

BODOLAND UNIVERSITY

OLD COURSE

REDUCED SYLLABUS

(1st, 3rd & 5th Semester under Life Science)

**B.Sc. Syllabus in Chemistry under Choice Based Credit System
(CBCS)**



DEPARTMENT OF CHEMISTRY
Bodoland University
Kokrajhar – 783 370
Assam, India

B.Sc. (Regular Course with *Life Sciences: Botany, Zoology & Chemistry*)

Sl. No.	CORE COURSE (12)	Ability Enhancement Compulsory Course (AECC) (2)	Skill Enhancement Course (SEC) (4)	Discipline Specific Elective (DSE) (6)
I	DSC-1 A (Bot)	(English/Hindi/MIL Communication)		
	DSC-2 A (Zoo)			
	DSC-3 A (Conceptual Organic Chemistry)			
II	DSC-1 B (Bot)	Environmental Science		
	DSC-2 B (Zoo)			
	DSC-3 B (Molecules of Life)			
III	DSC-1 C (Bot)		SEC-1 (Basic Analytical Chemistry)	
	DSC-2 C (Zoo)			
	DSC-3 C (Chemical Bonding)			
IV	DSC-1 D (Bot)		SEC-2 (Fuel Chemistry)	
	DSC-2 D (Zoo)			
	DSC-3 D (Physical Chemistry for Biosciences)			
V			SEC-3 (Chemical Technology & Society)	DSE-1 A (Bot)
				DSE-2 A (Zoo)
				DSE-3 A (Analytical Methods in Chemistry)
VI			SEC-4 (Chemistry of Cosmetics & Perfumes)	DSE-1 B (Bot)
				DSE-2 B (Zoo)
				DSE-3 B (Instrumental Methods of Chemical Analysis)

Chemistry GE courses for Honours students of Life Sciences

GE 1: Conceptual Organic Chemistry : CHY-L-103R

GE 2: Molecules of Life : CHY-L-203R

GE 3: Chemical Bonding : CHY-L-303R

GE 4: Physical Chemistry for Biosciences : CHY-L-403R

- SEC* courses of Chemistry of B.Sc. regular course under Physical sciences & Life Sciences are same.
- DSE* courses of Chemistry of B.Sc. regular course under Physical sciences & Life Sciences are same.

Curriculum Structures for B.Sc. (Regular Course)
Life Sciences (Botany, Zoology and Chemistry)
No. of papers =12+12=24, Total Credits= 120
Total Marks=2100

SEMESTER-I						
Paper Code	Course	L+T+P	Credit	End Sem	Internal	Total
Paper -101R	DSC-1 A (Bot)	4+0+2 5+1+0	6	60(L)+20(P) 60(L)+20(T)	20	100
Paper -102R	DSC-2 A (Zoo)	4+0+2	6	60(L)+20(P)	20	100
CHY-L-103R	DSC-3 A (Conceptual Organic Chemistry)	4+0+2	6	60(L)+20(P)	20	100
COMM-104HR	AECC-1: English/Hindi/MIL (Communication)	2	2	50		50
Total			20	290	60	350

SEMESTER-II						
Paper Code	Course	L+T+P	Credit	End Sem	Internal	Total
Paper-201R	DSC-1 B (Bot)	4+0+2 5+1+0	6	60(L)+20(P) 60(L)+20(T)	20	100
Paper -202R	DSC-2 B (Zoo)	4+0+2	6	60(L)+20(P)	20	100
CHY-L-203R	DSC-3 B (Molecules of Life)	4+0+2	6	60(L)+20(P)	20	100
ENV-204HR	AECC-2: Environmental Science	2	2	50		50
Total			20	290	60	350

SEMESTER-III						
Paper Code	Course	L+T+P	Credit	End Sem	Internal	Total
Paper-301R	DSC-1 C (Bot)	4+0+2 5+1+0	6	60(L)+20(P) 60(L)+20(T)	20	100
Paper -302R	DSC-2 C (Zoo)	4+0+2	6	60(L)+20(P)	20	100
CHY-L-303R	DSC-3 C (Chemical Bonding)	4+0+2	6	60(L)+20(P)	20	100
BAC-304HR	SEC-1:Basic Analytical Chemistry	2	2	50		50

