Proteins

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Outline of the presentation

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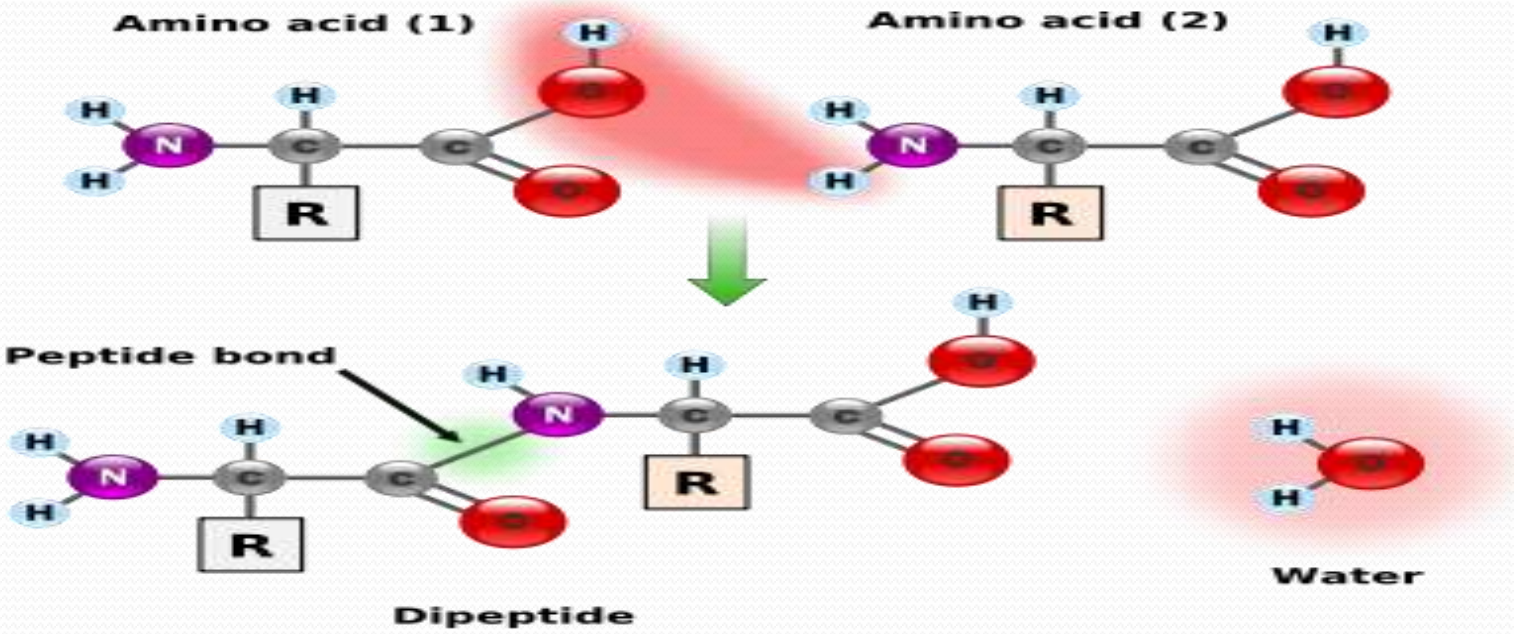
Proteins- Introduction

- Came from a Greek word “prota” meaning “of the first rank” or “of primary importance”
- These molecules were first described and named by the Swedish chemist Jöns Jakob Berzelius in 1838.
- The first protein to be sequenced was insulin, by Frederick Sanger.
- The first protein structures to be solved included haemoglobin and myoglobin, by Max Perutz and Sir John Cowdery Kendrew, respectively.

Protein-Definition

Proteins may be defined as the high molecular weight mixed polymers of alpha-amino acids joined together with peptide linkage.



