

# TOPICS TO KNOW

## Extended BIOLOGY

### **Biology**

1. Biological Molecules-draw all
  - a. Proteins/ Chiral? tissue types
    - i. 1',2'3',4' struct
    - ii. Peptide bond: sp<sup>2</sup>-like, planar, rotation around alpha carbon, dehydration/condensation synthesis
    - iii. Proline/Glycine bends
    - iv. Cysteine –diSulfide linkages: break with reducing agents, make with oxidizing agents
    - v. Arg, Lys, His charge at neutral pH
    - vi. pI, isoelectric focusing
    - vii. charge on basic AA at pH 7
    - viii. At a given pH for AA what is the ratio of protonated carboxy groups to deprotonated
    - ix. Describe the polarizable groups (protonated or not) of an acidic AA at pH =7
    - x. KNOW ALL AA; BASIC (HAL), ACIDIC, AROMATIC, CYCLIC(PROLINE), ACHIRAL; HYDROPHOBIC; CYSTEINE
    - xi. pK<sub>a</sub> of AA- COOH, NH<sub>2</sub>
    - xii. Structure of Antibody
  - b. Lipids: phospholipids, triglyceride
    - i. Bonds
  - c. Carbohydrates-define C<sub>n</sub>(H<sub>2</sub>O)<sub>n</sub>
    - i. has 1 degree of unsat
    - ii. Draw open/chain glucose
    - iii. S, M, L
    - iv. Sucrose- fructose/glucose
    - v. Lactose-Galactose/glucose
    - vi. Maltose- 2 Glucose
    - vii. L-glucose, D-Glucose, anomer, epimer, mutarotation
    - viii. Glycosidic- bond between hydroxyl and hemiacetal forming acetal
  - d. Nucleic acids: purines, pyrimidines
    - i. Residue: Nucleoside/Nucleotide
    - ii. Phosphodiester Bond
    - iii. Nucleosome-Histone+DNA
    - iv. Unwrapping of Histone (acetylation)
    - v. All DNA is ds except virus and during replication and transcription
  - e. RNA vs. DNA
    - i. ss vs ds
    - ii. 2'OH
    - iii. A,T,C,G,U
    - iv. antiparallel
  - f. Different RNA molecules
    - i. Most abundant rRNA

- Chart-macromolecule, residue, linkage, enzyme to break down
2. Organelles
    - a. Plasma Membrane
      - i. Aquaporins, cholesterol
      - ii. Double bound/kinky/unsaturated
      - iii. Bad saturated FA
    - b. Microfilaments: cleavage and contractability
    - c. Microtubules: transport and support (cytoskeleton); kinesin, dynein; taxol- anticancer
    - d. Intermediate filaments: support and anchoring
    - e. Glycocalx/Extracellular Matrix
    - f. Lysosome
      - i. pH 4-5.5
      - ii. Lipases, Protease, Amylase...
      - iii. Apoptosis, controlling protein ½ life (ubiquitin), foreign
    - g. Golgi
      - i. Distribution to organelles, PM, Exocytosis (requires ATP)
      - ii. NOT cytosolic proteins I.E. Glycolytic Enzymes (made on free ribosomes)
    - h. Mitochondria
      - i. Structure
      - ii. Self replicate
      - iii. Own dsDNA circular/ Ribosomes
      - iv. What size ribosomes?
      - v. Makes 20% of its own proteins
      - vi. pH of intermembrane space approx 4
    - i. Cell types CMEN tissue types:
      - i. Epithelial cells (cell types, simple epithelium, stratified epithelium)
      - ii. Endothelial cells specialized epithelial cells-Line organs/Line Blood Vessels
      - iii. Connective tissue cells (major cell types, fiber types, loose vs. dense, cartilage, blood, dermis of skin, extracellular matrix)
      - iv. BONE- osteocyte, osteoclast, chondrocyte
  3. Movement across membranes
    - a. Active/ Passive/2<sup>nd</sup> active transport
    - b. Carrier/Channels
      - i. What is transported across?
      - ii. Saturation kinetics curve
      - iii. Burke-weaver plot
  4. Organs
    - a. START WITH THE DINASAUR
    - b. Spleen
      - i. Kills RBC
    - c. Liver- Portal Vein-sinusoids-Hepatic-IVC; Blood Supply
      - i. Regulate Glucose

