# Semester-wise break up of course allotment to Ph.D. Dairy Chemistry Students (2009-2010)

<table>
<thead>
<tr>
<th>First Sem.</th>
<th>Course No.</th>
<th>Major courses</th>
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<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
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<td>Advances in chemistry of milk protein</td>
<td>3+0</td>
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<td>Advances in chemistry of milk lipid</td>
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<td>Advances in Chemistry of functional dairy foods and nutraceuticals</td>
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*The Doctoral students will have to register these courses if not studied at Masters’ level.

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## Semester-wise break up of course allotment to M.Sc. Dairy Chemistry Students (2009-2010)

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DC- 611  Physico-chemical Aspects of Milk Constituents (2 + 1)

Course contents

Objectives:
To impart knowledge in understanding the physico-chemical aspects of milk and milk products with special reference to their processing and quality assurance.

Theory

Unit-I
Acid Base equilibria in milk(1), Titratable acidity and pH of milk and factors affecting them(2). Buffering capacity and buffer index of milk(2), constituents of milk responsible for buffer action(2).

Unit-II
Oxidation Reduction equilibrium in milk(1), Redox Reactions and photo oxidations of milk(2), contributions of different milk constituents towards Redox potential(2). Density and specific gravity of milk(3)

Unit-III
Optical properties of milk(2), Interaction of light with milk and Dairy Products(3). Refractive Index of milk(1), color of milk and milk products(3). Light absorbance and scattering by milk constituents(2).

Unit-IV
Colloidal & surface phenomena in milk; surface tension(2), adsorption, Factors affecting surface tension of milk(2), Colloidal stability of casein micelles in milk(2), Role of salts in colloidal stability of milk(2), General aspects of foaming, churning and whipping in cream, emulsion stability, coalescence and dispersion(2).

UNIT V
Viscosity of milk(1), Newtonian and non Newtonian liquids(2), Gels, role of milk fat, rheology of milk gels, acid and rennet gels(3)

UNIT VI
Colligative properties of milk(2), boiling and freezing point(2), electrical conductivity(1), heat capacity and thermal conductivity(2), role of milk constituents on their properties(2).

Practicals
Measurement of pH and buffering capacity of different types of milk(2); To study the gel formation and gel stability of milk proteins(2); preparation of a Tris/phosphate/citrate buffer of a given molarity/ionic strength and pH(2); determination of pH of the buffer(1); estimation of calcium ions of milk using an ions selective electrode(2); determination of viscosity of condensed milk using falling ball viscometer(2); measuring the stability of an oil-in-water emulsion stabilised by milk proteins(2); foaming capacity and foam stability of caseins/whey proteins(3);
**Suggested Readings**


**List of Journals:**

1. Indian Journal of Dairy Science
2. International Dairy Federation Bulletin
3. International Dairy Journal
5. International Journal of Food Composition
6. Journal of Agricultural and Food Chemistry
7. Journal of Dairy Research
9. Journal of Food Science
10. Journal of Food Science and Technology
11. Milchwissenschaft-Milk Science International
12. LWT-Food Science and Technology

**DC-612 Milk carbohydrates, minerals and water soluble vitamins (2+1)**

**Course Contents**

**Objectives:**

To impart basic knowledge on all aspects of milk carbohydrates, minerals and water soluble vitamins and to project the importance of these milk constituents on the quality of milk and milk products as well as in human health.

**Theory**

**UNIT I**

Lactose: occurrence, isomers; molecular structure(2);

**UNIT II**

Physical properties:- crystalline habits; hydrate; lactose glass(2); equilibrium of different isomers in solution; solubility; density sweetness(2);

**UNIT III**
Chemical properties: hydrolysis; pyrolysis; oxidation; reduction; degradation with strong bases; derivatives; dehydration and fragmentation browning reaction; oligosaccharides in milk;

**UNIT IV**
Minerals: major and minor minerals; factors associated with variation in salt composition;

**UNIT V**
Physical equilibrium amongst milk salts; partitioning of salt constituents and factors affecting it; effect of various treatments on salt equilibrium;

**UNIT VI**
Salt balance and its importance in the processing of milk; protein mineral interactions; distribution and importance of trace elements in milk;

**UNIT VII**
Water soluble vitamins: thiamin; riboflavin; niacin; pantothenic acid; pyridoxine; biotin; folacin (folic acid) and cyanocobalamin;

**UNIT VIII**
Molecular structure; levels in milk and milk products; biological significance; factors affecting their levels; ascorbic acid structure; relation to Redox potential (Eh) of milk and milk products.