Total			20	290	60	350
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SEMESTER-IV						
Paper Code	Course	L+T+P	Credit	End Sem	Internal	Total
Paper-401R	DSC-1 D (Bot)	4+0+2 5+1+0	6	60(L)+20(P) 60(L)+20(T)	20	100
Paper -402R	DSC-2 D (Zoo)	4+0+2	6	60(L)+20(P)	20	100
CHY-L-403R	DSC-3 D (Physical Chemistry for Biosciences)	4+0+2	6	60(L)+20(P)	20	100
FCH-404HR	SEC-2: Fuel Chemistry	2	2	50		50
Total			20	290	60	350

SEMESTER-V						
Paper Code	Course	L+T+P	Credit	End Sem	Internal	Total
Paper-501R	DSE-1 A (Bot)	4+0+2 5+1+0	6	60(L)+20(P) 60(L)+20(T)	20	100
Paper-502R	DSE-2 A (Zoo)	4+0+2 5+1+0	6	60(L)+20(P) 60(L)+20(T)	20	100
CHY-D1HR	DSE-3 A: Analytical Methods in Chemistry	4+0+2	6	60(L)+20(P)	20	100
CTS-504R	SEC-3: Chemical Technology & Society	2	2	50		50
Total			20	290	60	350

SEMESTER-VI						
Paper Code	Course	L+T+P	Credit	End Sem	Internal	Total
Paper-601R	DSE-1 B (Bot)	4+0+2 5+1+0	6	60(L)+20(P) 60(L)+20(T)	20	100
Paper-603R	DSE-2 B (Zoo)	4+0+2 5+1+0	6	60(L)+20(P) 60(L)+20(T)	20	100
CHY-D2HR	DSE-3 B: Instrumental Methods of Chemical Analysis	4+0+2	6	60(L)+20(P)	20	100
CCP-604R	SEC-4: Chemistry of Cosmetics & Perfumes	2	2	50		50
Total			20	290	60	350

BAC: Basic Analytical Chemistry

FCH: Fuel Chemistry

CTS: Chemical Technology & Society

CCP: Chemistry of Cosmetics & Perfumes

SEMESTER-I

GE-1 (or DSC-3 A): Conceptual Organic Chemistry (Credits: Theory-4, Practicals-2)

THEORY (Lectures: 60)

Unit 1: Stereochemistry (18 Lectures)

Writing of Fischer projection, Newmann and Sawhorse projection and Wedge formulae.

Conformations: Restricted rotation about single bonds, Various conformations of ethane, butane. Relative stability of different conformations in terms of energy difference is to be discussed for all these compounds.

Geometrical Isomerism: Requirements for a molecule to show geometrical isomerism, Cis-

Trans and E/ Z notation along with CIP rules for geometrical isomers.

Optical Isomerism: Optical activity, chirality, enantiomerism, diastereoisomerism, racemic mixtures.

Relative and absolute configuration: D / L nomenclature system for configuration of carbohydrates (difference between d/l and D/L notations).

Unit 2: Addition Reactions (10 Lectures)

Alkenes and Alkynes: Hydrogenation, addition of halogens, Hydrohalogenation (Markovnikov's and anti-Markovnikov's addition), hydration, hydroxylation (cis and trans),

oxymercuration-demercuration, hydroboration-oxidation, ozonolysis.

Aldehydes and ketones: (acetaldehyde, benzaldehyde)

hydrogen cyanide and alcohols.

Addition- elimination reactions with ammonia and its derivatives

Name reactions: Aldol, cross Aldol, Claisen, Knoevengel, Cannizzaro, cross Cannizzaro

Unit 3: Substitution Reactions (15 Lectures)

Free radical substitution reactions: Halogenation of alkanes.

Nucleophilic substitution reactions: Alkyl, allyl and benzyl halides – substitution of halogen by some common nucleophiles. Mechanism of S_N1 and S_N2 reactions

Alcohols, amines and phenols: Substitution of active hydrogen, replacement of hydroxyl group in alcohols (using PCl₅, SOCl₂ and HI).

