PROTEIN

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Introduction

- A major component of food is PROTEIN
- The protein ingested as part of our diet are not the same protein required by the body
- Only 40 to 50 gr of protein is required by a normal adults

→supply essential amino acids

→replace the amino acid nitrogen converted to urea

AMINO ACIDS	
NON-ESSENTIAL	**ESSENTIAL**
Alanine	Arginine
Asparagine	Histidine
Aspartate	Isoleucine
Cysteine	Leucine
Glutamate	Lysine
Glutamine	Methionine
Glycine	Phenylalanine
Proline	Threonine
Serine	Tryptophan
Tyrosine	Valine

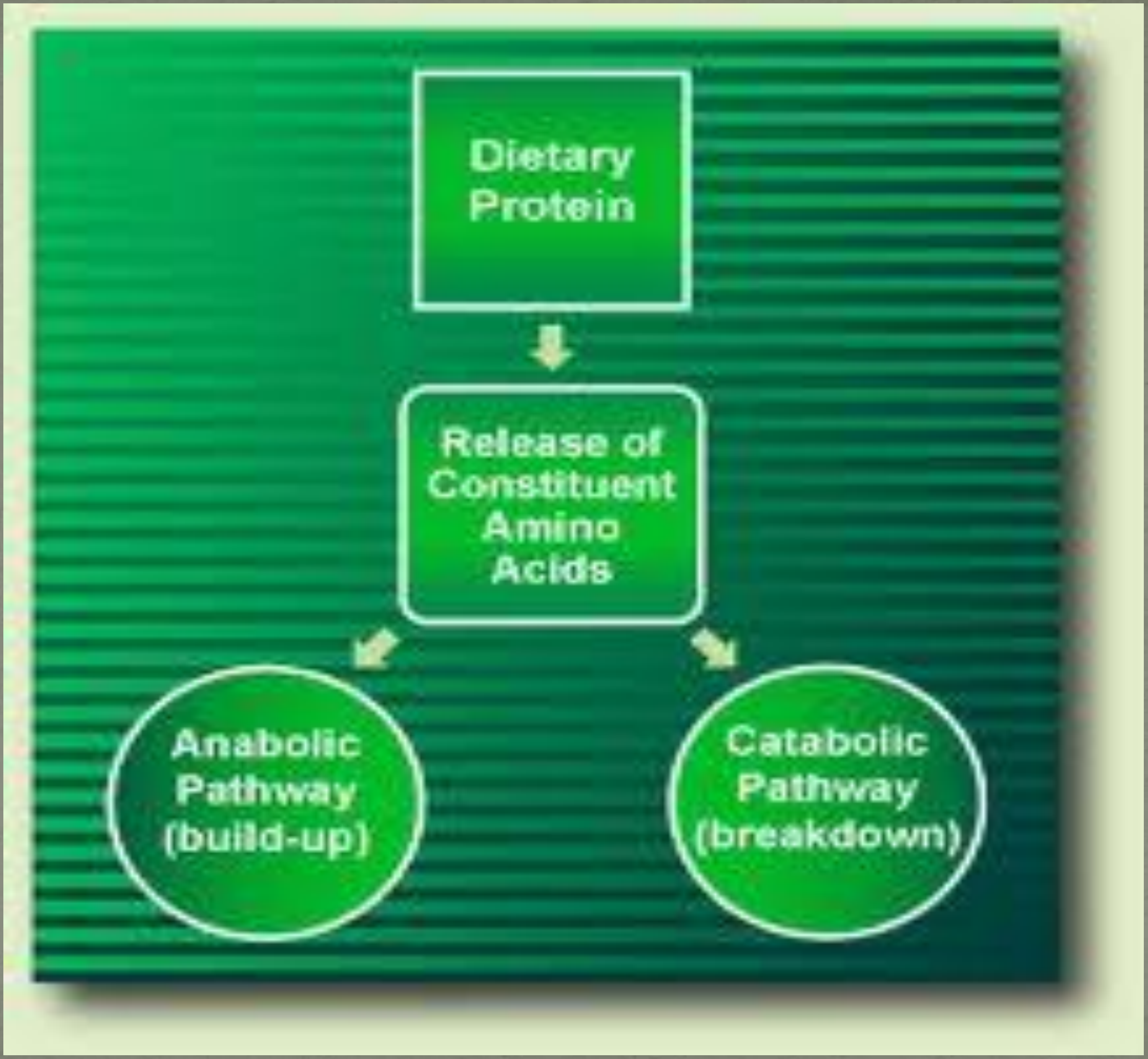
Amino acid synthesis

- Amino acid than can be synthesised in the human body: Non Essential

→Synthesised from the products of their catabolism (acetyl CoA, pyruvate)

