \div & \mathbf{72} \\ \text{buildings} & & \text{total} \\ \text{using steam} & & \text{buildings} \end{array} = \mathbf{0.25}$$

Step 2: Decimal × 360° = Angle

$$\mathbf{0.25} \times \mathbf{360^\circ} = \mathbf{90^\circ}$$

on the
circle graph.



The NOLOGIA Graph Selector

What kind of data are you analyzing?

Is it a continuous change over time?



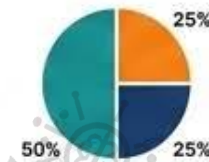
Use a
Line Graph

Are you counting distinct categories or groups?



Use a
Bar Graph

Are you showing percentages of a complete total?

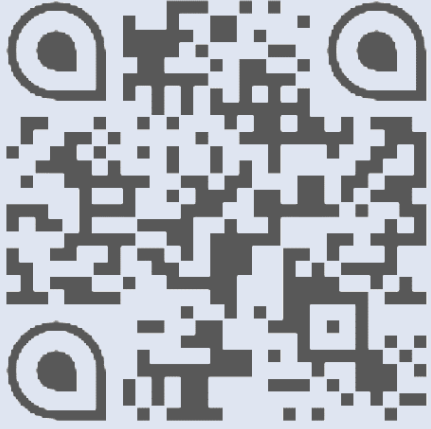


Use a
Circle Graph

Before you draw, let the data dictate your design.

The Ultimate NOLOGIA Master Matrix

Graph Type	Best Used For	X-Axis Represents	Y-Axis Represents
Line Graph 	Relationship between variables / continuous change over time.	Independent Variable (e.g., Time).	Dependent Variable (e.g., Temperature).
Bar Graph 	Comparing counted information / non-continuous discrete data.	Independent Variable (Distinct Categories)	Dependent Variable (Count / Amount)
Circle Graph 	Breaking down a fixed total into parts (percentages).	N/A (Represents the 100% Total)	N/A (Slices represent percentage parts)



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ختاماً، نسأل الله أن يوفقكم، وأن
تكون هذه الملزمة قد حققت
الفائدة المرجوة ♥



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