# Nutrition and Food Evaluation

# PROTEIN


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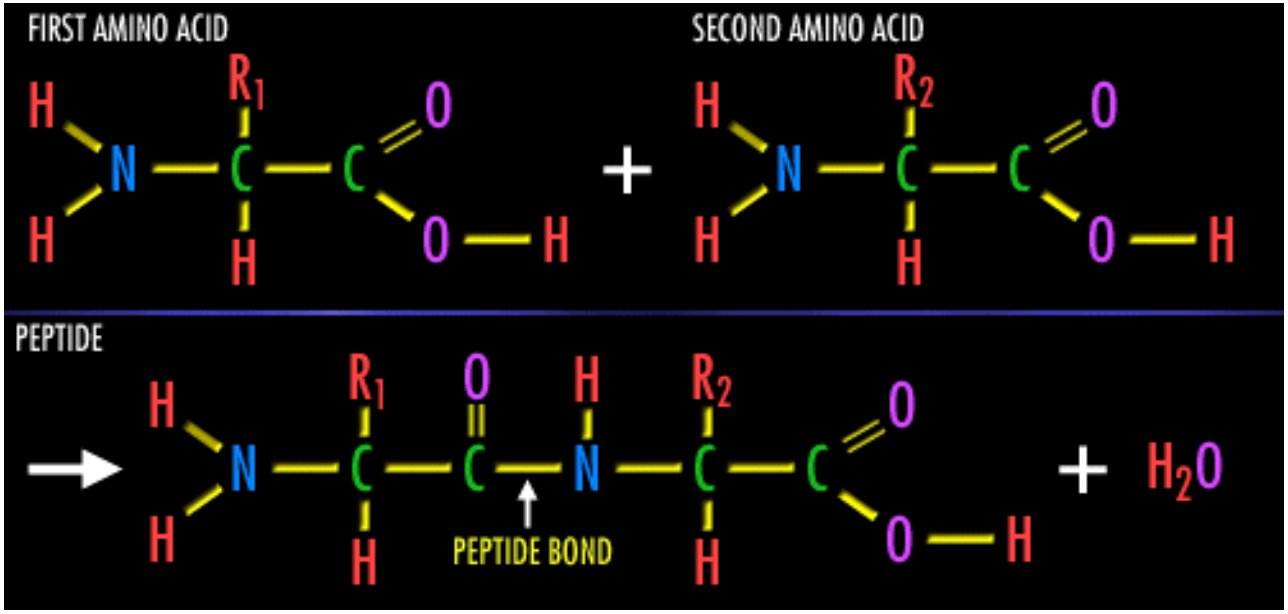
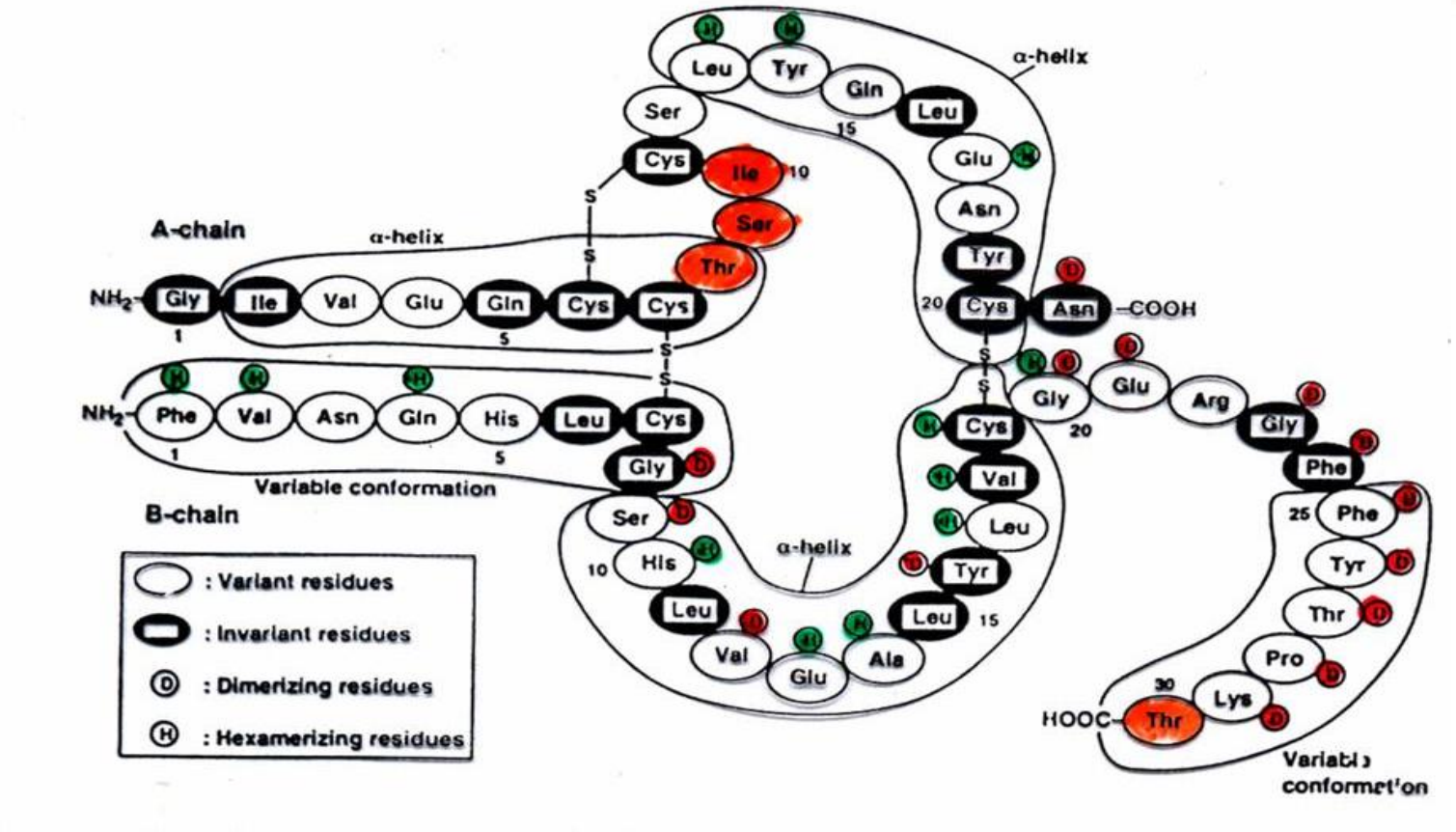
# Protein