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- ii. Protein synthesis ; coagulation proteins (require Vitamin K)
- iii. Protein degradation
- iv. Urea Cycle
- v. Stores Vitamins
- vi. Detox
- vii. Bile = cholesterol + bilirubin
- viii. Processes old RBC debris
  - 1. bilirubin-conjugated vs. unconjugated; pancreatic disease
  - 2. Fe+ storage
- d. Define organs of Circulatory System and Why? Mesoderm, 1<sup>st</sup> system develop
  - i. Heart
  - ii. Blood vessels
  - iii. Blood
  - iv. Lymph System
  - v. Kidneys
  - vi. Spleen
- e. Skin – desmosome, hemidesmosome, epidermis, hypodermis, dermis
- 5. Prokaryotes / Eukaryotes/ Virus / Fungus / Prion
  - a. Differences
  - b. Antibiotics resistance vs. sensitive
  - c. Plasmid
  - d. Genetic Variability in Prokaryotes: Translocation, transduction, conjugation, transformation
  - e. Antibiotic resistance
  - f. Lysogenic/Lytic;
  - g. Retro Virus; Reverse transcriptase
  - h. Fungus- haploid and diploid ;spores: dormant? Cell Wall; Eukaryote
  - i. Prion: PrP<sup>sc</sup>; PrP<sup>c</sup>
    - i. C=cell, sc=scarpie; amyloid; neurodegeneration; Like a Zombie
- 6. Enzymes
  - a. Positive/negative feedback
  - b. Comp/Non comp feed back
  - c. Substrate = reactant;
  - d. Activation Energy
  - e. Glucokinase/hexokinase
  - f. Lineweaver-Burke Plot
- 7. Metabolism (anabolic/catabolic)
  - a. Glycolysis/Krebs/PDC/ETC
    - i. NADH glycolysis, uncoupler, brown fat
    - ii. How many ATP in oxidative phosphorylation?
    - iii. Prok vs. Euk
  - b. Beta oxidation
    - i. Acetyl CoA
    - ii. ATP/fat approx
  - c. Protein degradation – intermediates krebs, glycolysis; Urea Cycle
  - d. Ketone Bodies
- 8. Mitosis
  - a. Cell Cycle; PMAT; Cytokinesis (actin role)
  - b. Number of chromosomes count centromeres
- 9. Meiosis
  - a. Spermatogenesis
    - i. Spermatogonium -> 1'spermatocyte -> 2'spermatocyte ->spermatid -> spermatozoa
    - ii. Chromosome reduction
  - b. Oogenesis
    - i. Oogonium -> 1'oocyte -> 2'oocyte ->ovum
    - ii. Born with primary oocytes
    - iii. Ovulate a secondary oocyte
    - iv. Complete Meiosis I once per month
    - v. Complete Meiosis II when 1<sup>st</sup> sperm hits 2'oocyte
- 10. Embryology
  - a. Reproduction
    - i. Fertilization- fusion of gamete (haploid) DNA
    - ii. Zygote->Morula->Blastula->Gastrula
    - iii. Blastula
      - 1. Hollows out
      - 2. HCG
      - 3. Implants in endometrium (uterine lining)
      - 4. Totipotent
  - b. Gastrulation
    - i. Mesoderm
      - 1. Means to reproduce
        - a. Gonads, uterus
      - 2. Means to move
        - a. Bone, Muscle
      - 3. Means to circulate
        - a. Circulatory system
    - ii. Ectoderm “attracto derm”
      - 1. Eyes, Hair, Nails, CNS, PNS
    - iii. Endoderm “internal derm”
      - 1. pancreas, gall bladder, adrenal cortex, intestines
  - c. Parthenogenesis-hammerhead sharks, lizards, scorpions, dragons...can be haploid or diploid
  - d. Germ layers
  - e. How cells differentiate: position/environment role of determinants
    - i. Every cell has all DNA
    - ii. Tadpole-proof that differentiation is reversible; all cells have all DNA
  - f. Fetal Circulation
  - g. Closure of shunts
- 11. Digestion
  - a. Villi vs. microvilli draw it!!!