Carboxylic acid derivatives: Hydrolysis

Ethers: Cleavage by HI

Electrophilic Substitution Reactions (aromatic compounds): General mechanism of electrophilic substitution reactions (nitration, halogenation, sulphonation, Friedel Crafts alkylation and acylation), directive influence of substituents.

Unit 4: Elimination Reactions (6 Lectures)

Alkyl halides (dehydrohalogenation, Saytzeff's rule), vicinal dihalides (dehalogenation), alcohols (dehydration), Quaternary ammonium salts (Hofmann's elimination). Mechanism of E₁ and E₂ reactions (nature of substrate and base), elimination vs substitution.

Unit 5: Oxidation (6 Lectures)

Alcohols: Oxidation with potassium permanganate, potassium dichromate, catalytic Dehydrogenation.

Aldehydes: Oxidation with Tollen's reagent

Ketones: Oxidation with potassium permanganate, sodium hypiodite (iodoform reaction).

Unit 6: Reductions (5 Lectures)

Aldehydes and Ketones: Catalytic hydrogenation, reduction with sodium borohydride, lithium aluminium hydride, Clemmensen, Wolff-Kishner

Carboxylic acids and their derivatives: Lithium aluminium hydride, sodium-ethanol and Rosenmund reduction.

Nitro compounds: Acidic, alkaline and neutral reducing agents, lithium aluminium hydride.

Recommended Texts:

1. I. L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
2. R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Pearson Education.
3. ArunBahl and B. S. Bahl :*Advanced Organic Chemistry*, S. Chand
4. Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry*, Orient Longman.
5. Eliel, E. L. & Wilen, S. H. *Stereochemistry of Organic Compounds*; Wiley: London, 1994.
6. T. W. Graham Solomon's *Organic Chemistry*, John Wiley and Sons.
7. P.S. Kalsi, *Stereochemistry, Conformation and Mechanism*, John Wiley and Sons.
8. D. Nasipuri, *Stereochemistry of Organic Compounds*, New Age International Publishers.

PRACTICAL-1

1. Purification of organic compounds by crystallization using the following solvents:

- a. Water
- b. Alcohol

2. Determination of the melting points of organic compounds (by Kjeldahl method and electrically heated melting point apparatus).

Organic preparations: Carry out the following preparations using 0.5 - 1 g of starting compound. Recrystallize the product and determine the melting point of the recrystallized sample. ***(Any three).

4. To prepare acetanilide by the acetylation of aniline.
5. To prepare p-bromoacetanilide.
6. Benzoylation of aniline or β -naphthol by Schotten-Baumann reaction
7. Hydrolysis of benzamide or ethyl benzoate.
8. Semicarbazone derivative of one the following compounds: acetone, ethyl methyl

ketone, diethylketone, cyclohexanone, benzaldehyde.

9. Nitration of nitrobenzene.

10. Oxidation of benzaldehyde by using alkaline potassium permanganate.

Recommended Texts:

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.*, Pearson (2012).

2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Longman, London & New York.

3. Ahluwalia, V.K.; Dhingra, S. & Gulati, A. *College Practical Chemistry*, Universities Press.

SEMESTER-III

GE-3 (or DSC-3 C): CHEMICAL BONDING

(Credits: Theory-4, Practicals-2)

THEORY

Lectures: 60

Unit 1: The covalent bond and the structure of molecules (10 Lectures)

Valence bond approach, Concept of resonance in various organic and inorganic compounds, Hybridization and structure, equivalent and non-equivalent hybrid orbitals, VSEPR model for predicting shapes of molecules and ions containing lone pairs, sigma and pi bonds.

Unit 2: Molecular Orbital Approach (10 Lectures)

LCAO method, symmetry and overlap for s-s, s-p and p-p combinations, MO treatment of homonuclear diatomic molecules of 2nd period (B₂, C₂, O₂).

Unit 3: Intermolecular forces: (8 Lectures)

Van der Waals forces, Hydrogen bonding and its applications, effects of these forces on melting point, boiling point and solubility.