- Complex Nutrition compound that contains of Nitrogen molecule, composed from amino acids with peptide bond.
- Protein has amina group (NH2) -> distinguished from Carbohydrate and Lipid
- Synthesize in plant and animal tissue

# Protein


FIRST AMINO ACID
SECOND AMINO ACID
PEPTIDE
PEPTIDE BOND
$H_2O$

# Protein


A-chain
α-helix
NH2
Gly
Ile
Val
Glu
Gln
Cys
Cys
Phe
Val
Asn
Gln
His
Leu
Cys
Gly
Variable conformation
B-chain
Leu
Tyr
Gln
Leu
Ser
Cys
Ile
Ser
Thr
Glu
Asn
Tyr
Cys
Asn
COOH
Gly
Glu
Arg
Gly
Phe
Cys
Val
Leu
Tyr
Leu
Val
Glu
Ala
His
Leu
Ser
α-helix
α-helix
Phe
Tyr
Thr
Pro
Lys
Thr
HOOC
: Variant residues
: Invariant residues
: Dimerizing residues
: Hexamerizing residues

# Protein Function

1. Essential for growth and tissue care
2. Essential compound precursor (enzyme, hormone, hemoglobin, neurotransmitter
3. Control body liquid  balance (intracellular liquid, extracellular liquid and intravascular liquid)

# Protein Function

4. Maintain accumulation of acid/base
5. Stimulate antibody production
6. Nutrient transporter (carrier protein)
7. Energy source (4kkal/gr)

# Protein Classification

Source :

1. Endogen protein : body tissue
2. Eksogen protein : diet

Synthesize :

1. Essential protein
2. Non essential protein

# Protein Classification

- Essential :

  Leu, Ile, Val, Trp, Phe, Thr, Lis, His, Met
- Conditional Essential :

  Pro, Ser, Arg, Cys, Gly, Tyr
- Non Essential :

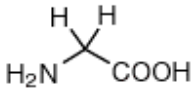
  Ala, Gln, Glu, Asp, Asn

# Protein Classification

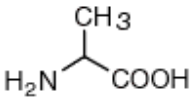
Amino Acid Precursor

- Met, Ser : Cys
- Phe : Tyr
- Glu, Gln, Asp : Arg
- Glu : Pro
- Ser : Gly

## Small

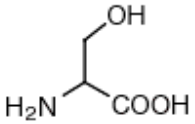


Glycine (Gly, G)
MW: 57.05

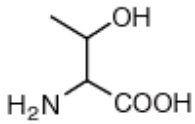


Alanine (Ala, A)
MW: 71.09

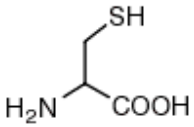
## Nucleophilic



Serine (Ser, S)
MW: 87.08, $pK_a$ ~ 16

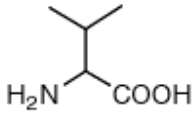


Threonine (Thr, T)
MW: 101.11, $pK_a$ ~ 16

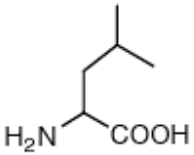


Cysteine (Cys, C)
MW: 103.15, $pK_a$ = 8.35

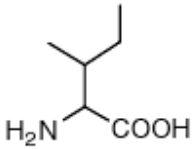
## Hydrophobic



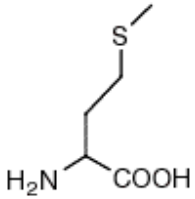
Valine (Val, V)
MW: 99.14



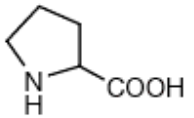
Leucine (Leu, L)
MW: 113.16



Isoleucine (Ile, I)
MW: 113.16

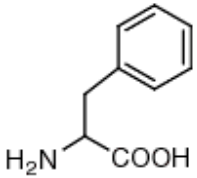


Methionine (Met, M)
MW: 131.19

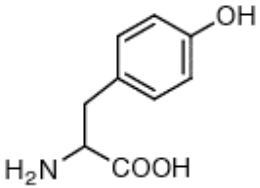


Proline (Pro, P)
MW: 97.12

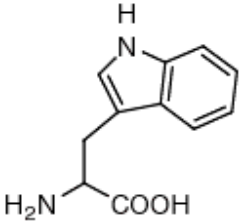
## Aromatic



Phenylalanine (Phe, F)
MW: 147.18

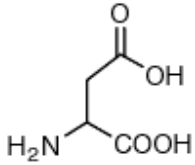


Tyrosine (Tyr, Y)
MW: 163.18

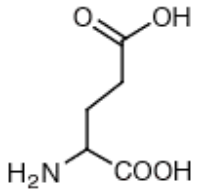


Tryptophan (Trp, W)
MW: 186.21

## Acidic

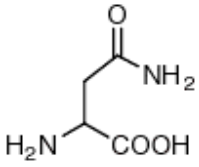


Aspartic Acid (Asp, D)
MW: 115.09, $pK_a$ = 3.9

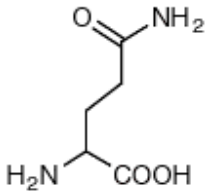


Glutamic Acid (Glu, E)
MW: 129.12, $pK_a$ = 4.07

## Amide

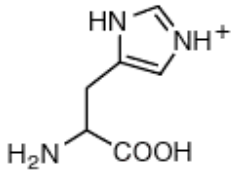


Asparagine (Asn, N)
MW: 114.11

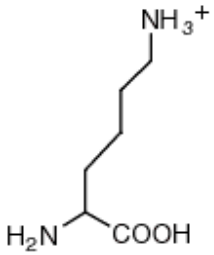


Glutamine (Gln, Q)
MW: 128.14

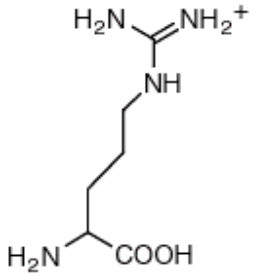
## Basic



Histidine (His, H)
MW: 137.14, $pK_a$ = 6.04



Lysine (Lys, K)
MW: 128.17, $pK_a$ = 10.79



Arginine (Arg, R)
MW: 156.19, $pK_a$ = 12.48

# Protein Classification

Amino Acid Function :