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- i. Lumen-mucous layer-symporter on microvilli on apical side of enterocyte-enterocyte-facilitated carrier on basolateral side of enterocyte-cappy located within villi-venule-vein-hepatic portal v.-liver sinusoids-liver-hepatic v.-IVC-RA (heart)-pulmonic-systemic circulation
  - b. Digestive Enzymes- pepsin endopeptidase
    - i. 5,5,2
  - c. Pancreas enzymes
  - d. Enzymes-ENTEROKINASE
  - e. Absorption: Stomach –aspirin, ethanol
    - i. Absorption based on pH and charge
  - f. Endocrine Control: CCK, Secretin, Gastrin
  - g. H.pylori
12. Kidneys
  - a. Epo
  - b. Aldosterone
  - c. ADH
  - d. Renin
  - e. Tmax (Reabsorption)
  - f. GFR
  - g. Clearance
13. Mechanical Respiration
  - a. Anatomy of resp tract
  - b. Surfactant
  - c. Diaphragm (NOT MYOGENIC BUT IS INVOLUNTARY), Intercostal muscles
  - d. Phrenic N.
  - e. Active vs Passive Breathing
  - f. Air: 21% Oxygen, 78% Nitrogen
14. Menstrual Cycle
  - a. Birth control
  - b. What causes menstruation?
  - c. 2<sup>nd</sup> trimester no more, placenta becomes paracrine
15. Cardiovascular System
  - a. Flow/ Clots; valves (mitral, tricuspid)
    - i. Right and left side heart failure
    - ii. Blood type and edema
    - iii. agglutination
  - b. Blood: Plasma and Cells: 2/3 blood volume
  - c. Diff b/w art veins: slope is affinity
  - d. O<sub>2</sub> sat curve
    - i. Sigmoidal=cooperative binding
    - ii. H<sup>+</sup>, HCO<sub>3</sub><sup>-</sup>, Temp, BPG
  - e. Mountain sickness
  - f. Starlings law
  - g. Off loading (STEP-BY-STEP): carbonic anhydrase
  - h. Conduction heart
    - i. Pulmonary vs systemic
    - j. Heart Sounds
    - k. Heart Valves
- l. EKG
  - m. Vagus nerve; normal heart rate
    - i. Cranial nerve, parasympathetic
  - n. Intercalated disks
  - o. Buffers phys: HCO<sub>3</sub><sup>-</sup>, Hb, Kidney, Albumin
  - p. Blood type
  - q. Erythroblastosis Fetalis
    - i. rhogam
  - r. Fetal Circ
  - s. Mixing in baby heart
  - t. Closure of Shunts
  - u. Lymph
  - v. Edema
  - w. Inflammation
  - x. BLOOD FLOW BRAIN, HEART, KIDNEY
16. Bone/Cartilidge
  - a. Purpose Support, Ca storage, Bone marrow
  - b. Vascularized, Innervated
17. Endocrine System
  - a. FLATPEG
  - b. ADRENAL GLAND
  - c. Peptide vs Steroid
  - d. Insulin vs. Glucagon
  - e. Thyroxine chart 1',2',3'
  - f. Posterior pituitary
  - g. Calcitonin/PTH
  - h. Auto-, para-, endo-, exo-, -crine
  - i. Pancreas endocrine/exocrine
  - j. Stress Hormones: GH, cortisone, glucagon
  - k. Positive feedback hormones (3)
18. Muscle
  - a. Sarcomere/Gross Structure
  - b. Contraction
  - c. Different types Conductance SA node pacemaker/atrioventricular septum non conductance
  - d. Red/White Fiber
  - e. Myoglobin
  - f. Tendon/Ligament
  - g. Hypertrophic
  - h. Why does heart muscle grow
  - i. Insertion/origin SCM
  - j. Flexion/extension
  - k. Myogenic no need for cranial input
  - l. Involuntary no conscious control
  - m. Myogenic vs. involuntary vs. type of muscle chart
19. Replication/ Transcription / Translation
  - a. Mutations
  - b. Methylation-last step in replication
  - c. Number of strands, number of progeny: semi-conservative
  - d. Semi conservative, nonconservative, dispersive