Unit 4: Transition Elements (3d series) (12 Lectures)

General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction.

Unit 5: Coordination Chemistry (10 Lectures)

Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. IUPAC system of nomenclature.

Unit 6: Crystal Field Theory (10 Lectures)

Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D.

Suggested Texts:

1. James E. Huheey, "*Inorganic Chemistry: Principles of structure and reactivity*", Prentice Hall, IV Edition.
2. D. S. Shriver and P.A. Atkins, "*Inorganic Chemistry*", Oxford University Press, IV Edition.
3. Alan G. Sharpe, "*Inorganic Chemistry*", University of Cambridge, III Edition.
4. J. D. Lee, "*A New Concise Inorganic Chemistry*", ELBS IV Edition

5. Grey L. Miessler and Donald A. Tarr, "Inorganic Chemistry", Prentice Hall, III Edition.
6. B. Douglas, D. H. McDaniel and J. J. Alexander, "Concepts and Models of Inorganic Chemistry", John Wiley and Sons, III Edition.
7. Rodgers, G.E. *Inorganic & Solid State Chemistry*, Cengage Learning India Ltd., 2008.

PRACTICAL-3

Titrimetric Analysis:

Preparations of standard solutions (concept of primary and secondary standards), Different units of concentration (molarity, molality, normality and formality)

(A) Titrations involving Acids-Bases:

Principles of acid-base titrations, Principle behind selection of an appropriate indicator.

1. Standardization of NaOH solution (standard solution of oxalic acid to be prepared)
2. Determination of concentration of carbonate and hydroxide present in a mixture.

(B) Titrations involving redox reactions:

Concept of electrode potential, principle behind selection of an appropriate indicator.

5. Standardization of KMnO_4 solution (standard solution of Mohr's salt to be prepared).
6. Determination of concentration of Fe(II) in Mohr's salt and/or $\text{K}_2\text{Cr}_2\text{O}_7$ using diphenylamine/N-phenyl anthranilic acid as internal indicator (standard solution of $\text{K}_2\text{Cr}_2\text{O}_7$ and /or Mohr's salt to be prepared).

(C) Complexometric Titrations

Principles of complexometric titrations

8. Determination of concentration of Mg (II) & Zn (II) by titrimetric method using EDTA.
10. Determination of concentration of total hardness of a given sample of water by complexometric titration.

(At least 2 experiments from each set)

Recommended Texts:

1. Vogel, A.I. *A Textbook of Quantitative Inorganic Analysis*, ELBS.
2. Harris, D.C. &Freeman, W.H. & Co. *Quantitative Chemical Analysis 7th Ed.*, New York.

SEC-1

BASIC ANALYTICAL CHEMISTRY

(Credits: 02) 30 Lectures

Introduction: Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators.

- a. Determination of pH of soil samples.
- b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.

- a. Determination of pH, acidity and alkalinity of a water sample.
- b. Determination of dissolved oxygen (DO) of a water sample.

Analysis of food products: Nutritional value of foods, idea about food processing and food preservations and adulteration.

- a. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.
- b. Analysis of preservatives and colouring matter.

Suggested Applications (Any one):

- a. To study the uses of phenolphthalein in trap cases.
- b. To analyse arson accelerants.
- c. To carry out analysis of gasoline.

Suggested Instrumental demonstrations:

- a. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.
- b. Spectrophotometric determination of Iron in Vitamin /Dietary Tablets.
- c. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drinks.

Reference Books:

2. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
3. Skoog, D.A., Holler, F.J. & Crouch, S. *Principles of Instrumental Analysis*, Cengage Learning India Edition, 2007.
4. Skoog, D.A.; West, D.M. & Holler, F.J. *Analytical Chemistry: An Introduction* 6th Ed., Saunders College Publishing, Fort Worth, Philadelphia (1994).
5. Harris, D. C. *Quantitative Chemical Analysis*, 9th ed. Macmillan Education, 2016.
6. Dean, J. A. *Analytical Chemistry Handbook*, McGraw Hill, 2004.
7. Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India, 1992.
8. Freifelder, D.M. *Physical Biochemistry* 2nd Ed., W.H. Freeman & Co.,

- N.Y. USA (1982).
9. Cooper, T.G. *The Tools of Biochemistry*, John Wiley & Sons, N.Y. USA. 16 (1977).
 10. Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7th Ed.*, Prentice Hall, 1996.
 11. Mendham, J., A. I. *Vogel's Quantitative Chemical Analysis 6th Ed.*, Pearson, 2009.
 12. Robinson, J.W. *Undergraduate Instrumental Analysis 5th Ed.*, Marcel Dekker, Inc., New York (1995).
 13. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.

