DOUGLAS COLLEGE

COURSE INFORMATION

DEPARTMENT SCIENCES AND MATHEMATICS DATE JUNE 1980

CHE 421	ORGANIC CHEMISTRY IIH	5
NAME & NUMBER OF COURSE	DESCRIPTIVE TITLE	SEMESTER HOURS CREDIT

CATALOGUE DESCRIPTION: This is a continuation of CHE 321 and deals with such topics as carbanions, amines, unsaturated carbonyl compounds, neighbouring group effects and heterocyclic compounds. Fats, carbohydrates and proteins are also treated. Emphasis would be placed on reaction mechanisms and the physical aspects of the science. Credit will not be given for both Chemistry 420 and Chemistry 421.

COURSE PREREQUISITES: CHE-321

COURSE COREQUISITES:

HOURS PER WEEK FOR EACH STUDENT.

LECTURE	4 HRS.	FIELD EXPERIENCE	
LABORATORY	3 HRS.	STUDENT DIRECTED LEARNING	1
SEMINAR	HRS.	OTHER (SPECIFY)	
		TOTAL	8

COLLEGE CREDIT TRANSFER	COLLEGE CREDIT NON-TRANSFER	NON-CREDIT
[x]	[ ]	[ ]

TRANSFER INFORMATION

EQUIVALENT COURSES

UBC Applied for
SFU
OTHER

UNASSIGNED CREDIT
(specify if unassigned within a discipline or a faculty)

Hendrick Ter Persad
COURSE DESIGNER

DEAN OF CURRICULUM AND INSTRUCTION

Raymond Wilson
DEPARTMENT HEAD

R. H. Tri
PRINCIPAL

Form C-1 (Revised April '72) Use blank paper for additional pages

NAME AND NUMBER OF COURSE

COURSES FOR WHICH THIS IS A PREREQUISITE:	RELATED COURSES:
NIL	

TEXTBOOKS, REFERENCES, MATERIALS (LIST READING RESOURCES ELSEWHERE)

Morrison, R.T. and Boyd, R.N., Organic Chemistry 3rd. Ed. (Allyn and Bacon) ($30.95).
This text is also used in CHE 321
Reference: Solomons, T.W.G., Organic Chemistry, Revised Ed. (John Wiley and Sons, 1978.)

COURSE OBJECTIVES, CONTENT, METHOD, EVALUATION:

OBJECTIVES

The student will be able to:

1. draw structures and name acid chlorides, anhydrides, amides and esters.
2. outline generally the role of the carbonyl group in nucleophilic acyl substitution and compare this with alkyl substitution.
3. give examples of the conversion of acid chlorides to acids, amides, esters, ketones and aldehydes.
4. give examples of the conversion of anhydrides to acids, amides, esters, and ketones.
5. give examples of the conversion of amides to acids, imides, and amines.
6. write equations for the preparation of esters from acids, acid chlorides and anhydrides.
7. give examples of the reaction of esters with acids, bases, Grignard reagents, lithium aluminum hydride and alkoxides.
8. give examples of Claisen and Friedel-Crafts reactions.
9. discuss in detail the mechanisms of acid and base hydrolysis of esters under the headings of kinetics, stereochemistry, tracer studies and isotopic exchange
10. discuss nuclear magnetic resonance spectroscopy and its uses in qualitative and quantitative organic analysis.
11. discuss the structural features of carbonions and the effect this structure has on the acidity of α-hydrogens
12. write equations for the halogenation of ketones, the iodoform reaction, aldol condensation, the Reformatsky reaction, Claisen condensation, Wittig reaction and propose reasonable mechanisms for each of the above.
13. combine the use of IR and nmr and chemical means to identify carbonyl compounds.

14. outline the uses of malonic ester in the synthesis of acids.

15. use acetoacetic ester to synthesize a variety of ketones.

16. discuss the decarboxylation mechanism of β-keto acids and malonic acids

17. show an understanding of the synthesis of acids and esters via 2-oxazolines and organoboranes.

18. demonstrate a knowledge of the alkylation of carbonyl compounds via enamines

19. draw the structure, classify and name aliphatic and aromatic amines.

20. outline the reaction for the synthesis of amines from nitro compounds, halides, by reductive amination, reduction of nitriles and the Hofmann degradation.

21. give examples of the reactions of amines with acids, halides, acid chlorides, sulfonyl chlorides and anhydrides.

22. write equations for ring substitution in aromatic amines, the Hofmann elimination and the reactions of amines with nitrous acid.