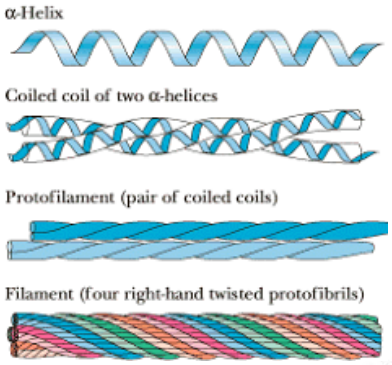
- Incomplete protein

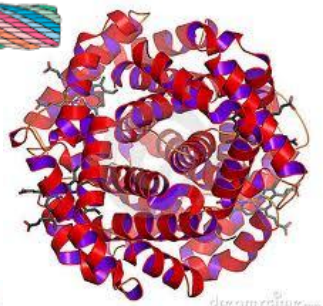
  ex. Zein (jagung)
- Complete protein

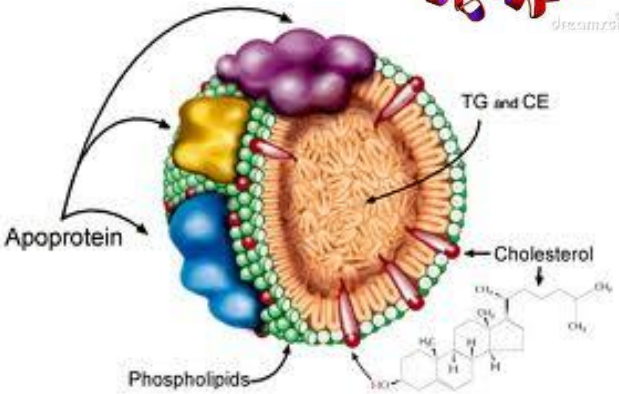
  ex. Glisin (soy), glutenin (wheat), animal prot
- Partially complete protein

  ex. Gliadin (wheat), legumin (beans)

# Protein Classification






Protein Form:

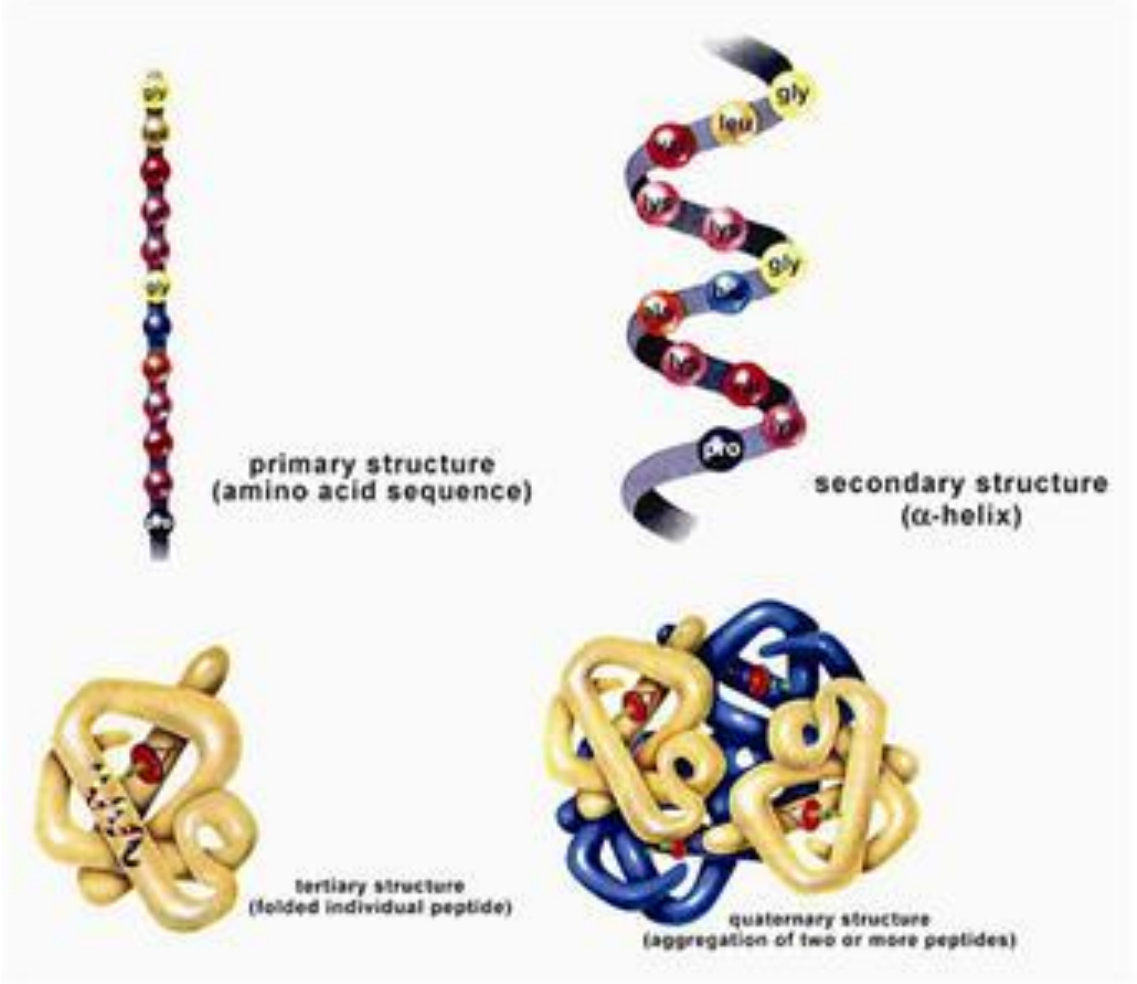
- Fibrous : higher mechanical stress, low solubility

  ex. Collagen, elastin, keratin, miosin
- Globular : more soluble, easy denatured

  ex. Albumin, globulin, histon, protamin
- Conjugated protein (bounded to prosthetic groups)