SEMESTER-V

CHEMISTRY-DSE-3A: ANALYTICAL METHODS IN CHEMISTRY (Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Qualitative and quantitative aspects of analysis:

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors.

(5 Lectures)

Optical methods of analysis:

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument.

Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques.

Structural illustration through interpretation of data, Effect and importance of isotope substitution.

Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction.

(25 Lectures)

Thermal methods of analysis:

Techniques for quantitative estimation of Ca and Mg from their mixture.

(5 Lectures)

Electroanalytical methods:

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations.

(10 Lectures)

Separation techniques:

Solvent extraction: Classification, principle and efficiency of the technique.

Mechanism of extraction: extraction by solvation and chelation.

Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media.

Chromatography: Classification, principle and efficiency of the technique.

Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.

Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiral chromatographic techniques using chiral columns (GC and HPLC).

(15 Lectures)

Reference Books:

- Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. *Vogel's Textbook of Quantitative Chemical Analysis*, John Wiley & Sons, 1989.
- Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
- Christian, G.D; *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
- Harris, D. C. *Exploring Chemical Analysis*, Ed. New York, W.H. Freeman, 2001.
- Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age, International Publisher, 2009.
- Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
- Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
- Ditts, R.V. *Analytical Chemistry; Methods of Separation*, van Nostrand, 1974.

PRACTICALS- DSE-3A LAB: ANALYTICAL METHODS IN CHEMISTRY

60 Lectures

I. Separation Techniques

1. Chromatography:

(a) Separation of mixtures

(i) Paper chromatographic separation of Fe^{3+} , Al^{3+} , and Cr^{3+} .

(ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the R_f values.

II. Solvent Extractions:

To separate a mixture of Ni^{2+} & Fe^{2+} by complexation with DMG and extracting the Ni^{2+} -DMG complex in chloroform, and determine its concentration by spectrophotometry.

III. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.

IV. Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.

V. Analysis of soil:

Determination of pH of soil.

Total soluble salt

Estimation of calcium, magnesium, phosphate,

nitrate.

VI Spectrophotometry

a. Determination of pK_a values of indicator using spectrophotometry.

b. Structural characterization of compounds by infrared spectroscopy.

c. Determination of dissolved oxygen in water.

Reference Books:

- Mendham, J., A. I. *Vogel's Quantitative Chemical Analysis* 6th Ed., Pearson, 2009.
- Willard, H.H. *et al.: Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
- Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York,

- 2004.
- Harris, D.C. *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
 - Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.
 - Skoog, D.A. Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Edition.
 - Mikes, O. & Chalmes, R.A. *Laboratory Handbook of Chromatographic & Allied Methods*, Elles Harwood Ltd. London.
 - Ditts, R.V. *Analytical Chemistry: Methods of separation*. Van Nostrand, New York, 1974.

SEC-3 CHEMICAL TECHNOLOGY & SOCIETY (Credits: 02)

Theory: 30 Lectures

Chemical Technology

Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid-liquid extraction, separation by absorption and adsorption.

Society

Exploration of societal and technological issues from a chemical perspective. Chemical and scientific literacy as a means to better understand topics like air and water (and the trace materials found in them that are referred to as pollutants); energy from natural sources (i.e. solar and renewable forms), from fossil fuels and from nuclear fission; materials like plastics and polymers and their natural analogues, proteins and nucleic acids.

Reference Book:

1. John W. Hill, Terry W. McCreary & Doris K. Kolb, *Chemistry for changing times* 13th Ed, Prentice-Hall (2012).