**Practical**
Estimation of lactose in milk by volumetric; gravimetric; polarimetric and colorimetric methods; estimation of sodium and potassium by flame photometry; calcium and magnesium by EDTA method; phosphorus by colorimetric method; citric acid and iron by colorimetric methods; vitamin C in milk by volumetric method and estimation of brown colouring matter/burnt particles in milk powder.

**Suggested Readings**


**DC-613 Chemistry of Milk Lipids (2 + 1)**
Course Contents

Objectives:

To impart the basic knowledge on all aspects of milk lipids and to project the importance of milk lipids in the quality of milk products as well as in human health.

Theory

UNIT I
Milk lipids: classification, gross composition(2) and physical properties(1); neutral and polar lipids and their role in milk and milk products(2).

UNIT II
Fatty acids profile(2): composition, properties and factors affecting them(2).

UNIT III
Unsaponifiable matter(1): composition with special reference to sterols(2) and fat soluble vitamins and caretenoids(2), chemistry, physiological functions and levels of milk(6).

UNIT IV
Chemical properties: hydrolysis by alkali(1)water and enzymes(1); hydrogenation and halogenation(1); transesterification and interesterification(1); oxidation by chemical reagents(1).

UNIT V
Auto-oxidation: Definition, theories(1), induction period(1), secondary products of auto oxidation(2), factors affecting, prevention and measurement(2); antioxidants: Definition, types, reaction mechanism and estimation(3).

Practical: Determination of melting point/slip point(1), peroxide value(1), TBA value(1), carbonyl value(2), unsaponifiable matter(2); estimation of total cholesterol by direct and indirect method(2); vitamin A(2), total phospholipids and free fatty acids in ghee(2); preparation of fatty acid esters and their analysis on GLC(2); estimation of antioxidants such as BHA(2).

Suggested Readings


List of Journals:
2. International Journal of Dairy Technology
3. Journal of Lipid Research
4. Journal of Dairy Research
5. Indian Journal of Dairy Science
6. Lipids
7. J. Am. Oil Chem. Soc

DC -614 Food Chemistry (3 + 1)
Course Contents

Objectives:
To impart knowledge on different aspects of food components

UNIT I:
Forms of water in foods(1), water solute interactions(1), and food stability, solute mobility and food stability(2); role of ice in the stability of food at sub-freezing temperatures(3),

UNIT II:
Starch: Forms(1), swelling, gelatinization food applications and their role in bread making(2); modification of starches for industrial applications(2), physico-chemical changes taking place during malting(2), mutual interactions of hydrocolloids and interactions with proteins and lipids(3); role of hydrocolloids in different food preparations(2);

UNIT III
Functional properties of food proteins(1); structure-function relationship and their modifications(4), denaturation of food proteins(3); effect of pressure on food proteins(3), enzymes & their application in food industry(4); physico-chemical properties of food lipids and their modifications(4);

UNIT IV
Indigenous and synthetic food pigments(3); legal requirements for food colourants(1); flavour compounds of different foods and flavour enhancers(3);

UNIT V
Changes taking place during fermentation(3); drying and roasting of chocolate and cocoa; chemistry of tea manufacture(1); composition of coffee beans(1); physico-chemical changes during roasting of coffee beans(2).

Practical

Determination of level of artificial sweeteners and crude fiber in food products(3); starch in flour by polarization method(1); total amino acids and polyphenols in lemon juice(1);
fat in grains(1); proteins in flour(2); tannins in coffee/tea, caffeine content in coffee(2); HMF in honey, and visit to a food industry(2).

**Suggested Readings**

Belitz, H.D. and Grosch, W. 1987. Food Chemistry

**List of Journals:**

1. International Dairy Journal
2. Journal of Dairy Science
3. Journal of Dairy Research
4. Milchwissenschaft
5. Dairy Science and Technology
6. Journal of Food Science
7. Food Chemistry
8. International Journal of Food Science and Technology
9. Analyst
10. Journal of Chromatography

**DC- 621 Chemistry of Milk Proteins ( 3+ 1)**

**Course Contents**

**Objectives:**
To impart knowledge on different aspects of milk proteins

**Theory**

**Unit -1**
Distribution and fractionation of different nitrogen fractions, non-protein nitrogen constituents, nomenclature of milk proteins(4).

**Unit-11**
Major milk proteins: caseins (acids and micellar), methods of isolation; fractionation of casein and heterogeneity, physico-chemical properties, glycosylation, phosphorylation, amino acid composition, primary and secondary structure of different fractions; casein micelle models(12).

**Unit -111**
alpha-Lactalbumin and beta-lactoglobulin - distribution and methods of isolation; whey protein concentrates and their functional properties(8).