  ex. Lipoprotein, phosphoprotein, nucleoprotein

# Protein Structure



# Protein Denaturation

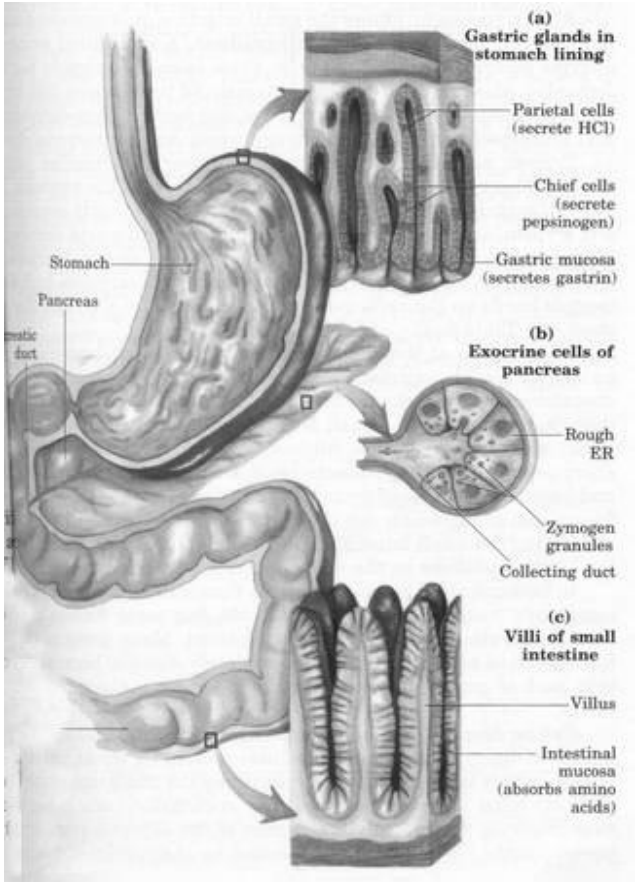
Denaturation

- is a process in which proteins lose the tertiary structure and secondary structure then present in their native state,
- by application of some external stress or compound such as a strong acid or base, a concentrated inorganic salt, an organic solvent (e.g., alcohol or chloroform), or heat
- Increase the protein digestibility

# Protein Digestion

Gastric digestion

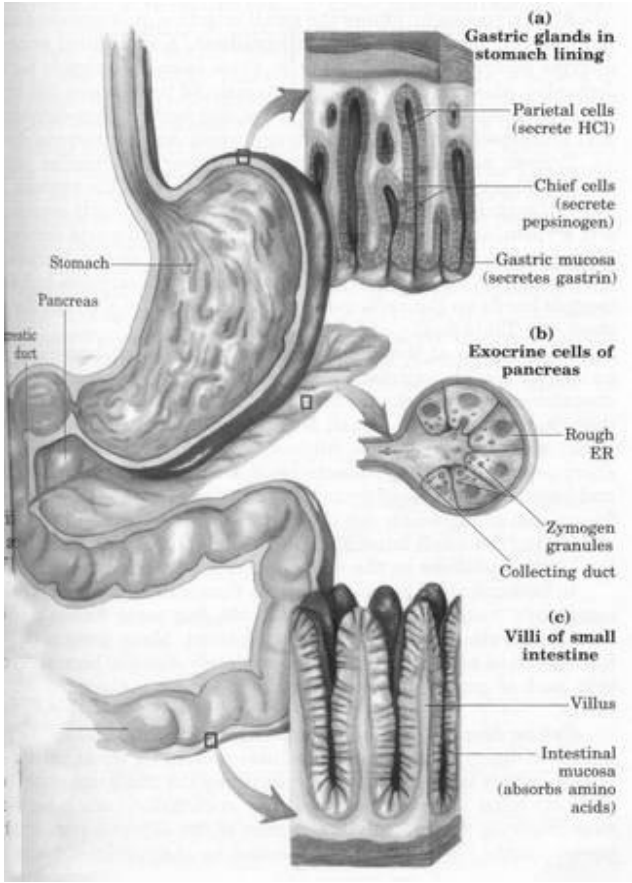
- Parietal cell -> HCl : protein denaturation
- Chief cell -> proenzym of Protease gastric : pepsinogen (activated by HCl) -> pepsin
- Cleavage the peptide bond -> polipeptide, proteose, pepton



# Protein Digestion

Small Intestine (Duodenum)

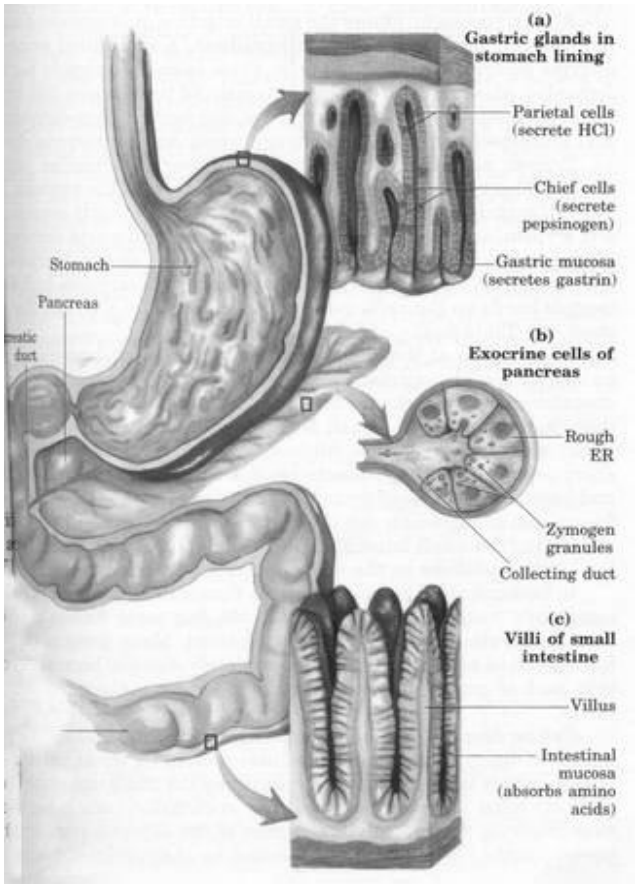
- Proenzym of pancreatic protease (trypsinogen, chemotrypsinogen, proelastase, procarboxypeptidase)
- Activated by enterokinase enzym of mucosa cell and tripsin
- Digestion : 30% amino acid, 70 % (dipeptide, tripeptide and more)



# Protein Digestion

Small Intestine (Jejunum)