- Amino acid than must be supplied in the diet: Essential

→ Synthesised in micro organism (bacteria) and passed through the food chain


Dietary Protein
Release of Constituent Amino Acids
Anabolic Pathway (build-up)
Catabolic Pathway (breakdown)

Facts about protein

- Proteins contain carbon, hydrogen, oxygen, **nitrogen** , and sometimes other atoms.
- They form the cellular structural elements, are **biochemical** catalysts, and are important regulators of **gene expression** .
- Nitrogen is essential to the formation of twenty different amino acids, the building blocks of all body cells.

Continue..

- Most of the protein is broken down into amino acids and absorbed by the small intestine
- Large molecules cannot be absorbed from the gut
- Therefore….these proteins are digested and their component amino acids absorbed into the blood stream

CONTINUE…

- Protein provides:

(1) Amino acids for protein synthesis

(2) Nitrogen atoms for nitrogen-containing compounds

(3) Energy → when carbohydrates and lipid resources are not available

CONTINUE..

- Amino acids are characterized by the presence of a terminal carboxyl group and an amino group in the alpha position, and they are connected by peptide bonds.

Uses of amino acid in the body

- **Protein synthesis**

- very important during growth

- In adults: new protein synthesis is directed towards replacement of proteins as they are constantly turned over

Continue…

- <u>**Synthesis of a variety of other compounds**</u>

→ Purines and pyrimidines
(components of nucleotides)
→ Catecholamines
(adrenaline and non-adrenaline)
→ Neurotransmitters (serotonin)
→ Histamine
→ Porphyrins
(central oxygen binding components of haemoglobin)

Continue…

- <u>As a biological fuel</u>

→10% energy production in humans is from amino acids.

→Higher in carnivores
(the diet is almost entirely protein)

Digestion & absorption

- Protein are broken down into small peptides and amino acids → absorbed in the small intestine

- In the stomach:

→ HCL – protein denaturation – activate pepsinogen digestive enzyme into pepsin

→ The break down of proteins to peptides and is catalyzed by pepsin

Digestion & absorption

- In the small intestine:

→The break down of protein to peptides is catalyzed by the pancreatic enzymes: trypsin and chymotrypsin

Digestion & absorption

- Peptides are broken down into amino acid by pancreatic carboxypeptidase and intestinal aminopeptidase
- Small peptides consisting of two or three amino acids that can be actively absorbed into epithelial cells
- Then…broken down into amno acid → released into the blood.

Digestion & absorption

- **Digestion breaks protein down to amino acids.**

- **If amino acids are in excess of the body's biological requirements**

→ they are metabolized to glycogen or fat and subsequently used for energy metabolism.

Digestion & absorption

- If amino acids are to be used for energy

→ their carbon skeletons are converted to acetyl CoA

→ which enters the Krebs cycle for oxidation, producing ATP.

→ The final products of protein catabolism include carbon dioxide, water, ATP, urea, and ammonia.