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- e. Proof Reading DNA Pol can do 3' to 5'
  - f. Promoter, +1 region, TATTA Box, Enhancer can be up or downstream
  - g. Post transcriptional modifications
  - h. Isozyme (i.e. troponin); alternative splicing
  - i. Charging
  - j. Translation
  - k. Actions of Peptidyl Transferase
  - l. Regulation of protein expression
    - i. Kinase, Acetylation, RNAi, RNAase, Methylation, Phosphatase, Cleavage, Environment (pH)
20. Genetics
- a. Pedigree
  - b. Mitochondria
  - c. Hardy – Weinberg
  - d. Test Cross
  - e. Segregation vs. Independent assortment
  - f. Dominant, recessive, Sex linked, co dominance, incomplete dominance, penetrance, expressivity, mosaic
  - g. Recombination frequency, map unit, linkage
  - h. Lac Operon, Trp Operon, cAMP
  - i. Trisomy vs. triploidy
  - j. Klinefelter, Turner
  - k. Nucleotide if A is 20% how many G's for DNA? For tRNA? For mRNA? How about T's?
21. Nervous System
- a. AP, saltatory, resting potential, removal of Nt from cleft
  - b. Equilibrium Potential
  - c. Resting membrane potential
  - d. Nernst
  - e. Oligodendrocytes, Schwann Cells
  - f. Parasympathetic, Sympathetic
  - g. End Nt (Para/Symp)
  - h. Pharmacology and role of hyper and hypo polarization
  - i. Brain functions and derivatives
  - j. Eye: Lens focuses light on retina
  - k. Ear
22. Biological Techniques
- a. RNAi
  - b. PCR
  - c. Cloning
  - d. Sequencing
  - e. Southern, Northern, Western
  - f. Microarrays
  - g. ELISA
23. Immunology
- a. Humoral-extracellular
  - b. Epitope
  - c. Antibody structure, Classes of antibody
    - i. IgM does not cross placental membrane
  - d. Cell mediated-intracellular
  - e. Primary vs. secondary lymph tissue
  - f. B-cells; T-Cells; Mature and made
  - g. Passive/Active
  - h. Mast Cells-histamine/heparin
  - i. MHC
  - j. NK cells
  - k. Types of Leukocytes
    - l. Worst mismatch reaction
    - m. Blood type coodominate
24. Body adjustments to core temperature: shivering, dilation, sweating, panting, thyroid involvement, fever
25. Diabetes-HbA1c affinity for glucose; glucose levels transient; hypoxia, ischemia
- a. Mutorotation
  - b. keto acidosis
26. Cancer common types, p53, oncogenes, tumor suppressor genes, MHC role in treatment
- a. Gain of function, loss of function
  - b. Taxol, interferon-+ nk cells
27. Evolution
- a. Homologous, Analogous
  - b. Speciation
  - c. Definition of species
  - d. Polymorphism
  - e. Adaptation and specialization
  - f. inbreeding/outbreeding/ bottlenecks
  - g. divergent, parallel (marsupial vs. placental), and convergent makes analogous (bat, insect) evolution
  - h. Symbiotic relationships- win-win
  - i. Parasitism –win-lose
  - j. Commensalism win-no effect
  - k. Natural selection
    - l. Fitness concept
    - m. Kingdom, Phylum, Class, Order, Family, Genus, Species
28. Classic conditioning/ operant conditioning: Automatic (no conscious response to stimuli) vs. non Automatic response to stimuli
- a. LOOK FOR EXAMPLES
29. MCAT disease
- a. Diabetes Mellitus-Type 1, type 2
    - i. Tired, night peeing, frequent urination, low blood pressure
  - b. Diabetes Insipidous- central, nephrogenic
  - c. Addison's Disease
  - d. Hyper/Hypo Thyroidism
    - i. Graves Disease – agonist...
  - e. Autoimmune Disease
    - i. Environment, antibody, target organ/cell

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**Extended BIOLOGY**

- f. Anti-cancer therapies
- g. HIV
  - i. CD4; T<sub>H</sub>
- h. SCID
  - i. No B-cells, T-Cells
  - ii. On January 21, 2010, the Advisory Committee on Heritable Disorders in Newborns and Children voted unanimously to add screening for Severe Combined Immune Deficiency or SCID - commonly known as bubble boy disease
- i. Menopause
  - i. No more follicles, low estrogen
  - ii. No osteoblasts, dry vag, hot flashes
  - iii. Rx: estrogen, progesterone
- j. Jaundice
  - i. Hemolysis, not conjugating bilirubin, pancreatic duct obstruction
- k. Dialysis
  - i. Femoral vein, internal jugular vein
  - ii. Creatinine, urea
  - iii. HCO<sub>3</sub><sup>-</sup>
- l. Downs
- m. MS
- n. KetoAcidosis
- o. Uncouplers- ASA, Brown Fat
- p. Blood doping
- q. Troponin
- r. Types of muscle
- s. Cystic Fibrosis