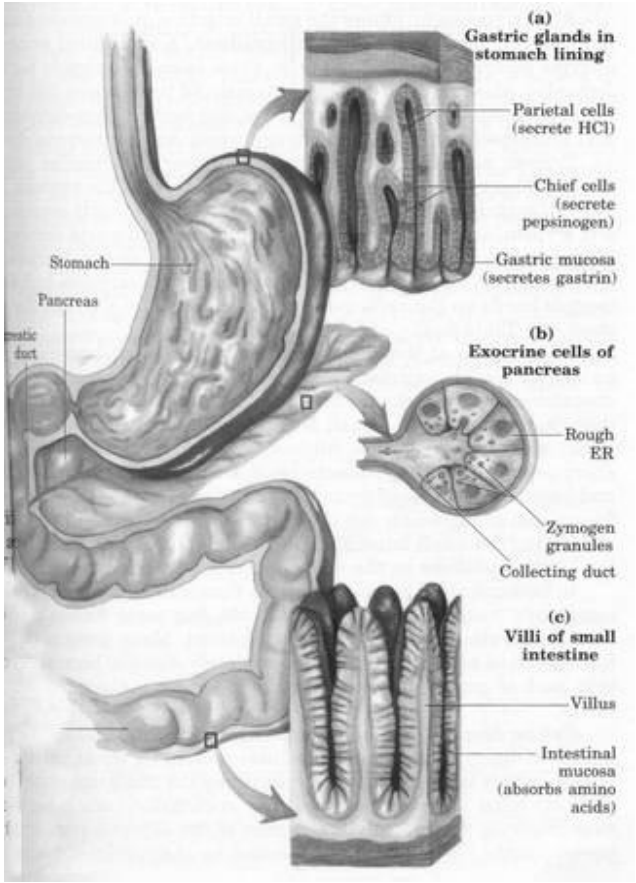
- Protease (carboxypeptidase and aminopeptidase : di and tripeptidase)
- Digestion : dipeptide



# Protein Digestion

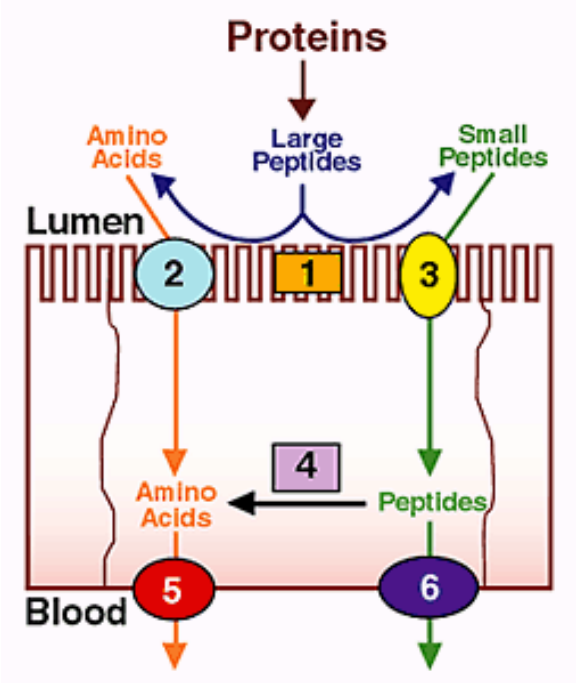
Small Intestine (Ileum)

- Protease (carboxypeptidase, aminopeptidase and dipeptidase)
- Digestion : amino acid
- Absorption

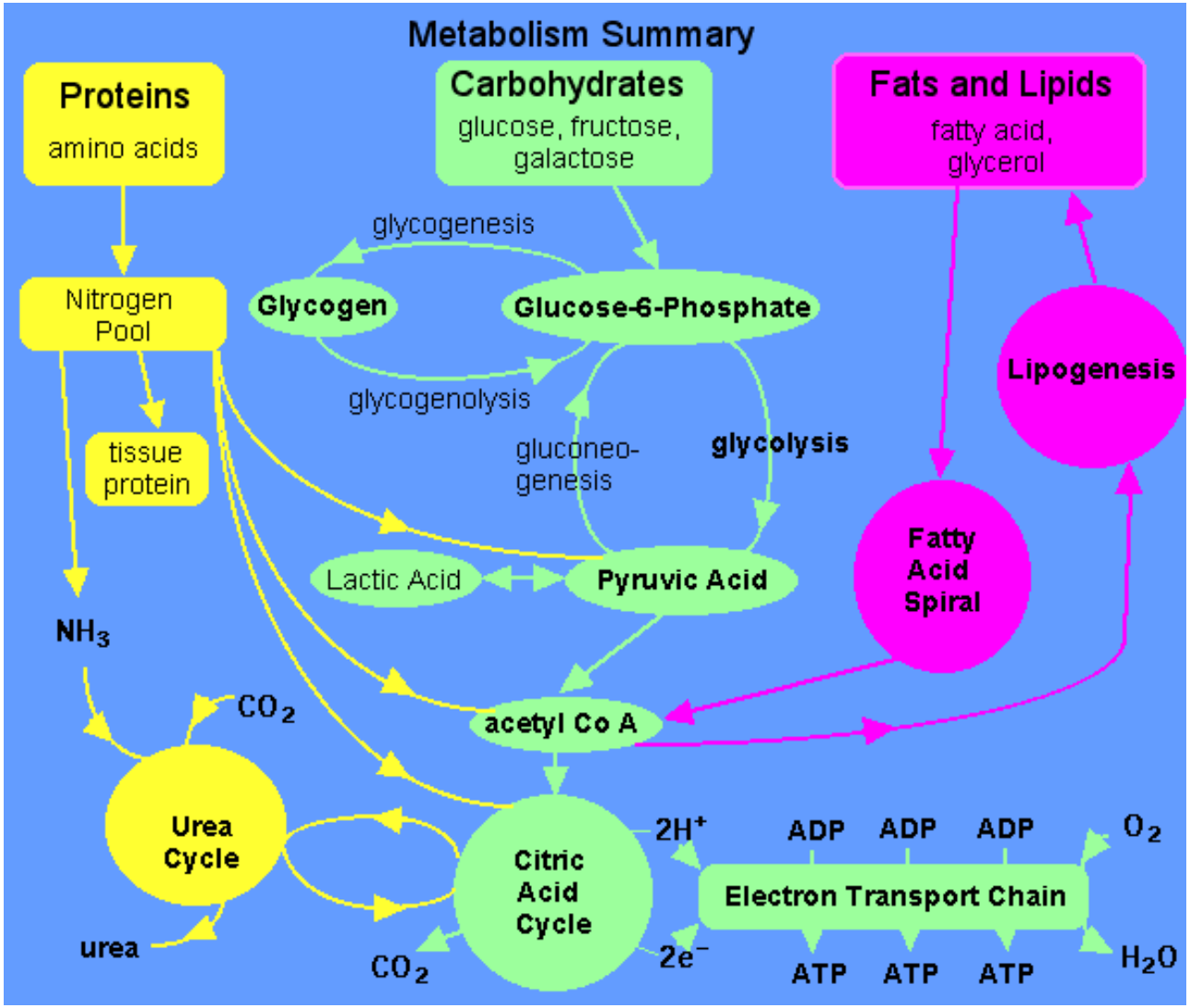


# Protein Absorption & Transport

- Amino acid absorp by the villy of ileum mucosa -> diffusion and active transport
- Distribute to amino acid pool (blood and intracellular tissue)
- Transport through blood to the liver and circulate to the cells all over the body