NATURE OF PROTEINS

- It's a Macronutrient.
- Aside from water, proteins are the most abundant kind of molecules in the body.
- Proteins constitute the chief solid matter of muscles, organs and endocrine glands.
- constitute about 20% of the body weight in an adult.
- Proteins differ from carbohydrates and fats in that they contain Nitrogen, this usually amounting to about 16 %.
- 1 gm of protein provide 6.25 gm of nitrogen

Building blocks of Protein : Amino Acids

- Molecules containing an AMINE group, CARBOXYLIC ACID group and a SIDE CHAIN which gives it variability.
- There are 22 different amino acids ordinarily required for synthesis of tissue proteins.
- Its key elements are C, H, O, and N
- Can be linked together in varying sequences to form a vast variety of proteins
- Absence of any of these amino acids could prevent body protein formation.
- Three categories of AA are present in our body.

Building blocks of Protein : Amino Acids Cont…

S No.	Essential Amino Acids	S No.	Conditionally Essential Amino Acids	S No.	Non Essential Amino acids
1	Leucine	1	Arginine	1	Alanine
2	Isoleucin	2	Cysteine	2	Asparagine
3	lysine	3	Tyrosine	3	Aspartic acid
4	Methionine	4	Glycine	4	Serine
5	Phenylalanine	5	Glutamine	5	Glutamic acid
6	Threonine	6	Proline		
7	Valine				
8	Tryptophan				
9	Histidine				

Classification of Proteins

(a) Based on physical properties and chemical composition

- Simple
- Conjugated
- Derived

Protein	Description	Examples
SIMPLE PROTEINS	•The simplest •Made of amino acid units only, joined by peptide bond •Upon hydrolysis they yield mixture of amino acids and nothing else.	•Albumins •Globulins •Glutelins •albuminoids
CONJUGATED PROTEINS	•Composed of simple proteins combined with a non-protein substance •The non-proteinous substance is called **prosthetic group** or **cofactor**.	•Nucleoproteins •Glycoproteins •Phosphoproteins •Hemoglobins
DERIVED PROTEINS	•Not naturally occurring proteins •Obtained from simple proteins by the action of enzymes and chemical agents. •Results from hydrolysis of proteins	•Peptones •Peptides •proteoses

Classification of Proteins Cont….

(b) Based on conformation and solubility.

Fibrous Protein: Tough and insoluble in ordinary solvents.

- Collagen of tendon and bone matrix
- alpha keratin of hair, skin and nails
- the elastin.

Globular Protein: Soluble in body fluids.

- Haemoglobin
- Insulin
- Albumin
- Enzymes and others.

Classification of Proteins Cont.....

(c) Based on nutritional properties

- **Biologically Complete proteins:**

  which contain enough of the indispensable amino acids to maintain body tissue and to promote a normal rate of growth. Include proteins found in eggs, milk, cheese, meat, poultry, and fish

- **Biologically Incomplete proteins:**

  Incapable of replacing or building new tissue, and hence cannot support life, let alone promote growth. Eg: Proteins found in grains, nuts, fruits, vegetables

Functions of Proteins

- Proteins are important for body building, growth, repair and maintenance of body tissues.
- Proteins are required for the synthesis of plasma proteins, haemoglobin, enzymes and hormones.
- Proteins like collagen, actin and myosin form the structural tissues - skin and muscles
- Maintenance of osmotic pressure.
- Albumin, a protein, acts as a buffer in the maintenance of blood pH (7)
- Protein can also supply energy (4 Kcal per one gm) when the calorie intake is inadequate, but this is not their primary function.
- Proteins are also the important source of N, S and Phosphorus for the body.

Functions of Proteins Cont..

- The proteins immunoglobulin act as prime defence against bacterial and viral infections.
- The contractile proteins actin and myocin aid in the movement of muscle fibre and microvilli.
- The enzymes are protein in nature and have high catalytic activity to speed up the chemical reaction in the body.
- The hormones which are protein in nature have great effect on metabolism and reproduction.
- Some proteins bind specific substances to be present as storage eg. Ferritin
- Some proteins helps in the transportation. eg. Haemoglobin, transferrin etc.
- The neurotransmitters are derived from amino acids. Eg. GABA from glutamate, Serotonin from tryptophan

Protein Requirements

Protein requirements depends upon :-

- Age
- Gender
- Growth
- Physiological variables
- Illness
- Worm infestations
- Emotional disturbances and stress situations
- The primary factor that influences protein requirement is energy intake

Protein Requirements cont…

- It is customary to express protein requirements in terms of body weight.
- The ICMR in 2010 recommended 1.0 g protein/Kg body weight for an Indian adult, assuming a NPU of 65 for the dietary proteins.
- Animal foods should supply 1/3 to 1/2 of total protein intake in adults, and 2/3 in children, pregnant and lactating women.
- Protein needs can be also higher for active people
- Protein supplements are not needed to meet protein needs.

