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- Kinetics is the study of reaction rates.
- The steady-state assumption facilitates a description of enzyme kinetics.
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- $K_M$ and $V_{max}$ values can be determined by several means.
- $K_M$ and $V_{max}$ values are important enzyme characteristics.
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Succinyl coenzyme A is a point of entry for several nonpolar amino acids
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26.1 Phosphatidate Is a Common Intermediate in the Synthesis of Phospholipids and Triacylglycerols

The synthesis of phospholipids requires an activated intermediate.

Some phospholipids are synthesized from an activated alcohol.

Phosphatidylcholine is an abundant phospholipid.

Excess choline is implicated in the development of heart disease.

Base-exchange reactions can generate phospholipids.

Sphingolipids are synthesized from ceramide.

Gangliosides are carbohydrate-rich sphingolipids that contain acidic sugars.

Sphingolipids confer diversity on lipid structure and function.

Respiratory distress syndrome and Tay-Sachs disease result from the disruption of lipid metabolism.

Ceramide metabolism stimulates tumor growth.

Phosphatidic acid phosphatase is a key regulatory enzyme in lipid metabolism.

26.2 Cholesterol Is Synthesized from Acetyl Coenzyme A in Three Stages

The synthesis of mevalonate, which is activated as isopentenyl pyrophosphate, initiates the synthesis of cholesterol.

Squalene (C30) is synthesized from six molecules of isopentenyl pyrophosphate (C5).

Squalene cyclizes to form cholesterol.

26.3 The Complex Regulation of Cholesterol Biosynthesis Takes Place at Several Levels

Lipoproteins transport cholesterol and triacylglycerols throughout the organism.

Low-density lipoproteins play a central role in cholesterol metabolism.

The absence of the LDL receptor leads to hypercholesterolemia and atherosclerosis.

Mutations in the LDL receptor prevent LDL release and result in receptor destruction.

Cycling of the LDL receptor is regulated.

HDL appears to protect against atherosclerosis.

The clinical management of cholesterol levels can be understood at a biochemical level.

26.4 Important Derivatives of Cholesterol Include Bile Salts and Steroid Hormones

Letters identify the steroid rings and numbers identify the carbon atoms.

Steroids are hydroxylated by cytochrome P450 monooxygenases that use NADPH and O2.

The cytochrome P450 system is widespread and performs a protective function.

Pregnenolone, a precursor of many other steroids, is formed from cholesterol by cleavage of its side chain.

Progesterone and corticosteroids are synthesized from pregnenolone.

Androgens and estrogens are synthesized from pregnenolone.

Vitamin D is derived from cholesterol by the ring-splitting activity of light.

CHAPTER 27 The Integration of Metabolism

27.1 Caloric Homeostasis Is a Means of Regulating Body Weight

27.2 The Brain Plays a Key Role in Caloric Homeostasis

Signals from the gastrointestinal tract induce feelings of satiety.

Leptin and insulin regulate long-term control over caloric homeostasis.

Leptin is one of several hormones secreted by adipose tissue.

Leptin resistance may be a contributing factor to obesity.

Dieting is used to combat obesity.

27.3 Diabetes Is a Common Metabolic Disease Often Resulting from Obesity

Insulin initiates a complex signal-transduction pathway in muscle.

Metabolic syndrome often precedes type 2 diabetes.

Excess fatty acids in muscle modify metabolism.

Insulin resistance in muscle facilitates pancreatic failure.

Metabolic derangements in type 1 diabetes result from insulin insufficiency and glucagon excess.

27.4 Exercise Beneficially Alters the Biochemistry of Cells

Mitochondrial biogenesis is stimulated by muscular activity.

Fuel choice during exercise is determined by the intensity and duration of activity.

27.5 Food Intake and Starvation Induce Metabolic Changes

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Metabolic adaptations in prolonged starvation minimize protein degradation.

27.6 Ethanol Alters Energy Metabolism in the Liver

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Excess ethanol consumption disrupts vitamin metabolism.