# Protein Metabolism



# Protein Metabolism

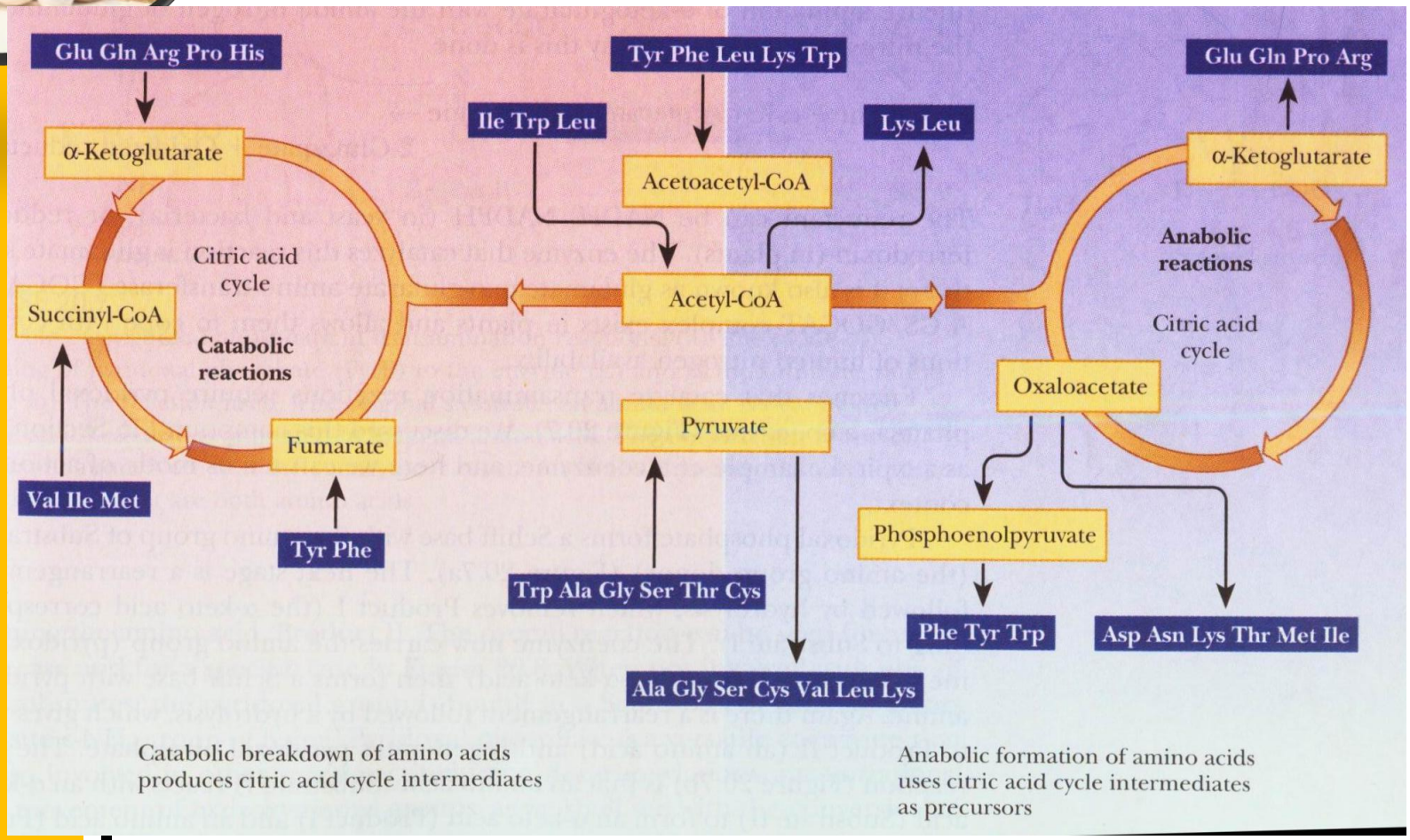
Liver

- Amino acid Oxidation
- Synthesize plasma protein
- Protein deamination -> urea from urine

