

Level 1

Natural Selection

Natural selection
Evolution
Gene Pool / Genes
Hardy-Weinberg
Equilibrium
Fitness
Adaptation
Darwin
Mutation

Level 2

Examples of Natural Selection

Natural Selection
Flowering / Climate
Phenotype
Genotype
Sickle-Cell Anemia
Antibiotic resistance
in bacteria

Level 3

Genetic Drift

Evolution
Genetic drift
Bottleneck
- N. Elephant Seal
Founder effect
- Finches, tortoises
Gene Flow
Microevolution

Level 4

Evidence of Evolution

Biogeography
Fossils
Anatomy
- Homology
- Analogy
- Embryology
- Vestigial
Molecular Evidence
Evolutionary tree

Level 5

Essential
Characteristics
are Conserved

- Life
- Genetic code
- Metabolism
- Central dogma
- Genes
- Eukaryotic cells
 - Eukarya
- Prokaryotic cells
 - Bacteria
 - Archaea

007 Speciation and Extinction

Speciation

- Adaptive Radiation

Extinction

- Mass Extinction

- Permian
- Cretaceous
(K/T Boundary)

Niche

Phylogeny 006

Convergent evolution

Analogy vs. Homology

Systematics

Taxon -

Cladogram

- Clade

Parsimony

rRNA vs. mtDNA

Monophyletic

008 - Speciation

Speciation

Species =

- Biological
- Morphological
- Phylogenetic
- Ecological

Pre-Zygotic Barriers

- Temporal
- Mechanical
- Habitat
- Gametic
- Behavior

Post-Zygotic Barriers

Allopatric vs. Sympatric
Speciation

009 - Populations Continue to Evolve

Natural Selection

- Directional
- Stabilizing
- Disruptive

Sexual Selection

- Intersexual vs. Intrasexual
- Sexual Dimorphism

Hybrid Zones

Galapagos Finches

011 - The Origin of Life

LUCA

Archaea
Bacteria

Prokaryotic cells

Eukaryotic cells

Multicellular life

Horizontal Gene Transfer

DNA

010 - Abiogenesis

Stromatolite

Miller-Urey Experiment

LUCA

Monomers - Protocell
(protobiont)

Ribozymes

012

Free Energy

Energy

1st Law of Thermodynamics

2nd Law of Thermodynamics

Gibbs Free Energy

Exergonic Reaction

- Cellular Respiration

Endergonic Reaction

- Photosynthesis

ATP

Energy Coupling

013 Free Energy

Respiration Photosynthesis

Redox reaction Light reaction

Glycolysis Photosystem

Citric acid cycle Chlorophyll

Oxidative phosphorylation NADPH

Chemiosmosis Calvin Cycle

NADH / FADH₂ Chloroplast

Mitochondria

Drawings

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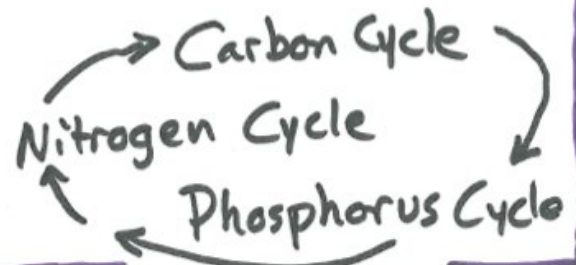
014 Environmental Matter Exchange

Carbohydrates
Mono- Di- Polysaccharides

Lipids
Glycerol, Fatty Acid

Proteins
Amino Acids
Four levels of structure

Nucleic Acids
DNA, RNA, Nucleotides



015 Membranes

Cell Membrane

Cell wall

Fluid Mosaic

Proteins

Phospholipids

Cholesterol

Glycoproteins

Selective Permeability

Aquaporins

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Figure 5.1A

016 Transport

Diffusion

Osmosis

Gradient

Passive Transport

Active Transport

Hypo- Iso- Hypertonic

Facilitated Diffusion

Exocytosis

Endocytosis

- phagocytosis

- pinocytosis

- receptor-mediated

017 Compartmentalists

- Plant vs. Animal Cells
- Organelles
- Endomembrane System
 - Rough ER
 - Smooth ER