CHAPTER 28 DNA Replication, Repair, and Recombination

28.1 DNA Replication Proceeds by the Polymerization of Deoxyribonucleoside Triphosphates Along a Template
DNA polymerases require a template and a primer.
All DNA polymerases have structural features in common.
Two bound metal ions participate in the polymerase reaction.
The specificity of replication is dictated by complementarity of shape between bases.
An RNA primer synthesized by primase enables DNA synthesis to begin.
One strand of DNA is made continuously, whereas the other strand is synthesized in fragments.
DNA ligase joins ends of DNA in duplex regions.
The separation of DNA strands requires specific helicases and ATP hydrolysis.

28.2 DNA Unwinding and Supercoiling Are Controlled by Topoisomerases
The linking number of DNA, a topological property, determines the degree of supercoiling.
Topoisomerases prepare the double helix for unwinding.
Type I topoisomerases relax supercoiled structures.
Type II topoisomerases can introduce negative supercoils through coupling to ATP hydrolysis.

28.3 DNA Replication Is Highly Coordinated
DNA replication requires highly processive polymerases.
The leading and lagging strands are synthesized in a coordinated fashion.
DNA replication in Escherichia coli begins at a unique site.
DNA synthesis in eukaryotes is initiated at multiple sites.
Telomeres are unique structures at the ends of linear chromosomes.
Telomeres are replicated by telomerase, a specialized polymerase that carries its own RNA template.

28.4 Many Types of DNA Damage Can Be Repaired
Errors can arise in DNA replication.
Bases can be damaged by oxidizing agents, alkylating agents, and light.
DNA damage can be detected and repaired by a variety of systems.
The presence of thymine instead of uracil in DNA permits the repair of deaminated cytosine.
Some genetic diseases are caused by the expansion of repeats of three nucleotides.
Many cancers are caused by the defective repair of DNA.
Many potential carcinogens can be detected by their mutagenic action on bacteria.

28.5 DNA Recombination Plays Important Roles in Replication, Repair, and Other Processes
RecA can initiate recombination by promoting strand invasion.
Some recombination reactions proceed through Holliday-junction intermediates.

CHAPTER 29 RNA Synthesis and Processing
RNA synthesis comprises three stages: Initiation, elongation, and termination.

29.1 RNA Polymerases Catalyze Transcription
RNA chains are formed de novo and grow in the 5'-to-3' direction.
RNA polymerases backtrack and correct errors.
RNA polymerase binds to promoter sites on the DNA template to initiate transcription.
Sigma subunits of RNA polymerase recognize promoter sites.
RNA polymerases must unwind the template double helix for transcription to take place.
Elongation takes place at transcription bubbles that move along the DNA template.
Sequences within the newly transcribed RNA signal termination.
Some messenger RNAs directly sense metabolite concentrations.
The rho protein helps to terminate the transcription of some genes.
Some antibiotics inhibit transcription.
Precursors of transfer and ribosomal RNA are cleaved and chemically modified after transcription in prokaryotes.

29.2 Transcription in Eukaryotes Is Highly Regulated
Three types of RNA polymerase synthesize RNA in eukaryotic cells.
Three common elements can be found in the RNA polymerase II promoter region.
The TFIID protein complex initiates the assembly of the active transcription complex.
Multiple transcription factors interact with eukaryotic promoters.
Enhancer sequences can stimulate transcription at start sites thousands of bases away.

29.3 The Transcription Products of Eukaryotic Polymerases Are Processed
RNA polymerase I produces three ribosomal RNAs.
RNA polymerase III produces transfer RNA.
The product of RNA polymerase II, the pre-mRNA transcript, acquires a 5' cap and a 3' poly(A) tail.
Small regulatory RNAs are cleaved from larger precursors.
RNA editing changes the proteins encoded by mRNA.
Sequences at the ends of introns specify splice sites in mRNA precursors.
Splicing consists of two sequential transesterification reactions.
Small nuclear RNAs in spliceosomes catalyze the splicing of mRNA precursors.
Transcription and processing of mRNA are coupled.
Mutations that affect pre-mRNA splicing cause disease.
Most human pre-mRNAs can be spliced in alternative ways to yield different proteins.