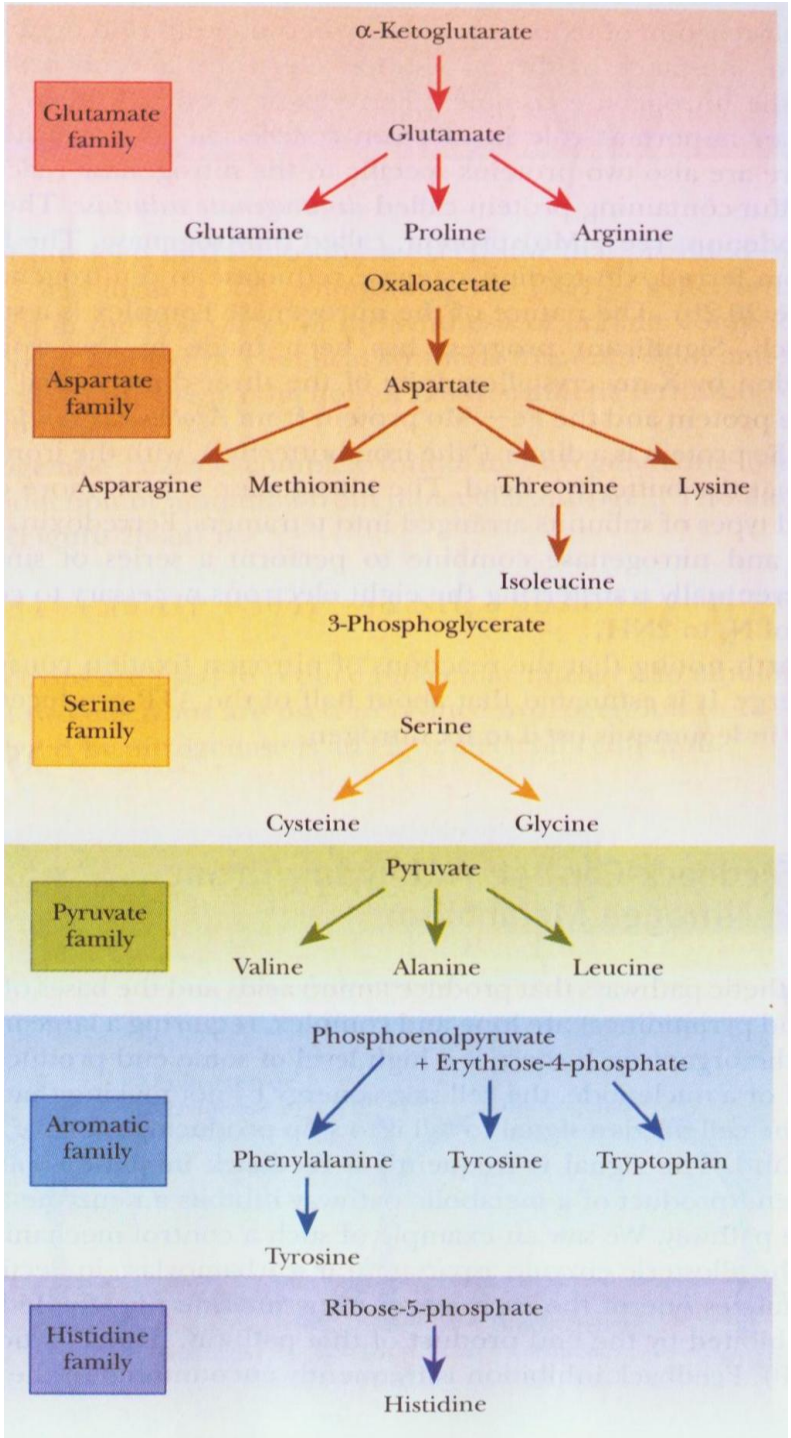
Cell

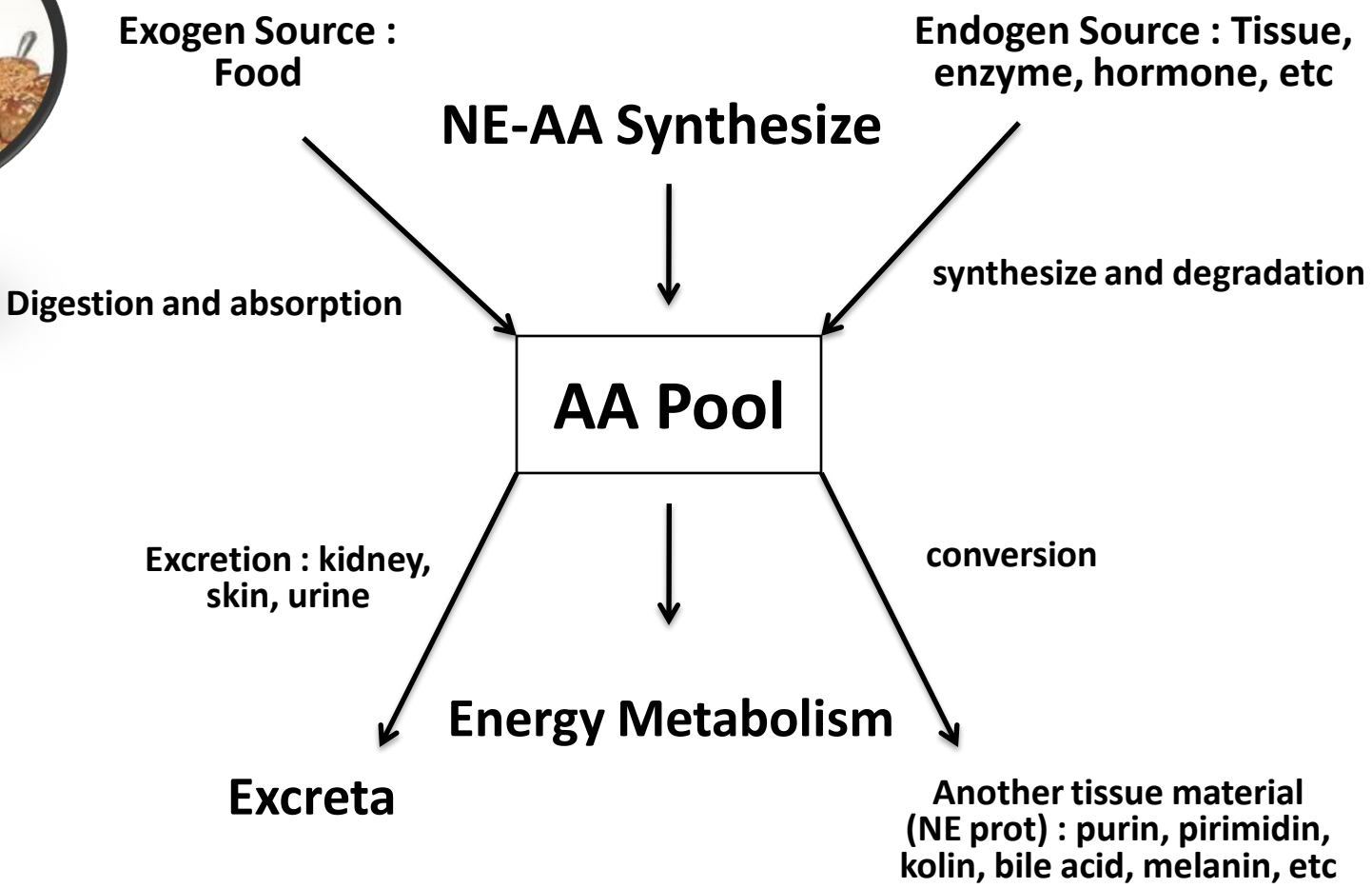
- Synthesize new protein
- High protein content will recirculate to liver
- Deaminated amino acid will go to energy metabolism (ketogenic acid)

# Protein Metabolism



# Protein Metabolism




Exogen Source : Food
Endogen Source : Tissue, enzyme, hormone, etc
NE-AA Synthesize
Digestion and absorption
synthesize and degradation
AA Pool
Excretion : kidney, skin, urine
conversion
Energy Metabolism
Excreta
Another tissue material (NE prot) : purin, pirimidin, kolin, bile acid, melanin, etc