Digestion & absorption

- **Amino acid -- carbon skeleton:**

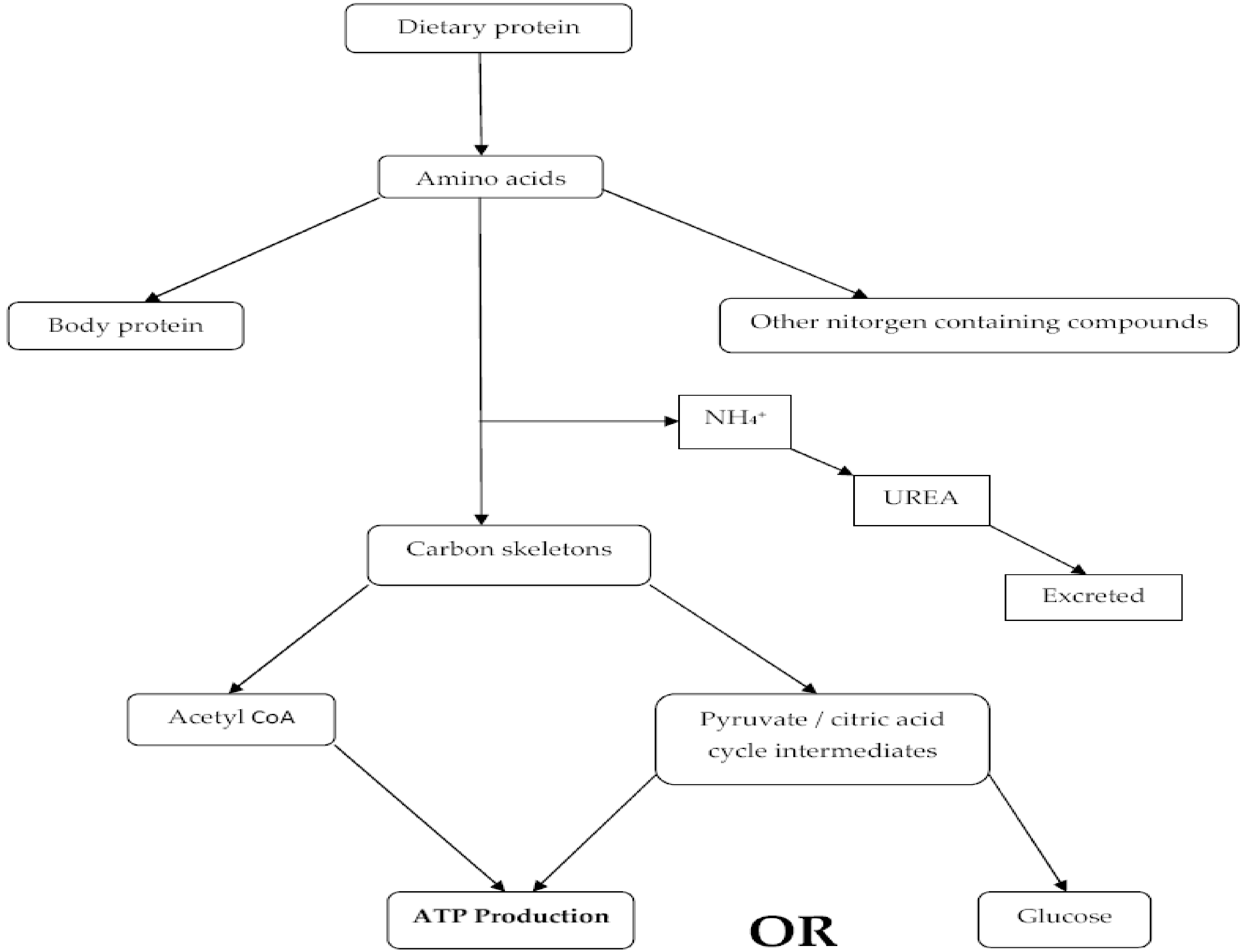
Acetyl CoA → TCA cycle CO2

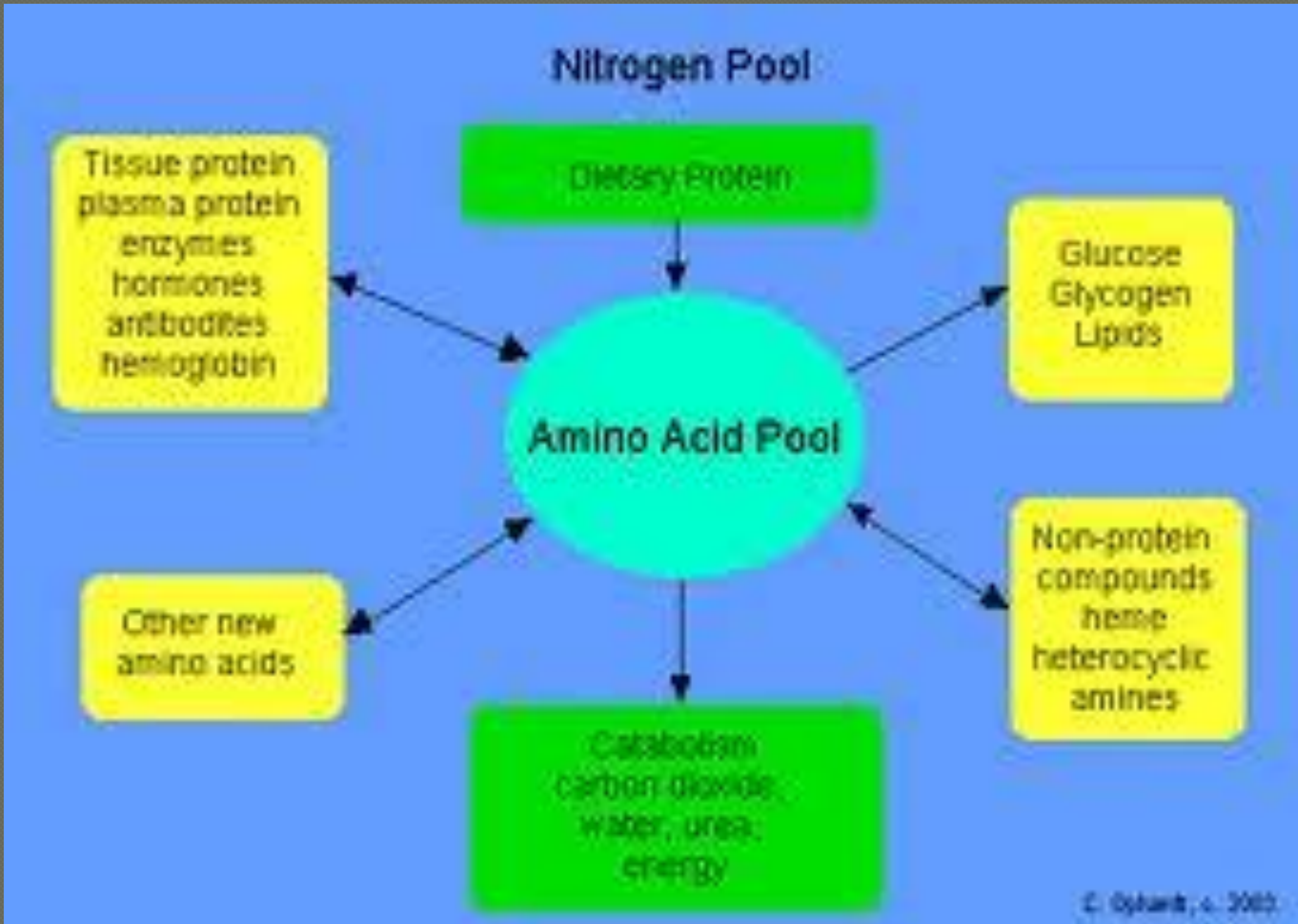
→ ketogenesis., lipogenesis

Pyruvate → TCA cycle

→ gluconeogenesis

AMINO ACID METABOLISM



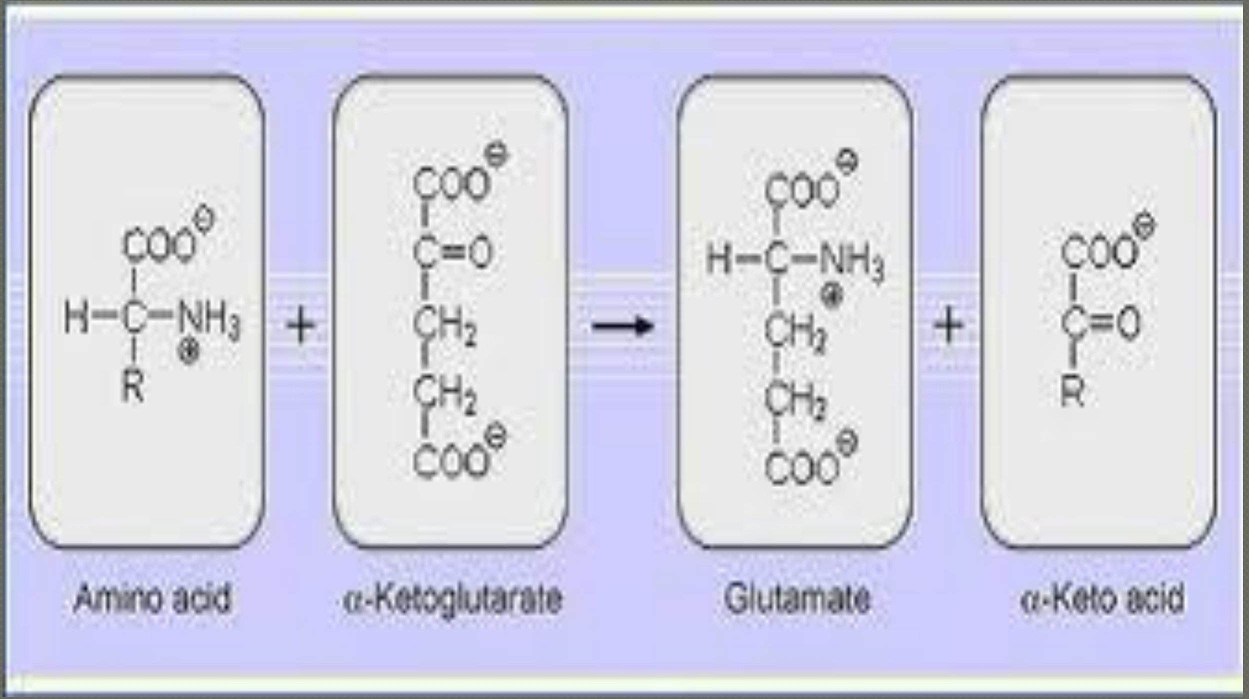

Nitrogen Pool
Dietary Protein
Tissue protein
plasma protein
enzymes
hormones
antibodies
hemoglobin
Glucose
Glycogen
Lipids
Amino Acid Pool
Other new
amino acids
Non-protein
compounds
heme
heterocyclic
amines
Catabolism
carbon dioxide,
water, urea,
energy

Digestion & absorption

- excess protein is not stored in the body
- reformed in the liver to compounds containing nitrogen, and compounds that do not contain the element nitrogen
- Then synthesized into UREA
- Urea is transported along with other waste substances to the kidneys and excreted in urine