Unit-1V
Denaturation of caseins and whey proteins as affected by change of temperature, pH and additives; casein-whey protein interactions; genetic polymorphism (10)

Unit-V
Minor milk proteins: proteose-peptone, immunoglobulins, lactoferrin, lipoprotein and fat globule membrane proteins(8).

Unit-V1
Milk enzymes: properties and their significance with particular reference to lipases, phosphatases, catalase, peroxidase, xanthine oxidase, lysozyme, lactoperoxidase and galactosyl transferase(11).

Practical
Estimation of different nitrogen fractions of milk by Kjeldahl method(2). Milk protein(2) estimation by Folin method(1). Isolation of acid and micellar casein(2); urea fractionation of acid casein(2); separation of amino acids using thin layer/paper chromatography(1); isolation of alpha-lactalbumin and beta-lactoglobulin by ammonium sulphate precipitation(2); polyacrylamide gel electrophoresis of milk proteins(1); estimation of milk enzymes like lipase, alkaline phosphatase and lactoperoxidase(4); fractionation of milk proteins by molecular sieving(1); estimation of hexoses and sialic acid in casein(2).

Suggested Readings

List of Journals:
1. Indian Journal of Dairy Science
2. International Dairy Federation Bulletin
3. International Dairy Journal
DC-622 CHEMISTRY OF MILK PRODUCTS 3+1

Course Contents

Objectives

To project the physico-chemical changes and effects of various milk constituents of the milk products during manufacture and storage.

Theory

UNIT I
Physico-chemical changes taking place during manufacturing and storage of concentrated milk(4); structure and physico-chemical properties of dried milk as affected by different process treatments(4); stability of milk powder(1); physical properties of instant milk powder(1)

UNIT II
Role and mechanism of action of stabilizers and emulsifiers in ice cream(3). Biological activity of infant milk and infant food formulations(3).

UNIT III
Heat stability of concentrated milk as affected by different process variables(2); milk constituents(2) and additives(1); milk clotting enzymes from different sources(2).

UNIT IV
Changes taking place during manufacturing and ripening of cheese(7); chemical defects in cheese(2). Homo- & hetero - fermentations(3).

UNIT V
Size distribution of fat globules and factors affecting it(3); creaming phenomena(1); mechanism of churning(2); physico-chemical characteristics; grading and standards of butter(3).

UNIT VI
Physico chemical constants of ghee(4), ghee flavour(2), texture (grains) in ghee(1), detection of adulteration in ghee(2).

Practical
Determination of lactose and sucrose in condensed milk and ice-cream(2); determination of heat stability of milk and its concentrate(1); determination of moisture in skim milk powder/infant food by vacuum oven(1); determination of fat in cream by Gerber and Rose-Gottlieb methods(2); determination of moisture, fat (Gerber method), curd and salt in butter(2); determination of diacetyl and acetyl methyl carbinol in butter/cultured products(2); determination of RM, Polenske value(1), iodine value, saponification value of ghee(2); determination of nitrite, nitrate, free amino acids and free fatty acids in cheese(3); determination of rennet clotting time of milk(1).

Suggested Readings

7. ISI Handbook of Food Analysis S.P. 18 (Part II) Dairy Products. 1981 ISI Specifications (concerned) (ISI)

List of journals

1. J. Dairy Res
2. Indian Dairyman
5. Lipids
6. Milchwissenschaft
7. Lipid Res.

DC-623 Chemical Quality Assurance (2+1)

Objectives: To project the importance of chemical quality assurance and quality control in relation to dairy industry and impart basic knowledge on all aspects of chemical quality assurance.

Theory

Unit I

Concept of quality assurance and quality control in relation to dairy industry(2); quality management systems - ISO 9000(2); total quality management (TQM) (2); hazard analysis of critical control points (HACCP) (2); good manufacturing practices (GMP) (1); role of international organisations such as ISO; IDF; CAC; AOAC; WTO(2) and national
organisations like BIS; CCFS; Good laboratory practices (GLP), laboratory Accreditation

Unit II
PFA and Agmark; significance of milk and milk products order (MMPO) and APEDA (Agricultural and Processed Foods Export Development Authority) in dairy industry; guidelines for setting up quality control laboratory; sampling of milk and milk products; dairy detergents and sanitizers; calibration of milk testing glassware; preparation of standard reagents;

Unit III
Instrumentation in analysis of milk and milk products; detection of adulterants in milk and milk products; Quality of packaging material for dairy products

Unit IV
Chemical contaminants /residues : pesticides; antibiotics; heavy metals; radionuclides etc. in dairy products.