23. discuss the effects of structure on basicity.

24. give examples of the Sandmeyer reaction and the reactions of diazonium salts with CN, OH and H.

25. demonstrate in some detail the use of diazonium salts in synthesis with special emphasis on directional subtleties.

26. show a knowledge of the analysis of amines by the Hinsberg method and by the use of IR and nmr spectroscopy.

27. draw the structures and name the phenols.

28. write equations for the preparation of phenols by the industrial methods, hydrolysis of diazonium salts and the oxidation of arylthallium compounds.

29. give examples of the reactions of phenols with base and the use of the product in the Williamson synthesis.

30. discuss with examples the ring substitution reactions with emphasis on directional modes of nitration, sulfonation, halogenation, Friedel-Craft acylation, and nitrosation. In addition the use of these reactions in synthesizing new compounds.

31. discuss the effect of phenol structure on acidity.

32. give examples of the Kolbe and Reimer-Tiemann reactions.

33. discuss the spectroscopic analysis of phenols with emphasis on the strong O-H stretching band in the IR and the position of the O-H proton signal in the nmr.

34. discuss bimolecular displacement mechanisms for nueleophilic aromatic substitution with emphasis on intermediates and effect of substituents on rate.

35. outline reactions involving benzyne and discuss the reaction with regard to mechanism, orientation, labeled reactions and interpretation of product distribution.

36. name and draw structures of the more important α,β-unsaturated compounds with emphasis on the carbonyl containing ones.

37. discuss electrophilic addition of α,β-unsaturated carbonyl compounds under the headings of reactivity and orientation.

38. give examples of the Michael addition and the Diels-Alder reaction and recognize their roles in synthetic chemistry.

39. define and discuss the term anchimeric assistance, neighbouring group effects, classical and non-classical cations.

40. discuss the mechanism of the Hofmann rearrangement under the headings of intramolecularity, stereochemistry and timing of the steps.

41. discuss the mechanism of the rearrangement of hydroperoxides with emphasis on migratory aptitudes and timing of the steps.

42. discuss the mechanism of the pinacol rearrangement with emphasis on the intermediate and migratory aptitudes of groups.

43. discuss the mechanisms of the pinacol deamination with emphasis on conformational effects.

44. discuss the effects of stereochemistry on the bromination of optically active bromohydrins and show how the mechanism explains product distribution.

45. show using a mechanistic approach how compounds like caniphene hydrochloride yield compounds like isobornyl chloride.

46. draw the resonance structures of naphthalene anthracene and phenanthrene and name the derivatives of napthalene.

47. write equations for the reaction of napthalene with chromic acid, sodium in ethanol, nitric acid, bromine, and acid chloride and discuss the orientation of electrophilic substitution with emphasis on the stability of the intermediate.

48. use the Haworth synthesis to prepare naphthalene and naphthalene derivatives.

49. draw the structure or name the important fatty acids from C_{11} to C_{17} and use this knowledge to name the important fats and oils associated with these acids.

50. discuss with examples the importance of saponification, hydrogenation and hydrogenolysis in the fats and oils industry.

51. determine saponification and iodine numbers

52. discuss the mechanism of soap action in the cleaning process and the effects of hard water and acids on soaps

53. outline the synthesis of specific detergents given a fat or alcohol or hydrocarbon and discuss the structural features of a good synthetic detergent.

54. write equations to show the metabolism of fats and fatty acids with co-enzyme 8

55. draw the structure of a typical wax and outline its synthesis.

56. explain the function of unsaturation and its importance in paints and drying oils and also their contribution to occasional spontaneous combustion processes.

57. draw the structures of glycine, alanine valine, leucine, serine, phenylalanine, aspartic acid, glutamic acid, lysine and thyroxine.

58. discuss the acid-base properties of amino acids and define iso-electric point as it relates to these properties.

59. outline the ninhydrin reaction and discuss its importance.

60. give reactions for the synthesis of peptides showing a knowledge of the use of protective groups for obtaining a pre-determined structure.

61. discuss chemically and physically how a protein sequence can be determined.

62. with the aid of chymotrypsin outline the enzyme catalysis of a peptide bond and discuss the mechanism of this action.

63. define the terms peptide bond, basic and acidic amino acids, essential amino acid, amphoteric and zwitter ion.

64. define and classify carbohydrates as monosaccharides, oligosaccharides and polysaccharides.

65. define aldoses and ketoses with examples.

66. define stereoisomerism terminology and relate these to carbohydrates.