29.4 The Discovery of Catalytic RNA was Revealing in Regard to Both Mechanism and Evolution
CHAPTER 30 Protein Synthesis

30.1 Protein Synthesis Requires the Translation of Nucleotide Sequences into Amino Acid Sequences

The synthesis of long proteins requires a low error frequency.
Transfer RNA molecules have a common design.
Some transfer RNA molecules recognize more than one codon because of wobble in base-pairing.

30.2 Aminoacyl Transfer RNA Synthetases Read the Genetic Code

Amino acids are first activated by adenylation.
Aminoacyl-tRNA synthetases have highly discriminating amino acid activation sites.
Proofreading by aminoacyl-tRNA synthetases increases the fidelity of protein synthesis.
Synthetases recognize various features of transfer RNA molecules.
Aminoacyl-tRNA synthetases can be divided into two classes.

30.3 The Ribosome Is the Site of Protein Synthesis

Ribosomal RNAs (5S, 16S, and 23S rRNA) play a central role in protein synthesis.
Ribosomes have three tRNA-binding sites that bridge the 30s and 50s subunits.
The start signal is usually AUG preceded by several bases that pair with 16S rRNA.
Bacterial protein synthesis is initiated by formylmethionyl transfer RNA.
Formylmethionyl-tRNA\_f is placed in the P site of the ribosome in the formation of the 70S initiation complex.
Elongation factors deliver aminoacyl-tRNA to the ribosome.
Peptidyl transferase catalyzes peptide-bond synthesis.
The formation of a peptide bond is followed by the GTP-driven translocation of tRNAs and mRNA.
Protein synthesis is terminated by release factors that read stop codons.

30.4 Eukaryotic Protein Synthesis Differs from Bacterial Protein Synthesis Primarily in Translation Initiation

Mutations in initiation factor 2 cause a curious pathological condition.

30.5 A Variety of Antibiotics and Toxins Can Inhibit Protein Synthesis

Some antibiotics inhibit protein synthesis.
Diphtheria toxin blocks protein synthesis in eukaryotes by inhibiting translocation.
Ricin fatally modifies 28S ribosomal RNA.

30.6 Ribosomes Bound to the Endoplasmic Reticulum Manufacture Secretory and Membrane Proteins

Protein synthesis begins on ribosomes that are free in the cytoplasm.
Signal sequences mark proteins for translocation across the endoplasmic reticulum membrane.
Transport vesicles carry cargo proteins to their final destination.

CHAPTER 31 The Control of Gene Expression in Prokaryotes

31.1 Many DNA-Binding Proteins Recognize Specific DNA Sequences

The helix-turn-helix motif is common to many prokaryotic DNA-binding proteins.

31.2 Prokaryotic DNA-Binding Proteins Bind Specifically to Regulatory Sites in Operons

An operon consists of regulatory elements and protein-encoding genes.
The lac repressor protein in the absence of lactose binds to the operator and blocks transcription.
Ligand binding can induce structural changes in regulatory proteins.
The operon is a common regulatory unit in prokaryotes.
Transcription can be stimulated by proteins that contact RNA polymerase.

31.3 Regulatory Circuits Can Result in Switching Between Patterns of Gene Expression

The λ repressor regulates its own expression.
A circuit based on the λ repressor and Cro forms a genetic switch.
Many prokaryotic cells release chemical signals that regulate gene expression in other cells.
Biofilms are complex communities of prokaryotes.

31.4 Gene Expression Can Be Controlled at Posttranscriptional Levels

Attenuation is a prokaryotic mechanism for regulating transcription through the modulation of nascent RNA secondary structure.

CHAPTER 32 The Control of Gene Expression in Eukaryotes

32.1 Eukaryotic DNA Is Organized into Chromatin

Nucleosomes are complexes of DNA and histones.
DNA wraps around histone octamers to form nucleosomes.