Protein Requirements cont…

- Recommendations for protein intake are based on the concept of "nitrogen balance." Protein contains nitrogen, and as proteins are broken down in the body, nitrogen is excreted. Consequently, nitrogen must be continually replaced through the diet (as protein) so that the body can continue to make proteins.
- For most adults, an even nitrogen balance is ideal, meaning that the amount of nitrogen provided in the diet is equivalent to the amount of nitrogen excreted.
- In contrast, children require a positive nitrogen balance to support growth and development.
- Pregnant and lactating women also require a positive nitrogen balance.

Protein Requirements cont..

Recommended Dietary Allowance for Proteins for Indians

Group	Category/Age	Protein -RDA
Infants	0-6 months	1.16 gm/kg/day
	6-12 months	1.69 gm/kg/day
Pre school child	1-5 years	0.94 gm/kg/day
School children	6-10 years	0.91 gm/kg/day
Adolescents	11-18 years-Boys	0.88 gm/kg/day
	11-18 years-Girls	0.86 gm/kg/day
Adult-Man	Sedentary, Moderate and heavy worker	1.00 gm/kg/day
Adult-Woman	Sedentary, Moderate and heavy worker	1.00 gm/kg/day
Pregnant woman		78 gm/day
Lactating mother	For first 6 months	74 gm/day
	For next six months	68 gm/day

Sources of Protein

Humans obtained protein from two main dietary sources

Animal Sources:

Proteins of animal origin are found in Milk, Meat , Fish , eggs and cheese. Egg proteins are considered to be the best among food proteins, known as “reference protein”

Vegetable Sources:

Vegetable proteins are found in pulses/legumes, cereals, beans, nuts, oil seed cakes ect.

Sources of protein cont…

- Protein foods of animal origin, such as eggs, milk, fish, poultry, and meat.




Sources of protein cont…

- Plant protein foods like cereals, pulses, vegetables, nuts and fruits.