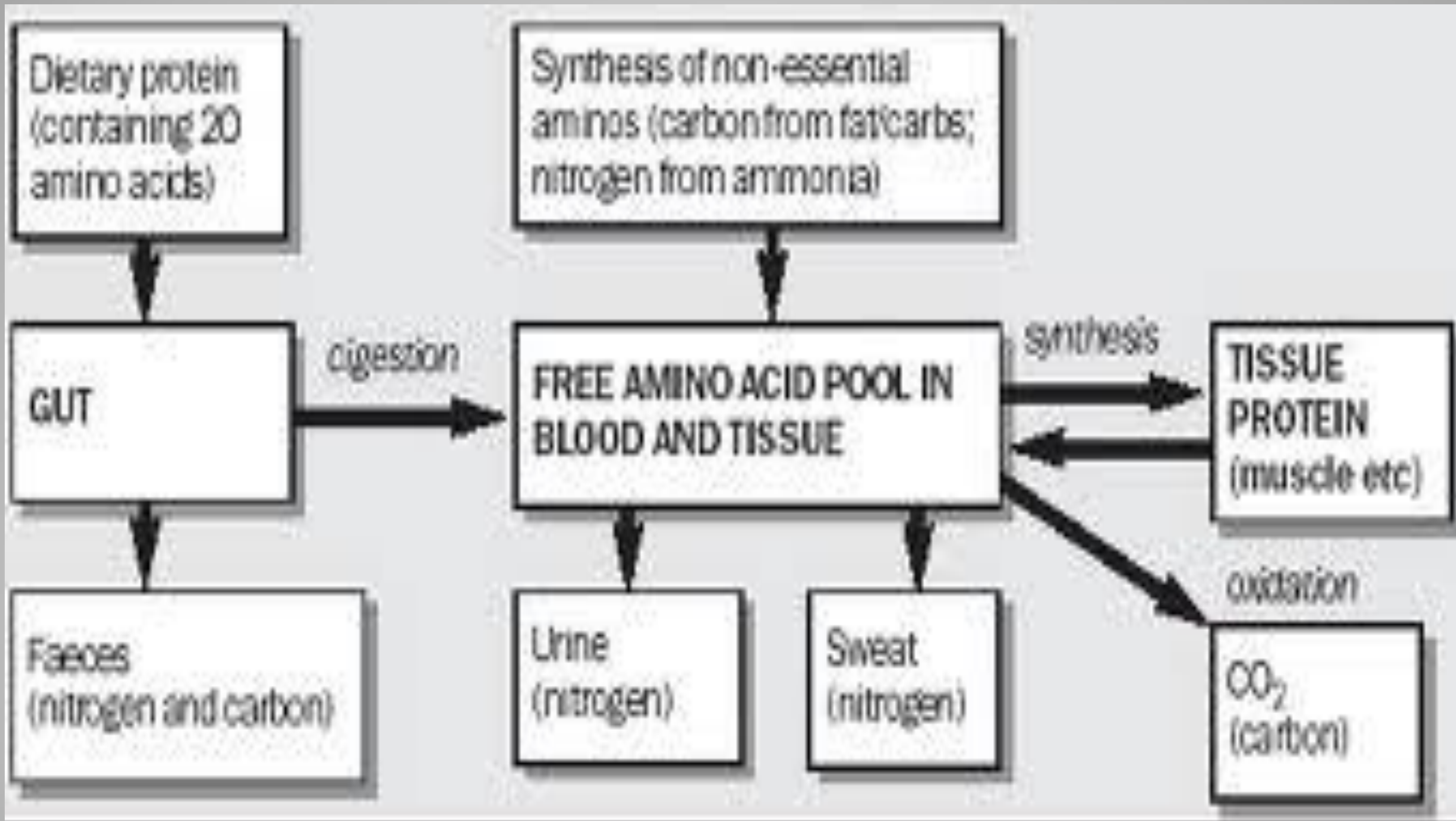
Digestion & absorption

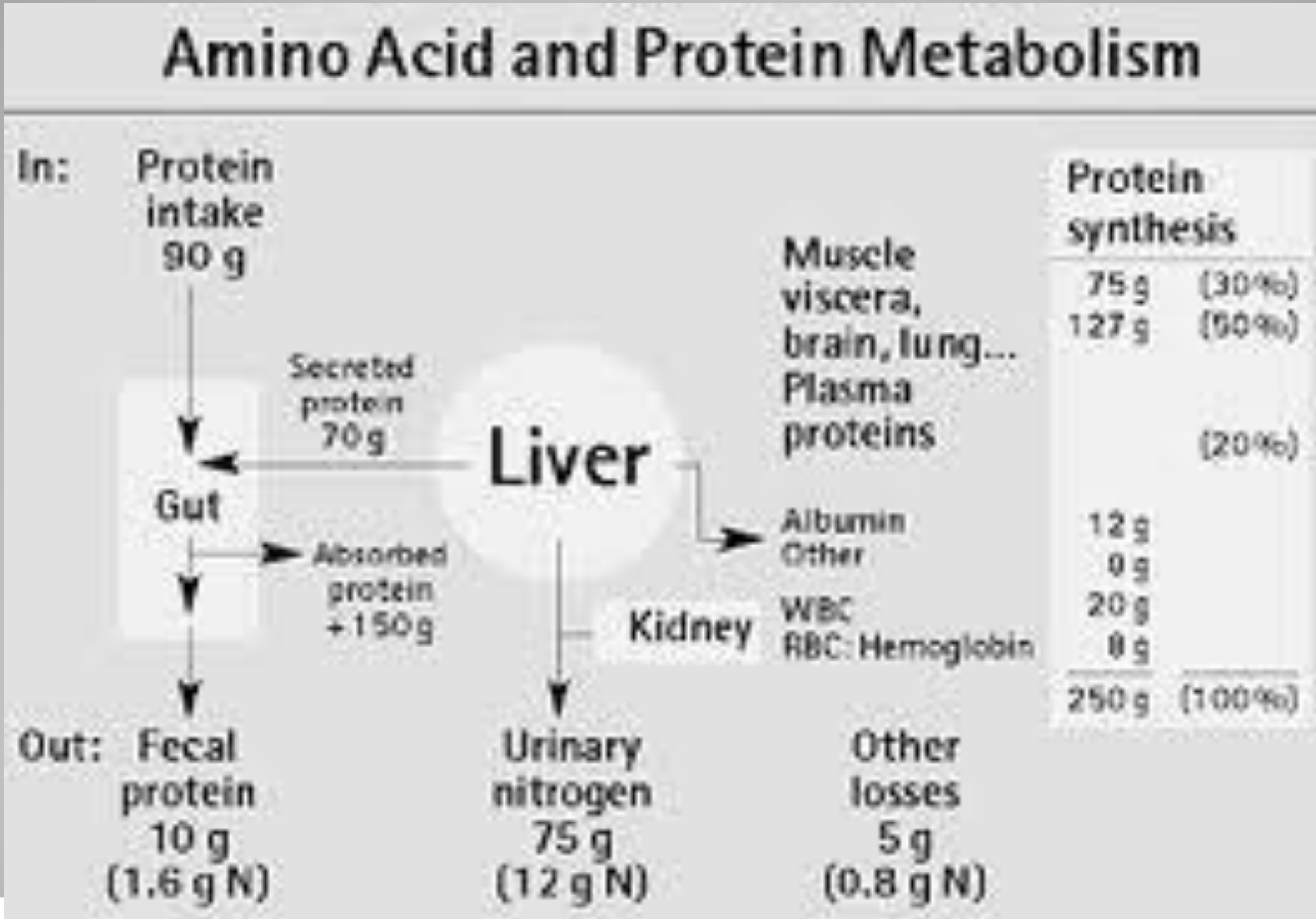
- Amino acids → "transamination"
- Together with glucagon →urea cycle