# TOPICS TO KNOW

## Extended BIOLOGY

### General Chemistry

1. Periodic Table
2. Isotope/%weight
3. Periodic Trends/Zeffective
4. Quantum numbers
5. Hund/Pauli/Heisenberg
6. Isoelectric/Paramagnetic/Diamagnetic
7. Stoichiometry
8. Reaction Types: Double Displacement, combustion....
9. PV = NRT and deviations
10. Intermolecular Forces
  - a. Boiling Point Ranking
11. Lewis Structures
12. Phase Change Diagram
  - a. Axis, subliming
13.  $q = mc\Delta t$
14. Rate Law
  - a. Transition state graph
15.  $\Delta G$ 
  - a. sane sign temp dep
16. Hess Law
  - a. 3 flavors
  - b. Bonds broken- bonds formed
  - c. Products-reactants
17. Thermodynamics
18. Molarity, Molality, 5 moles into 1 L; define both
19. Colligative Properties
  - a. Tonicity, hyper, hypo particles in solution
  - b. Osmotic- Normal, Normality
  - c. Osmotic pressure, BP elevation, FP depression, VP depression, Conductance
20. Lewis / Bronsted-Lowry
21. Acid / Base Titration
22. Indicators
23.  $K_{sp}$
24. Batteries
25. Oxidation numbers
  - a. Bicarb reaction is it a redox
  - b. Are combustion reactions redox?
26. NERNST
27. Strong Acids
28. Strong Bases

### Organic Chemistry

1. Biological Molecules
  - a. Proteins, Carbohydrates, Lipid, Nucleic Acids, Plasma Membrane
  - b. Mutorotation, Micelle
2. Carbohydrate- carbohydrate  $C_n(H_2O)_n$
3. Naming Compounds
4. NMR / IR
5. SN1 / E1
  - a. Carbocation (strong electrophile)
  - b.  $3 > 2 > 1$
  - c. Nucleophile strength unimportant
  - d. Protic Solvent
  - e. Racemic
  - f. 2 steps
  - g. Intermediate
  - h. Leaving group (Cl, Br, I)
  - i. E means elimination double bond
  - j. Drive E1 with heat
  - k. Intermediate (graph)
6. SN2 / E2
  - a. Weak electrophile
  - b.  $1 > 2 > 3$
  - c. Nucleophile strength important
  - d. Aprotic
  - e. Inversion
  - f. 1 Step Concerted
  - g. Transition state
  - h. Transition state graph
  - i. E2 Driven by bulky strong base (t-butoxide)
7. Hybridization  $sp^3d$  PF<sub>5</sub>, SF<sub>6</sub>
8. Aromatics
9. Carbonyl Reactions
  - a. Acid Catalyst: Catalyst not created nor destroyed must be regenerated
10. Epimer, Anomer
11. Cyclohexane
  - a. Chair
  - b. Bulky always equatorial
  - c. All others want equatorial- except:
    - i. when position is defined by cis/trans
    - ii. next to a bulky- branching, unsaturation (kinky)
12. Oxidation Reactions
13. Separation Techniques
  - a. Extraction
    - i. Hydrophilic vs. Hydrophobic
    - ii. Separation benzoic acid, phenol
  - b. TLC
  - c. Gas Chromotagraphy
14. Acid / Base Ranking
15. Hydrophobic / Hydrophilic
16. Isomers\

## TOPICS TO KNOW

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- a. How many diastereomers of a given molecule
- b. Draw all isomers

### **Physics**

1. Formulas
2. Thermodynamics
3. Newton's Three Laws
4. Adiabatic Process
5. Springs
6. Pendulums
7. Waves
8. Electrostatics
  - a.  $F=qE$ ; force is parallel
  - b. Static Charge
9. Magnetic Fields
  - a. Perpendicular in b
  - b. Moving charge
10. Capacitance
  - a.  $A = A/D$
11. Fluids
12. Buoyancy
13. Continuity
14. Light
15. Mirrors/Lenses
  - a. Hyperopia/Myopia
16. Circuits
17. Radioactive Decay
  - a. Alpha particle
18. Collisions
19. Energy
20. Power
21. Work
22. Torque
23. Planets
24. Motion