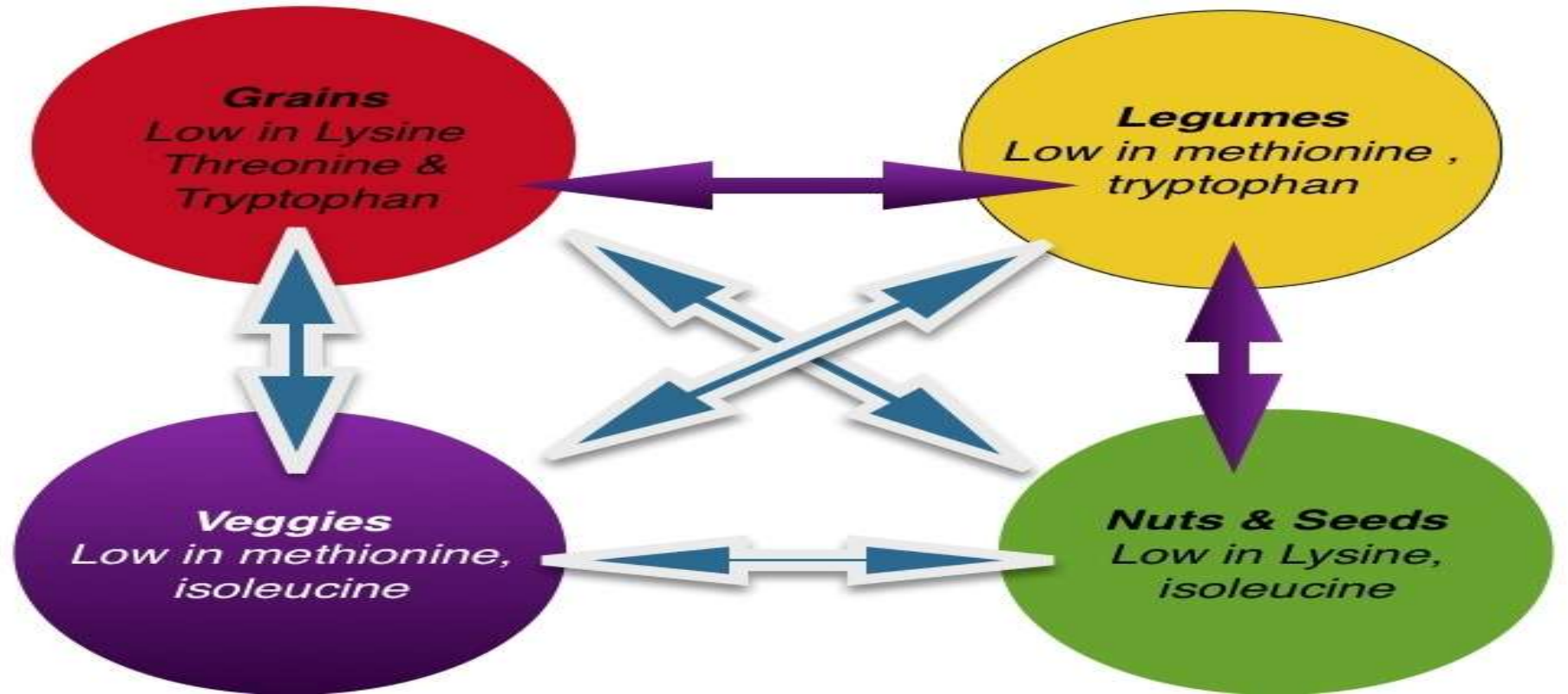
Sources of protein cont…

Protein content of some foods

Food	Example	Protein (gm. /100 gm of food)
Animal foods	Milk	3.2-4.3
	Meat	18.0-26.0
	Egg	13.0
	Fish	15.0-23.0
Plant foods	Cereals	6.0-13.0
	Pulses	21.0-28.0
	Vegetables	1-4
	Fruits	1-3
	Nuts	4.5-29.0
	Soyabean	43.2
Others	Fats and Sugars	nil

Sources of protein cont…

- When two or more vegetarian food eating together their proteins supplement one another k/as supplementary action of proteins.



Sources of protein cont…

- Food combinations that provide complete proteins:

- Grains+Legumes

  Eg. Rice-Dal, Chapati-Dal, Idli-Sambhar, Razma-Rice
- Peanut butter sandwich
- Rice and beans
- Lentil soup with rye bread

Recommendations on Diet for Proteins

- Eat nutritionally balanced diet to get adequate protein
- Meat and fish are good sources
- Vegetarians must eat proper combination of plant proteins from both cereal and pulses groups
- Include Soyabean in your diet
- Two to three servings of protein-rich food must be ensured every day
- One serving may be equivalent to : - One to two cups of cooked meat, poultry, fish - Half cup of cooked dry beans/ lentils/ legumes - One egg - Handful of fried/roasted- salted groundnuts - Handful of roasted Bengal grams

Protein Metabolism

- Fate of protein in the body result in
  1) Catabolism in the liver-break down and urea formation
  2) Formation of tissue protein
  3)Formation of other nitrogenous substances

- Amino acids provide the nitrogen for the synthesis of many nitrogenous compound of the body including bile acids, creatine, purine, pyrimidines, ephinephrine, thyroxine, aminosugars, enzymes and the base of the phospholipids.

- In normal health the nitrogen ingested equals to that excreted in urine, feces and sweats.

Methods of evaluating protein quality

Protein efficiency ratio (PER) :-

- It is the simplest method.
- It measure the weight gain of a growing animal with reference to its protein intake.
- A high PER (>2.5) assigned to proteins that are efficient at promoting growth. Eg. Animals protein
- Major source of error in this method is the use of weight gain per se as sole criterion of protein value. It also dose not include protein required for maintenance.
- From 1919 until very recently, the PER had been a widely used method for evaluating the quality of protein in food.

$$PER = \frac{Gain\ in\ body\ mass(g)}{Protein\ intake(g)}$$

Methods of evaluating protein quality cont..