Digestion & absorption

- "Transamination"
  - → Amino acids – alpha ketoglutamate
- "oxidative deamination"
  - → to form Amomnia
  - → synthesis Urea


Dietary protein (containing 20 amino acids)
Synthesis of non-essential aminos (carbon from fat/carbs; nitrogen from ammonia)
GUT
digestion
FREE AMINO ACID POOL IN BLOOD AND TISSUE
synthesis
TISSUE PROTEIN (muscle etc)
oxidation
Faeces (nitrogen and carbon)
Urine (nitrogen)
Sweat (nitrogen)
CO_2 (carbon)


Amino Acid and Protein Metabolism
In:
Protein intake 90 g
Secreted protein 70 g
Liver
Gut
Absorbed protein +150g
Kidney
Muscle viscera, brain, lung...
Plasma proteins
Albumin
Other
WBC
RBC: Hemoglobin
Protein synthesis
75 g (30%)
127 g (50%)
(20%)
12 g
9 g
20 g
8 g
250 g (100%)
Out:
Fecal protein 10 g (1.6 g N)
Urinary nitrogen 75 g (12 g N)
Other losses 5 g (0.8 g N)

Summary

- Stomach

→HCl: denaturasi protein & activate pepsinogen

→Break down of protein (pepsin) into peptides / polypeptides

- Small intestine

→Break down of protein by pancreatic enzyme: trypsin, chymotrypsin, into peptides

Continue…

- Peptides → by carbosipeptidase & intestinal aminopeptidase → Amino acids
- Bring to duodenum, absorbed into epithelial cells
- Amino acid absorbed → cells → blood

Continue…

- If amino acids are in excess of the body's biological requirements:
  - →they are metabolized to glycogen or fat and subsequently used for energy metabolism.

- If amino acids are to be used for energy:
  1. Converted to acetyl CoA
  2. Converted to pyruvate

Continue…

- Converted to acetyl CoA:
  - →their carbon skeletons are converted to acetyl CoA
  - → enters the Krebs cycle for oxidation (ketogenesis. Lipogenesis)
- Converted to pyruvate:
  - →enters the Kreb cycle (gluconeogenesis)

From Kreb Cycle:

- →producing ATP
- →The final products of protein catabolism include carbon dioxide, water, ATP, urea, and ammonia.

Continue..