018 Feedback Loops

- Homeostasis
- Negative feedback
- Thermoregulation
- Positive feedback
- Labor
 - Ethylene

Pancreas
Insulin
Glucagon
Diabetes

Level 19 Environmental Response

- Behavioral Response
- Hibernation
 - Migration
- Physiological Response
- Sweating
 - Shivering
- Thermoregulation
- Counter current Heat Exchange
 - Cognitive Maps

Level 20

Biosphere
Biome
Ecosystem
Community
Population
Organism

Biotic
and
Abiotic
Factors

- Predator - Prey
- Food Webs
- Biofilms
- Ecology

Level 21

Homeostatic Evolution

Excretory System

Nephron

Filtration, Reabsorption,
Secretion, Excretion

Urea, Ammonia, Uric Acid

Respiratory System

Lung / Alveoli

Gill / Lamella

Tiktaalik

Level 22

Homeostatic Disruptions

Osmoconformer

Osmoregulator

Invasive Species

Biodiversity

Endangered Species

Threatened Species

023 Plant/Animal Defense

Plant

Nonspecific
Hypersensitive Response
R-gene

Animal

Nonspecific
Inflammatory Response

Specific

←
Humoral

Antigen
Antibody
B cells

→
Cell-Mediated

Cytotoxic
T Cells

Helper T

HIV Infection

024 Timing and Coordination

Germination

Differentiation

Transcription factors

Induction

SRV gene

Apoptosis

RNA interference

Homeotic genes

Mutants

Development

025

Timing and Control

Plants

Phototropism

· Auxin

Photoperiodism

· Phytochrome

Animals

Circadian rhythm

Pineal gland

Bacteria

Quorum sensing

Autoinducer

026

Behavior and Natural Selection

Behavior

· Innate

· Learned

Natural Selection

Phototropism

Photoperiodism

Courtship rituals

Pollination

Level 27

DNA and RNA

History

- Avery / Griffith

- Hershey-Chase

- Watson-Crick

- Prokaryote
- Eukaryote

Chromosomes

DNA / RNA Structure

DNA Replication

Transcription

Translation

Phenotype

Genetic Engineering

Level 28

Cell Cycle

Cell Division

Cell Cycle

- Interphase

- M Phase

- Cytokinesis

Mitosis

· Diploid

Cycle

Meiosis

· Haploid

Fertilization

- Independent assortment

- Random fertilization

- Crossing Over

Level 29 Genetics

P, F₁, F₂ generation
Dominant vs. Recessive
Phenotype vs. Genotype
True-breeding
Monohybrid cross
Dihybrid cross
Heterozygous
Homozygous
Pedigree
Law of addition
Law of multiplication

Level 30 Advanced Genetics

Incomplete Co-Dominance
Multiple alleles (ABO)
Pleiotropy
Polygenic Inheritance
Linked genes
Autosomes
Sex linkage
Sex chromosomes
Non-nuclear inheritance
Gene maps

Level 31 Gene Regulation

Gene regulation
Gene expression
Operon

- Promoter
- Repressor
- Operator
- Genes

Lac operon
Trp operon
Histone
Transcription factors
Enhancers

Level 32

Signal transmission
Gene expression
Endocrine system
Nervous system
Glands / Target cells
Hormones

- Lipid-soluble
testosterone
- Water-soluble
epinephrine

Level 33

Genotypes
Phenotypes

Mutation

Base substitution

Insertion/Deletion

'Frameshift'