Net protein ratio (NPR) :-

This method was developed to overcome the drawbacks of PER method.

In this method another group of animals beside test animals included to whom protein free diet is given and the amount of protein required for maintenance was calculated.

It is calculated as difference in final body weight between test group fed the protein in diet, and a group receiving a protein free diet divided by the amount of protein taken by the test group

Methods of evaluating protein quality cont..

Digestibility Coefficient :-

It is the proportion of food protein which is absorbed.

It is computed from the measurement of the nitrogen content of the food ingested and the nitrogen excreted in faeces, taking into account the extent to which faecal nitrogen is "endogenous" which in turn is measured as faecal nitrogen lost on a protein-free diet.

$$\text{True protein digestible} = \frac{I - (F - Fe)}{I} * 100$$

Where I = Nitrogen intake

F = Faecal nitrogen lost on a test diet

Fe = Faecal nitrogen lost on a protein free diet

Methods of evaluating protein quality cont..

Biological Value (BV) :-

It is the percentage of absorbed nitrogen that is retained by the body for growth and maintenance.

It is expressed as nitrogen retained divided by nitrogen absorbed.

$$BV = \frac{I-(F-Fe)-(U-Ue)}{I-(F-Fe)} * 100$$

Where I = Nitrogen intake

F = Faecal nitrogen lost on a test diet

Fe = Faecal nitrogen lost on a protein free diet

U = Urinary nitrogen on test diet

Ue = Urinary nitrogen on protein free diet

Methods of evaluating protein quality cont..

Amino acid score (AAS) :-

It is a measure of the concentration of each essential amino acid in the test protein expressed as a percentage of that amino acid in the reference protein such as Egg or Milk or a provisional amino acid pattern.

The AAS do not take the digestibility of the protein and absorption of amino acid into account, and thus, actual utilization from a given food might differ.

The score is calculated from the following equation:-

$$\text{Amino acid score} = \frac{\text{mg of amino acid in 1 gm of test protein}}{\text{mg of amino acid in 1 gm of reference protein}} * 100$$

Methods of evaluating protein quality cont..

Net Protein utilization (NPU) :-

It is the proportion of food nitrogen that is retained in the body under standard conditions.

It is the product of digestibility coefficient and biological value divided by 100.

The NPU gives a more complete expression of protein quality then AAS.

When food proteins are completely digested, the NPU and BV would be the same

Methods of evaluating protein quality cont..

Net dietary protein calories percent (PE ratio) :-

It relates protein quality to energy intake.

Dietary protein is expressed as percentage of total calories rather than as that of total weight and is calculated as

$$\text{N D p Cal \%} = \frac{\text{Protein calories}}{\text{Total calorie intake}} * 100 * \text{NPU}$$

A diet providing less than 5% or 8% of the calories from proteins dose not meet the protein requirement of an adult or child, respectively.

Methods of evaluating protein quality cont..

Protein digestibility corrected amino acid score (PDCAAS) :-

- It is the amino acid score corrected for the digestibility of the protein
- **It** is a method of evaluating the protein quality based on both the amino acid requirements of humans and their ability to digest it.
- The PDCAAS rating was adopted by the US Food and Drug Administration (FDA) and the Food and Agricultural Organization of the United Nations/World health Organization (FAO/WHO) in 1993 as "the preferred 'best'" method to determine protein quality.

- The formula for calculating the PDCAAS percentage is: (mg of limiting amino acid in 1 g of test protein / mg of same amino acid in 1 g of reference protein) x faecal true digestibility percentage.

Assessment of protein nutrition status

A battery of tests have been suggested to assess the state of protein nutrition. These include:-

1. Arm muscle circumference

   It should be more than 13.5 cm

2. The urinary creatinine-height index

   CHI=24 hr urine creatinine of patient/24 hr urine creatinine (normal child of same height). Level below 1 indicate severe malnutrition

3. Serum albumin levels

   Level below 2.5 gm/dl indicate severe malnutrition

4. Serum transferrin levels

   Level below 0.45 mg/ml indicate severe malnutrition

5. Total body nitrogen

   The ratio of Non essential and Essential AA increases

Disorders related with Protein

(a) Disorders due to deficiency of Protein

PROTEIN-ENERGY MALNUTRITION

Especially common in children in underdeveloped nations.