32.2 Transcription Factors Bind DNA and Regulate Transcription Initiation

A range of DNA-binding structures are employed by eukaryotic DNA-binding proteins.
Activation domains interact with other proteins.
Multiple transcription factors interact with eukaryotic regulatory regions.
Enhancers can stimulate transcription in specific cell types.
Induced pluripotent stem cells can be generated by introducing four transcription factors into differentiated cells.

32.3 The Control of Gene Expression Can Require Chromatin Remodeling
The methylation of DNA can alter patterns of gene expression.
Steroids and related hydrophobic molecules pass through membranes and bind to DNA-binding receptors.
Nuclear hormone receptors regulate transcription by recruiting coactivators to the transcription complex.
Steroid-hormone receptors are targets for drugs.
Chromatin structure is modulated through covalent modifications of histone tails.
Histone deacetylases contribute to transcriptional repression.

32.4 Eukaryotic Gene Expression Can Be Controlled at Posttranscriptional Levels
Genes associated with iron metabolism are translationally regulated in animals.
Small RNAs regulate the expression of many eukaryotic genes.

Part IV RESPONDING TO ENVIRONMENTAL CHANGES

33.1 A Wide Variety of Organic Compounds Are Detected by Olfaction
Olfaction is mediated by an enormous family of seven-transmembrane-helix receptors.
Odorants are decoded by a combinatorial mechanism.

33.2 Taste Is a Combination of Senses That Function by Different Mechanisms
Sequencing of the human genome led to the discovery of a large family of 7TM bitter receptors.
A heterodimeric 7TM receptor responds to sweet compounds.
Umami, the taste of glutamate and aspartate, is mediated by a heterodimeric receptor related to the sweet receptor.
Salty tastes are detected primarily by the passage of sodium ions through channels.
Sour tastes arise from the effects of hydrogen ions (acids) on channels.

33.3 Photoreceptor Molecules in the Eye Detect Visible Light
Rhodopsin, a specialized 7TM receptor, absorbs visible light.
Light absorption induces a specific isomerization of bound 11-cis-retinal.
Light-induced lowering of the calcium level coordinates recovery.
Color vision is mediated by three cone receptors that are homologs of rhodopsin.
Rearrangements in the genes for the green and red pigments lead to "color blindness."

33.4 Hearing Depends on the Speedy Detection of Mechanical Stimuli
Hair cells use a connected bundle of stereocilia to detect tiny motions.
Mechanosensory channels have been identified in Drosophila and vertebrates.

33.5 Touch Includes the Sensing of Pressure, Temperature, and Other Factors
Studies of capsaicin reveal a receptor for sensing high temperatures and other painful stimuli.

CHAPTER 34 The Immune System

Innate immunity is an evolutionarily ancient defense system.
The adaptive immune system responds by using the principles of evolution.

34.1 Antibodies Possess Distinct Antigen-Binding and Effector Units
The immunoglobulin fold consists of a beta-sandwich framework with hypervariable loops.
X-ray analyses have revealed how antibodies bind antigens.
Large antigens bind antibodies with numerous interactions.

34.2 Antibodies Bind Specific Molecules Through Hypervariable Loops
The immunoglobulin fold consists of a beta-sandwich framework with hypervariable loops.

34.3 Diversity Is Generated by Gene Rearrangements
J (joining) genes and D (diversity) genes increase antibody diversity.
More than 10^9 antibodies can be formed by combinational association and somatic mutation.
The oligomerization of antibodies expressed on the surfaces of immature B cells triggers antibody secretion.
Different classes of antibodies are formed by the hopping of V families.

34.4 Major-Histocompatibility-Complex Proteins Present Peptide Antigens on Cell Surfaces for Recognition by T-Cell Receptors
Peptides presented by MHC proteins occupy a deep groove flanked by alpha helices.
T-cell receptors are antibody-like proteins containing variable and constant regions.
CD8 on cytotoxic T cells acts in concert with T-cell receptors.
Helper T cells stimulate cells that display foreign peptides bound to class II MHC proteins.
Helper T cells rely on the T-cell receptor and CD4 to recognize foreign peptides on antigen-presenting cells.
MHC proteins are highly diverse.
Human immunodeficiency viruses subvert the immune system by destroying helper T cells.

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