Practical:
Preparation of standard solutions and buffers; testing of available chlorine content in hypochlorites/bleaching powder; determination of purity of common salt for butter and cheese making; detection of common adulterants in milk and foreign fat/oil in ghee; checking the calibration of lactometers; hydrometers; butyrometers; milk pipette and thermometer; qualitative colour tests to distinguish between azo dyes and natural dyes in butter; detection of pesticide residues and antibiotics in milk.

Suggested Readings
IDF - Special Issue No. 9302. Quality Assurance (QA) and Good Lab. Practices (GLP) in Dairy Laboratories.
IDF - Special Issue No. 9701 1997 Monograph on Residues and Contaminants in milk and milk products

Official methods of A.O.A.C. (11th and 15th editions- revised from time to time)

ISI Handbook of Food Analysis S.P. 18 (Part II) Dairy Products. 1981 ISI Specifications (concerned) (ISI)

Journals
1. Indian J. Dairy Sci.
2. Indian Dairyman
4. J. Food Quality
5. Environmental Sci. and Tech.
6. Food additives and contaminants
7. J. Food safety

DC-624 Research Techniques 2 + 1

Course content

Objectives:

To impart the advanced knowledge on the use of analytical techniques in Dairy Chemistry

Theory

Unit-1
Electrophoresis: principle and types(2), isoelectric focussing(2).

Unit-11
Column Chromatography(1), TLC(1), GLC(2), HPLC(2), gel-permeation(2), ion-exchange(2), affinity(2).

Unit-111
Spectrophotometry: UV, visible, IR and flame photometry(4); potentiometry: principle, various electrodes(3); electrometric measurements of pH, buffers(2).

Unit-1V
Radiotracer technique: nuclear transformation, nuclear decay, measurement of radioactivity and safety precautions for radioactive materials(4).

Unit-V
Separation of bio-molecules using membranes; ultracentrifugation((4)).

Practical
Preparation of methyl esters of fatty acids of milk fat followed by their GLC separation and estimation(2); TLC separation of amino acids(1); gel-filtration of biomolecules(2); preparation of a buffer and measurement of its pH electro-metrically and using indicators(1); SDS gel electrophoresis and molecular weight determination(2); determination of absorption spectra of BSA and demonstration of Beer's law(2); determination of sodium and potassium by flame photometry(2); ultracentrifugal preparation of micellar casein(1), separation of milk proteins using ion-exchange chromatography(2).

Suggested Readings

Cooper, T.G. 1977. The Tools of Biochemistry, John Wiley & Sons, U.S.A.
Wilson,K and Walker,J--- Practical Biochemistry, principals and techniques,Cambridge Univ. Press.K
Sawheney,SK and Randhir Singh, An introduction to practical Biochemistry, Narosa Publishers, New Delhi
List of Journals:
1. Analytical Biochemistry
2. Journal of Chromatography
3. Journal of Biochemistry
4. Journal of Agricultural and Food Chemistry
5. Journal of Dairy Research
7. Journal of Food Science
8. Dairy Science and Technology

DC- 711 Advances in Chemistry of Milk Proteins (3 + 0)

Objectives: To impart knowledge on different aspects of milk proteins

UNIT I
Biosynthesis of milk proteins, proteins and lipoproteins of milk fat globule membrane (MFGM)

(9)

UNIT II
Amino acid sequence of caseins, structure - function relationship of casein and whey protein; association - dissociation equilibria(10);

UNIT III
Physical, chemical and enzymatic modification of milk proteins and their functional characteristics; (7)

UNIT IV
Mechanism of action and biological role of specific and non-specific antimicrobial factors in milk - immunoglobulins, lactoferrin, lactoperoxidase and lysozyme; (9)

UNIT V
Milk derived bioactive peptides – their properties; significance and application; bitter peptides in cheese; growth factors in milk. (10)

UNIT VI
Therapeutic and allergy aspects of milk proteins; protein films and coatings; their properties and applications. (9)

Suggested Readings
Hans Visser; 1992 Protein - Interactions. VCS, New York
Proceedings of IDF Seminar on Indigenous antimicrobial agents of milk - Recent developments; Uppasala, Sweden, 1993

List of Journals:

1. International Dairy Journal
2. Journal of Dairy Science
3. Journal of Dairy Research
4. Milchwissenschaft
5. Dairy Science and Technology
6. Journal of Food Science
7. Food Chemistry
8. International Journal of Food Science and Technology
9. Analyst
10. Journal of Chromatography

DC- 712 Advances in Chemistry of Milk Lipids (3 + 0)
Course Contents

Objectives:

To impart the advanced knowledge on different aspects of milk lipids with special reference to their relation with human health.