# Nutrition Value of Protein

Based on :

- Essential amino acid
- Amino acid balance
- Fitness to purpose
- Digestibility

# Protein Digestibility

Influenced by :

- Processing technique
- Anti-nutrition compound
- Reaction between protein and another compound

# Nilai Gizi Protein

1. Amino acid

- Essential Amino Acid
- Amino acid balance
- Limiting Amino Acid

  Nuts : metionin, Cerealia : lisin

# Evaluasi Nilai Gizi Protein

1. Teoritis

   nilai biologis suatu protein dibatasi oleh proporsi relative asam amino esensial yang terkandung di dalamnya

- Skor Asam Amino

  membandingkan kandungan AA antara bahan uji dengan protein patokan (AA yg paling defisien)

- PDCAAS (Protein Digestibility Corrected Amino Acid Score )

  Peringkat kualitas protein ditentukan dengan cara membandingkan profil asam amino protein dari makanan tertentu terhadap standar profil asam amino

- Skor Asam Amino

= mg AA per gram protein uji x 100

mg AA yang sama per gram protein patokan

- PDCAAS = Skor AAE terendah x DC prot sejati

| Protein | PER | Digestibility | AAS | PDCAAS |
|---|---|---|---|---|
| Egg | 3.8 | 98 | 121 | 118 |
| Cow's milk | 3.1 | 95 | 127 | 121 |
| Beef | 2.9 | 98 | 94 | 92 |
| Soy | 2.1 | 95 | 96 | 91 |
| Wheat | 1.5 | 91 | 47 | 42 |

# Evaluasi Nilai Gizi Protein

2. In Vitro

Uji invitro : murah, singkat

- Penentuan aktivitas antitripsin dan antikimotripsin

  (Berdasarkan penurunan aktivitas hidrolisis tripsin pada suatu substrat)
- Penentuan aktivitas hemaglutinin

  (aktivitas hemaglutinin ekstrak kacang-kacangan didasarkan pada kemampuannya untuk mengaglutinasi sel darah merah)
- Penentuan daya cerna protein

  (pepsin-tripsin, pepsin-pankreatin dan teknik multienzim : tripsin, kimotripsin dan peptidase)

# Evaluasi Nilai Gizi Protein

3. In Vivo

Uji invivo : hewan coba & manusia (biologis)

- Protein Efficiency Ration (PER)
- Net Protein Ratio (NPR)
- Biological Value (BV)
- Net Protein Utilization (NPU)
- Daya Cerna Sejati (DC Sejati) / True digestibility

# Evaluasi Nilai Gizi Protein

PER

- Metode ini dikembangkan oleh Osborne, Mendel dan Ferry tahun 1919, merupakan evaluasi nilai gizi protein yang banyak digunakan.
- Telah ditetapkan sebagai metode resmi FDA untuk penetapan mutu protein dalam *nutrition labelling*.
- PER dilakukan selama 28 hari pada hewan coba tikus, menggunakan jenis pakan standart (AIN/ANRC).

# Evaluasi Nilai Gizi Protein

PERHITUNGAN PER ⇨

$$\text{PER} = \frac{\text{Pertambahan berat badan}}{\text{Jumlah protein yang dikonsumsi}}$$

⇩

Perhitungan PER ⇨ dihitung untuk tiap ekor tikus
rata-ratanya untuk tiap group/kelompok.

⇩

Nilai PER kontrol
(ransum kasein)
atau PER kasein dikoreksi

⇨

$$\frac{2.5}{\text{PER kasein yang diperoleh}}$$

# Evaluasi Nilai Gizi Protein

PER

- PER sampel = perub BB / jumlah protein konsumsi
- PER kasein terkoreksi =  2.5 / PER kasein teranalisis
- PER terkoreksi = PER sampel / PER kasein terkoreksi

# Evaluasi Nilai Gizi Protein

NPR

- NPR dikembangkan untuk memecahkan masalah teoritis pada PER, dimana dalam penetapan PER semua protein yang dikonsumsi diasumsikan digunakan semua untuk pertumbuhan, tidak mengantisipasi fungsi protein pemeliharaan.
- Pelaksanaan NPR sama dengan PER, hanya terdapat grup tikus yang diberi ransum non protein dan lama waktu NPR hanya 10 hari

$$NPR = \frac{\text{Pertambahan berat (protein yang diuji)} - \text{Penurunan berat (non protein)}}{\text{Konsumsi protein yang diuji}}$$

# Evaluasi Nilai Gizi Protein

BV, DC dan NPU

- Metode ini dikembangkan untuk mengevaluasi protein secara biologis dengan menggunakan subjek manusia, namun pada perkembangan selanjutnya metode BV ini diadopsi untuk dilakukan pada hewan coba tikus

# Evaluasi Nilai Gizi Protein

$$BV = \frac{N\ konsumsi - (N\ feses - N\ metabolik) - (N\ urin - N\ endogen)}{N\ konsumsi - (N\ feses - N\ metabolik)}$$

$$D = \frac{N\ konsumsi - (N\ feses - N\ metabolik)}{N\ konsumsi}$$

# Evaluasi Nilai Gizi Protein

NPU

perbandingan antara jumlah nitrogen yang diretensi dalam tubuh dengan jumlah nitrogen yang dikonsumsi.

$$\text{NPU} = \frac{\text{N konsumsi} - (\text{N feses} - \text{N metabolik}) - (\text{N urine} - \text{N endogen}) \times 100}{\text{N yang dikonsumsi}}$$

# Studi Kasus

1. Jelaskan bagaimana kecernaan protein untuk produk dendeng dan tauge !

2. Hitung nilai PER terkoreksi dari bahan XY jika diketahui PER kasein teranalisis 2,35. Perubahan berat badan tikus rata-rata dari 213 g menjadi 249 g selama masa pemeliharaan 30 hari dengan asupan pakan XY. Rerata jumlah konsumsi pakan 19.5 gr/hari dan kadar protein bahan XY adalah 76%.

3. Jelaskan arti nilai PER dari soal no 2 tersebut!

4. Tentukan nilai NPR soal no. 2 jika diketahui pada kelompok kontrol terjadi penurunan BB tikus sebanyak 5 gr selama masa pemeliharaan!


ANY
questions?