Major health and nutritional problem of our country

Manifest primarily by inadequate dietary intake of protein and energy

Insufficiency of food- the so called “FOOD GAP” appears to be the chief cause

It is estimated to be an underlying cause in 30 % of deaths among children under age 5.

Is also affect people who have suffered severe physical trauma that increases protein needs (for example, extensive skin burns)

Disorders related with Protein cont…

There are 2 types of protein-energy malnutrition:

1. Marasmus

- A state of semi-starvation that can occur in people of all ages who have limited access to food, but is most common in non-breastfed children given diluted infant formula.
- Weight loss, severe muscle wasting, severe loss of visible fa stores, weakness, fatigue and frequent infections are the symptoms.

Disorders related with Protein cont…

2. Kwashiorkor

- A Ghanaian word for "the evil spirit that infects the child".
- Was first described in 1933 and typically occurs in children younger than 4 years old, fed diets high in carbohydrates with little or no protein.
- Muscle wasting, edema (fluid retention), low wt. for height, diffuse pigmentation, sparse hair and an enlarged and fatty liver, with the preservation of visible fat stores are its symptoms.

Disorders related with Protein cont…

Some other effects of protein deficiencies are:

- Edema
- Weak immune system.
- Weight loss
- Thinning or brittle hair and hair loss
- Ridges or deep lines in finger and toe nails
- Skin becomes very light, burns easily in the sun

Disorders related with Protein cont…

- Reduced pigmentation in the hair on scalp and body
- Skin rashes, dryness, flakiness
- General weakness and lethargy
- Muscle soreness, weakness and cramps
- Slowness in healing wounds, cuts, scrapes, and bruises
- Bedsores and other skin ulcers

Management of PEM

There is no simple solution to the problem of PEM, many types of action are necessary

The following method is adopted from the 8th Food and Agriculture Organization of United Nations and WHO expert committee on nutrition for the prevention of PEM in the community

- **Health promotion**

  Measure directed to pregnant and lactating women

  Promotion of breast feeding

  Development of low cost weaning food

  Nutrition education

  Family planning and spacing of birth

Management of PEM cont…

- **Specific protection**

  The child diet must contain protein and energy rich foods, milk, eggs, fresh fruits should be given if possible

  Immunization

  Food fortification

- **Early diagnosis and treatment**

  Periodic surveillance

  Early diagnosis and treatment of infections and diarrhoea

  Deworming of heavily infested children

  Development of supplementary feeding programmes during epidemics.

  Family planning and spacing of birth

- **Rehabilitation**

  Nutritional rehabilitation services

  Hospitalization

  Follow up care

Disorders related with Protein cont…

(b)Disorders due to excessive intake of Protein

- The effect of excessive dietary intake of protein have not been studied extensively and the findings are uncertain or equivocal.
- It increases obligatory fluid loss, may lead to dehydration.
- High protein intake especially casein, in infants can result in acidosis and aminoacidemia.
- In adult it is associated with Heart diseases, obesity and colon cancer.
- Bone-demineralization, which will lead to osteoporosis and kidney stone formation.

References

- Park's Text book of preventive and social Medicine, K. Park
- Text book of preventive and social Medicine, Piyush and O P Gahi
- Essential pediatrics, O P Gahi
- Text book of Public health and Community Medicine, AFMC and WHO
- Basics of Clinical Nutrition by YK Joshi
- Hand Book of Pediatric nutrition
- Public Health & Preventive Medicine- Wallace/Maxcy-Rosenau-Last
- Nutrients requirements and recommended dietary allowance for Indians. A Report of the Expert Group of the Indian Council of Medical Research 2009
- Dietary protein quality evaluation in human nutrition. Report of an FAO Expert Consultation.
- Recent developments in protein quality evaluation by E. Boutrif
- www.ncbi.nlm.nit.gov/pubmed

Thank you