Theory

UNIT I
Origin, composition, structure and physical chemistry of milk fat globule membrane. Comparative aspects of milk lipids from different species such as human, bovine, buffalo, sheep, goat, pig and camel (12)

UNIT II
Lipolytic enzymes from different species including human; bile salts; stimulated lipase and esterases. Biosynthesis of fatty acids; glycerol; neutral lipids; phospholipids; sphingolipids; cholesterol(10)

UNIT III
Essential fatty acids, prostaglandins and flavor compounds. Conjugated linoleic acids – different isomers, factors affecting their levels in dairy products and their significance: (10)

UNIT IV
Chemistry of oxygen in relation to auto-oxidation of milk fat including effect of milk components and environmental factors, thermal oxidation, chemical and biological properties of heated and oxidized fats, (12)

**UNIT V**

**Suggested Readings**

Fox, P.F. and McSwamy, PLH 1997 Dairy Chemistry and Biochemistry London: Blackie

**List of Journals:**

2. International Journal of Dairy Technology
3. Journal of Lipid Research
4. Journal of Dairy Research
5. Indian Journal of Dairy Science
6. Lipids
7. J. Am. Oil Chem. Soc

**DC 713   ADVANCES IN CHEMISTRY OF FUNCTIONAL DAIRY FOODS AND NUTRACEUTICALS.** (3+0)

**Course Contents**

**Objectives:**
To impart knowledge to the students about the chemical aspects of functional dairy foods and nutraceuticals.
UNIT I

UNIT II
Bio-functional milk proteins and their therapeutic potential, recent advances in their bio-separation(3), Generation of bioactive peptides from casein and whey proteins, their isolation and characterization(3), technological and health aspects(2), colostrums as source of nutraceuticals(7).

UNIT III
Technological and nutritional aspects of milk lipids(3), conjugated linoleic acids (CLA) in milk(2), their variation, physiological effects and their importance in dairy foods(3). Omega fatty acid and their health attributes(2), strategies to reduce the cholesterol in dairy products(4).

UNIT IV

UNIT V
Milk oligosaccharides, structural and technological aspects(3), health promoting aspects of milk oligosaccharides(4).

DC- 721  Advances In Chemistry of milk processing (3+0)
Course Contents

Objectives:
To highlight the impact of processing parameters on the milk constituents with special reference to chemical changes involved.
To impart the knowledge on the status and chemistry of contaminants in milk and milk products.
To impart the basic knowledge on the chemistry and significance of additives.

Theory:
UNIT I:
Heat induced changes and interactions between protein, lipids, carbohydrate and minerals during processing of milk. Effect of heat on the proteins of concentrated milk systems. Inactivation of milk indigenous enzymes during processing, Milk fat replacers(12).
UNIT II:
Physical changes in the fat globules in unhomogenized and homogenized milk; cold agglutination – its mechanisms and role (9).

UNIT III
Specific and non – specific enzymatic coagulation of milk (7).

UNIT IV
Status and formation of bioactive peptides in fermented milk products (9).

UNIT V
Chemistry involved in high pressure processing of milk (9).

UNIT VI
Heavy metals, drugs, pesticides, and polybiphenyls in milk (9).

Suggested Reading:
1. IDF Special issue 9701, 1997
8. Intense Sweeteners. Handbook of food analysis, 2nd ed. (Ed. by Leo ML Nollet)

List of Journals:
1. International Dairy Journal
2. Journal of Dairy Science
3. Journal of Dairy Research
4. Milchwissenschaft
5. Dairy Science and Technology
6. Journal of Food Science
7. Food Chemistry
8. International Journal of Food Science and Technology
9. Analyst
10. Journal of Chromatography
11. Journal of Food safety
12. Journal of Food Science and Technology
13. Indian journal of Dairy Science
14. Bulletin of environmental contamination and toxicology
Course Contents

Objectives:
To highlight the importance of modern analytical techniques used for analysis of milk and milk products.

Theory:

UNIT I:
Isoelectric focusing(4) and 2-D polyacrylamide gel electrophoresis (PAGE) (4), Capillary zone electrophoresis(4), Enzyme linked immunosorbent assay (ELISA) (4).

UNIT II:
Blotting techniques(3), High performance liquid chromatography (HPLC) (4), Protein sequencing(4), X-ray crystallography(4), Circular dichroism (CD) (5).

UNIT III:

Suggested Reading:


Swadesh, J (1997) HPLC - Practical and Industrial applications CRC Press FL.


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1. International Dairy Journal
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