Department of Science
Grande Prairie Regional College

Biochemistry 3200

Structure and Function of Biological Molecules

Course Outline
2006-2007

Instructor
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Course Description:	Designed to illustrate, in detail, the relationships between structure and function in biological molecules. It covers: the structure of proteins; techniques used to study proteins; contractile proteins and immunoglobulins as illustrations of protein function; enzyme catalysis, kinetics, and regulation; structural carbohydrates and glycobiology; the structure of lipids; biological membranes and mechanisms of transport; molecular mechanisms in biosignalling.
Pre-requisites:	BC 2000, CH 1020 and CH 2630
Notes:	1. Students with grades of less than B- in pre-requisite courses require consent of the department. 2. This course may not be taken for credit if credit has already been obtained in BC 2030 or BC 2050.
Transferability:	Biochemistry 320 – University of Alberta
Text-book:	Lehninger Principles of Biochemistry (4^{th} edition) (Chapters 3-7, 10-12) David Nelson & Michael Cox W.H. Freeman and Co. (2005)
Requirements:	Since participation in lectures and completion of assignments are essential to achieving success in this course, regular attendance at classes is highly recommended. Those who chose not to attend must assume whatever risks are involved. In this regard, your attention is directed to the Academic Guidelines of Grande Prairie Regional College.
Evaluation:	Mid-term Exam I 30% Mid-term Exam II 30% Final Exam 40% Mid-term Exam I will test knowledge of material covered in the first third of the course. Mid-term Exam II will test knowledge of material covered since the first mid-term exam. The Final Exam will be cumulative and test knowledge of the entire course.

BC 3200 – Topic Outline & Required Readings

Hours	Topic	Readings
5	Amino acids, peptides, and proteins	
	Amino acids	
	Amino acids share common structural features	76-77
	Amino acids can be classified by R group	78-80
	Uncommon amino acids	80-81
	Peptides and proteins	
	Peptides are chains of amino acids	85-86
	Sizes of biologically active peptides and polypeptides	86-87
	Amino acid composition and additional chemical groups	87-88
	Four levels of protein structure	88
	Working with proteins	
	Separation and purification	7-8
	Column chromatography	89-92
	Electrophoresis	92-95
	Activity and specific activity	94-95
	Covalent structure of proteins	
	Amino acid sequence determines protein function	96-97
	Amino acid sequence determination	97-100
	Other methods of amino acid sequence determination	100-104
	Chemical synthesis of peptides	104-106
	Biochemical information from amino acid sequences	106
	Protein sequences and evolution	
	Protein sequences and evolution	106-110
5	The three-dimensional structure of proteins (5)	
	Overview	
	Weak interactions stabilize protein conformation	116-118
	The peptide bond and Ramachandran plots	118-120
	Protein secondary structure	
	Structure and stability of the α helix	120-122
	β sheets and β turns	123-124
	Characteristic bond angles and amino acid content	124-125
	Protein tertiary and quaternary structure	
	Tertiary structureand fibrous proteins (inc Box 4-2, 4-3)	125-129
	Tertiary structure and globular proteins	129-135
	Methods for determining the 3-D structure of a protein	Box 4-4
	Common structural patterns in globular proteins	138-141
	Protein structural classification	141-144
	Protein quaternary structure	144-146