Sexual recombination

- Meiosis

Nondisjunction

Down Syndrome

Polyploidy

CCR5-Δ32

PKU

Level 34

Increasing
Variation

Variation

Viruses

Prokaryotes

Horizontal acquisition

• Conjugation

• Transformation

• Transduction

Plasmids

Eukaryotes

• Independent
assortment

• Crossing over

• Random
fertilization

Level 35

Viral
Replication

Virus

Capsid-Envelope

Lytic Cycle

Lysogenic Cycle

- Prophage

Retrovirus

- Reverse
transcriptase

AIDS

HIV

Virulence

Level 36

Cell
Communication

Quorum sensing

Vibrio fischeri

Autoinducer

Luciferase

Planktonic

Colonial

Epinephrine

Glycogen

CREB

Level 37

Cell Communication

Cell to Cell

- Antigen Presenting Cell

Short Distance

- Local regulator
- Neurotransmitter

Long Distance

- Hormone
- HGH

Receptor

Secondary Message

Level 38

Signal Transduction Pathway

Ligand

Protein modification

Phosphorylation cascade

Transduction

G-Protein

Secondary messenger

cAMP

Protein Kinase

Level 39

Changes In Pathways

Tetrodotoxin

Na⁺ ion channel

Newt/garter snake

Anthrax

Adenylate cyclase

Diabetes

Insulin receptor

GLUT

Level 40

Information Exchange

Signal

- Bee dance

Behavior

- Courtship ritual

- Territory

Monogamy / Polygamy

Agonistic behavior

Dominance hierarchy

Learned vs. Innate Behavior

Level 41

Nervous System

Nervous System

- Central
- Peripheral

Neuron

Action potential

Myelin sheath

Voltage-gated channels

Synapse

- Neurotransmitters

Excitatory / Inhibitory

Brain

- Cerebral cortex

Level 43

Cellular Organelles

Nucleus

- Nucleolus
- Chromatin

Smooth ER

Rough ER

Golgi apparatus

Ribosomes

Lysosomes

Vacuoles

Peroxisomes

Chloroplast

Mitochondria

Level 42

Biological Molecules

Polymers

- Monomers

Proteins

- Amino acids
- Four levels of structure

Lipids

- Phospholipids

Carbohydrates

- Mono- di- poly-saccharides

Nucleic Acids

- DNA and RNA
- Nucleotides

Level 44

Cellular Specialization

Cells

Tissues

- Epithelial
- Connective
- Muscle
- Nervous

Organs

Stem cells

- Totipotent
- Pluripotent

Gastrulation

- Ectoderm
- Mesoderm
- Endoderm

gene regulation

Level 45 Organ Systems

Endocrine system
Skeletal system
Circulatory system
Respiratory system
Muscular system
Integumentary system
Lymphatic system
Immune system
Excretory system
Digestive system
Reproductive system
Nervous system

Level 46 Communities

BBECP
Exponential growth
Logistic growth
Limiting factors

- Density dependent
- Density independent

Carrying Capacity (K)
Human Population
Demographic transition

Level 47 Ecosystems

Ecosystem
Matter vs. Energy
Primary Productivity
Biomass
Energy Pyramid
Food Chain
Producer/Consumer
Food Web
Human impacts
Biotic vs. Abiotic
Impacts

Level 48 Enzymes

Enzyme
Substrate
Active Site
Induced Fit
Cofactors/Coenzymes
Competitive inhibition
Allosteric inhibition
Activation energy
Reaction rate

Level 49 Cooperative Interactions

Prisoner's Dilemma
Cooperation
Natural Selection

Cells - Rumen

. Bacteria . Protozoa
. Archaea . Fungi . Viruses

Organelles

. Signal transduction

Organs

. Digestive system

Level 50 Populations

Community

Niche

Symbiosis

Commensalism

Mutualism

Competition

Predation/Parasitism

Ecosystem Feedback

Invasive Species

Level 51 Ecosystem Change

Ecosystem Impacts

Climate Change

Greenhouse Effect

Continental Drift

Pangaea

El Niño

Primary Succession

Secondary Succession

Level 52 Cellular Variation

Molecular Variation

Chlorophyll A vs. B

Purple Earth

Phospholipids

Genetic Variation

Heterozygote Advantage

Sickle cell and CF

Gene Duplication

Antifreeze Protein

Level 53 Genotype Expression

Genotype
Phenotype
Himalayan Rabbit
Seasonal Melanin
Flower Color and pH
Lac⁺ Bacteria
Male pattern baldness
Thalidomide

Level 54 Population Variation and Dynamics

Devil Facial Tumor Disease
Genetic Diversity
Bottleneck / Founder
HIV and $\Delta 32$ mutation
Hardy-Weinberg
Equilibrium
 $p + q = 1$
 $p^2 + 2pq + q^2 = 1$

Level 55 Biodiversity

Biodiversity

- Species diversity
- Genetic diversity
- Ecosystem diversity

Keystone Species

- Jaguar
- Sea Otters