67. outline the mechanism of cyclization and de-cyclization and its importance in the muta-rotation of glucose.

68. draw the structures of sucrose and a partial structure of cellulose as examples of di-and poly-saccharides.

69. outline the reaction of some carbohydrates with Br_2, $Ag(NH_3)_2^+$, Na/Hg and $LiAlH_4$ HNO_3 and phenylhydrazine.

70. Outline the steps for the determination of the structure of (+) glucose considering the possible eight enantiomeric pairs possible for $C_6H_{12}O_6$

71. define anomeric centre, osazone, reducing and non-reducing sugars, glycoside aldohexose and ketopentose.

COURSE OUTLINE:

1. FUNCTIONAL DERIVATIVES OF CARBOXYLIC ACIDS

Structure and nomenclature, Preparation and Reactions of Acid Chlorides, Anhydrides, Amides, Imides and Esters, Mechanism and synthesis using above.

11. SPECTROSCOPY AND STRUCTURE II

The nmr spectrum, Equivalent and non-equivalent protons, chemical shift, Peak area and proton counting, splitting of signals, spin-spin coupling, spin coupling constants, Quantitative and qualitative analysis of organic molecules by nmr.

111. CARBANIONS - I and II

Acidity of α-hydrogens, Halogenations of ketones, Aldol condensations, Wittig reaction, Claisen condensations, Reformatsky reaction, Mechanisms. Malonic Ester and Acetoacetic ester synthesis, αβ-Unsaturated carbonyl compounds, conjugate addition.

1V. AMINES

Structure, Classifications, Properties, Nomenclature, Stereochemistry of nitrogen, Preparation, Reactions, Structure and Basicity, Substituent effects, Hofmann elimination, Conversion to amides, Aromatic Amines, Sulfanilamide, Nitrous acid reactions, Diazonium salts, Sandmeyer reaction and other replacement reactions, Synthesis using diazonium salts, Azo compounds, Analysis.

V. PHENOLS

Structure and Nomenclature, Properties, Preparations, Reactions, Acidity, Williamson synthesis, Fries rearrangement, Ring substitution, Kolbe reaction, Reimer-Tiemann reaction, Analysis.

Vl. ARYL HALIDES

Preparations, reactions, structure and properties, benzyne, mechanism of bimolecular displacement.

Vll. α,β-UNSATURATED COMPOUNDS

Structure and properties, Nomenclature,Preparation, Electrophilic addition, Nucleophilic addition, Michael addition, Diels-Alder reaction, Quinones.

V111. REARRANGEMENTS AND NEIGHBORING GROUP EFFECTS

Intramolecular Nucleophilic attack, Hofmann rearrangement, Pinacol rearrangement,stereo-chemistry, Anchimeric assistance, Introduction to

non-classical ions.

1X. POLYNUCLEAR AROMATIC COMPOUNDS

Structure, Nomenclature, Substitution reactions (with emphasis on Naphthalene), Orientation of substitution, Haworth synthesis, Anthracene and Phenanthrene, Structure and nomenclature, Reactions.

X. FATS

Occurrence, Composition, Hydrolysis, Soap, Micelles, Degradation, Detergents, Unsaturated fats, Hardening of oils, Drying oils, Phosphoglycerides, Phosphate esters, Phospholipids, Waxes, Metabolism of Fats.

Xl. CARBOHYDRATES

Monosaccharides, Structure of Glucose, Mutarotation and the Cyclic Formula of Glucose, Conformations of Glucose, Other representative Aldoses, Fructose, Reactions of Monosaccharides, Osazones, Glycosides, Disaccharides, Structure of Sucrose, Lactose, Maltose, Cellobiose, Polysaccharides, Starch, Glycogen, Cellulose, Photosynthesis.

Xll. PROTEINS AND AMINO ACIDS

Structure, Isoelectric point, Configuration of Amino acids, Preparation, Peptides, Geometry of linkage, Structure determination, Synthesis of peptides, Proteins - classification and function, Denaturation, Conjugated proteins, Prosthetic groups, Coenzymes, Secondary Structure.

METHOD

The course will be presented using lectures, assigned readings, problem sessions and class discussions. Films and other audio-visual aids, handouts and programmed material will be used where appropriate. The laboratory course will be used to illustrate the practical aspects of the course material. Close co-ordination will be maintained between laboratory and classroom work whenever possible.

EVALUATION	PERCENTAGES
1. Class tests (a minimum of three) and Assignments	45%
2. Final Examination	30%
3. Laboratory	25%