	Protein denaturation and folding	
	Denaturation and renaturation of proteins	147-148
	Polypeptide folding	148-151
	Molecular chaperones and assisted folding	151-153
2	Protein function	
	Ligands and binding	157-158
	Protein interactions : molecular motors	
	Myosin and actin	182-184
	The organization of thin and thick filaments	184-185
	Sliding filaments and muscle contraction	185-186
6	Enzymes	
	An introduction to enzymes	
	The importance of enzymes	190-191
	Enzymes, cofactors and classification	191-193
	How enzymes work	
	Active sites and reaction coordinate diagrams	193-195
	Thermodynamic definitions- reaction equilibria and rates	195-196
	Catalytic power and specificity of enzymes	196-200
	Types of catalysis	200-202
	Enzyme kinetics and mechanism	
	Substrate concentration and reaction rate (inc Box 6-1)	202-205
	Kinetic parameters used to compare enzyme activities	205-207
	Bisubstrate enzyme-catalyzed reactions	207-208
	Enzyme inhibitors: reversible and irreversible (Box 6-2)	208-212
	Enzyme activity depends on pH	212
	Examples of reactions	
	Chymotrypsin—acylation and deacylation of a serine residue (including Box 6-3)	213-218
	Hexokinase—induced fit on substrate binding	218-219
	Enolase—use of metal ions	219, 222
	Regulatory enzymes	
	Allosteric enzymes and regulation of pathways	225-227, 167-170
	Kinetic properties of allosteric enzymes	227-228
	Regulation by covalent modification	228-232
4	Carbohydrates and glycobiology (4)	
	Monosaccharides and disaccharides	
	Aldoses, ketoses and stereoisomers	238-240
	Cyclic structures	240-243
	Hexose derivatives	243-244
	Disaccharides contain a glycosidic bond	245-246
	Polysaccharides	
	Homopolysaccharides	247-250
	Homopolysaccharide folding	250-252
	Heteropolysaccharides	252-255
	Glycoconjugates: proteoglycans, glycoproteins, and glycolipids	
	Proteoglycans	255-259

	Glycoproteins and glycolipids	258-261
	Carbohydrates as informational molecules	
	Lectins and the “sugar code”	262-267
	Working with carbohydrates	267-268
	Glycosylation and protein targetting	1068-1071
3	Lipids	
	Storage lipids	
	Fatty acids: structure, properties and nomenclature	343-345
	Triacylglycerols—stored energy and insulation	345-347
	Waxes	348
	Membrane lipids	
	Glycerophospholipids	349-350
	Galactolipids	351
	Sphingolipids	352-353
	Sterols (cholesterol)	354-355
	Lipids as signals, cofactors and pigments – introduction	
6	Biological membranes and transport	
	The composition and architecture of membranes	
	Membranes contain characteristic lipids and proteins	370-371
	The lipid bilayer	371-373
	Integral and peripheral membrane proteins	373-375
	Predicting the topology of an integral membrane protein	376-378
	Anchoring proteins with covalently attached lipid	379
	Membrane dynamics	
	The ordering of acyl groups in a bilayer	380-381
	Transbilayer movement (flip-flop) of lipids	381-382
	Lateral diffusion of lipids and proteins in a bilayer	382-383
	Membrane rafts	383-385
	Cell-cell interactions and adhesion—integrins and cadherins	385-386
	Membrane fusion	387-389
	Solute transport across membranes	
	Introduction—types of transport	389-393
	Facilitated diffusion by transporter proteins e.g. the glucose transporter (GLUT I)	393-395
	Primary active transport e.g. Na K ATPase	397-400
	Secondary active transport e.g. the lactose transporter; the glucose-Na symporter	402-406
	Ionophores e.g. valinomycin	406
	Aquaporins	406-408
5	Biosignalling	
	Molecular mechanisms of signal transduction	
	Biological signals	421
	Overview of molecular mechanism (specificity, amplification, desensitization, integration)	422-424

Six fundamental signaling systems 424
Lipids as signals, cofactors and pigments
Phosphatidylinositols and sphingosine derivates as intracellular signals 357-358, 442-443
Eicosanoids—paracrine hormones 358-359
Steroid hormones 359-360, 465-466
Vitamins A and D—hormone precursors 360-362
Vitamins E and K 362-363
Gated ion channels
Gated ion channels underlie electrical signaling in excitable cells 425-426
Acetylcholine receptor, a ligand-gated ion channel 411-415, 426-427,
Receptor enzymes
The insulin receptor—a tyrosine-specific protein kinase 429-430
G-protein coupled receptors and second messengers
The β-adrenergic receptor system and cAMP 435-439
De-sensitization 439-441
Second messengers 441-445
Sensory transduction in vision, olefaction and gustation
Light and the visual signal 456-459
Olefaction and gustation 460-462
G protein-coupled systems share several features 462-464