[Excess Protein – not stored in the body]

- Transamination → convert amino acid into alpha-keto glutamante
- Oxidative deamination → to form Ammonia

→ used for synthesis urea

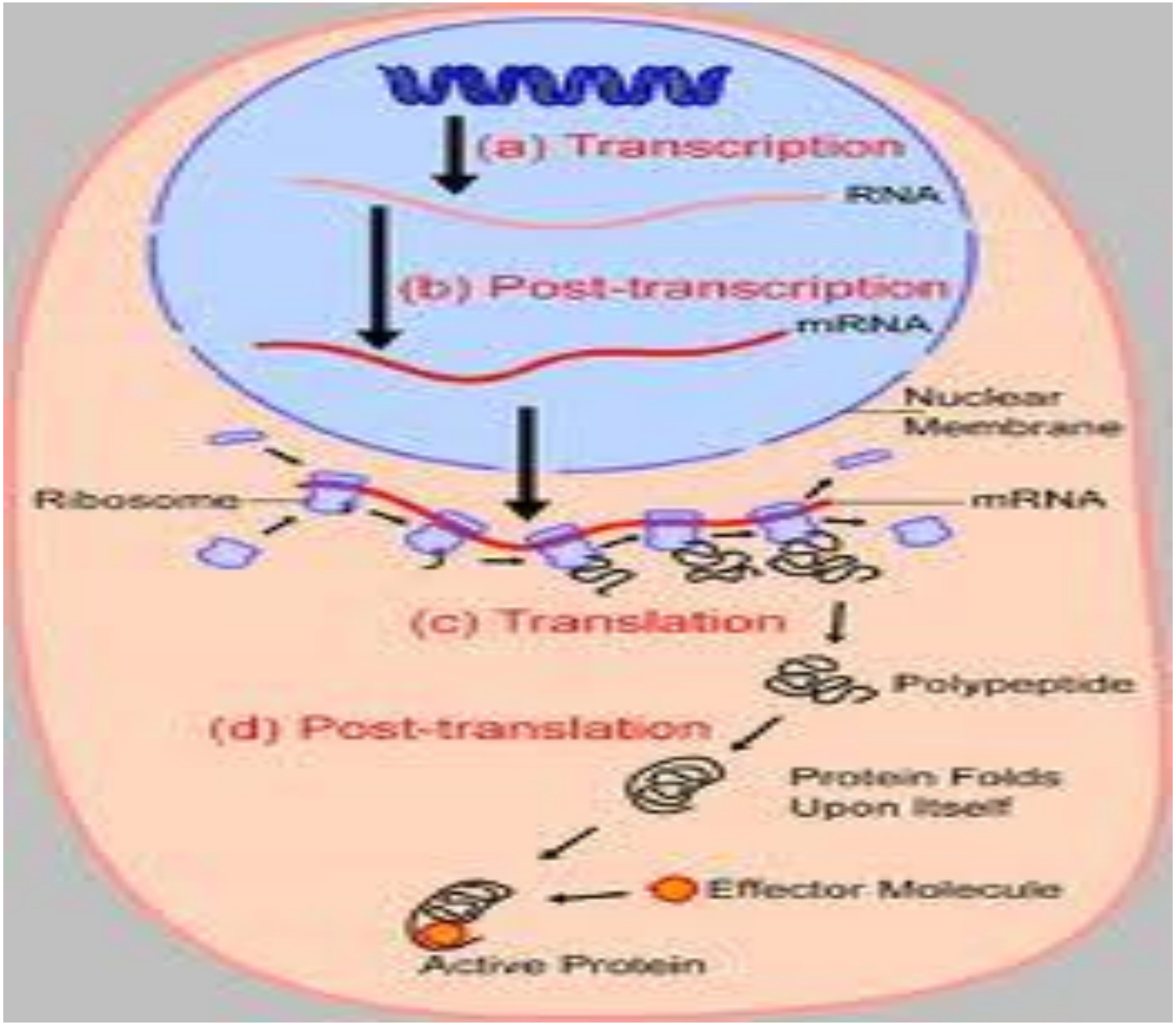
- Excess protein → liver → separated compounds contain N and compounds without N

  i.e. (NH_3) or (NH_4OH)

- Synthesised → UREA (liver) → transported to Kidney → excreted (urine)

BIOSYNTHESIS PROTEIN

- Biosinthesis = gene expression
- → DNA gene kode → "transcription" into RNA (in ribosom) → *protein*
- → Ribosomes are made from complexes of RNAs and protein
- "Translation" → polypeptides
- Post translation → PROTEIN


(a) Transcription
RNA
(b) Post-transcription
mRNA
Nuclear
Membrane
Ribosome
mRNA
(c) Translation
Polypeptide
(d) Post-translation
Protein Folds
Upon itself
Effector Molecule
Active Protein

Thank you