# What makes **dairy** an **essential** part of a **sustainable** diet?

# MEET the speaker

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# About Abby...

Bachelor of Dietetics

- University of Pretoria

Master of Nutrition

- University of Stellenbosch

- Nutrition education
- Nutrition counselling
- Clinical nutrition
- **Pizza connoisseur**

28 states in the USA have an official state beverage...

**21 of those chose milk...**

**#DairyDay #Moorica**

(Image: https://www.teepublic.com/t-shirt/5093115-cow-_moorica-american-flag-usa-4th-of-july-gift

How is

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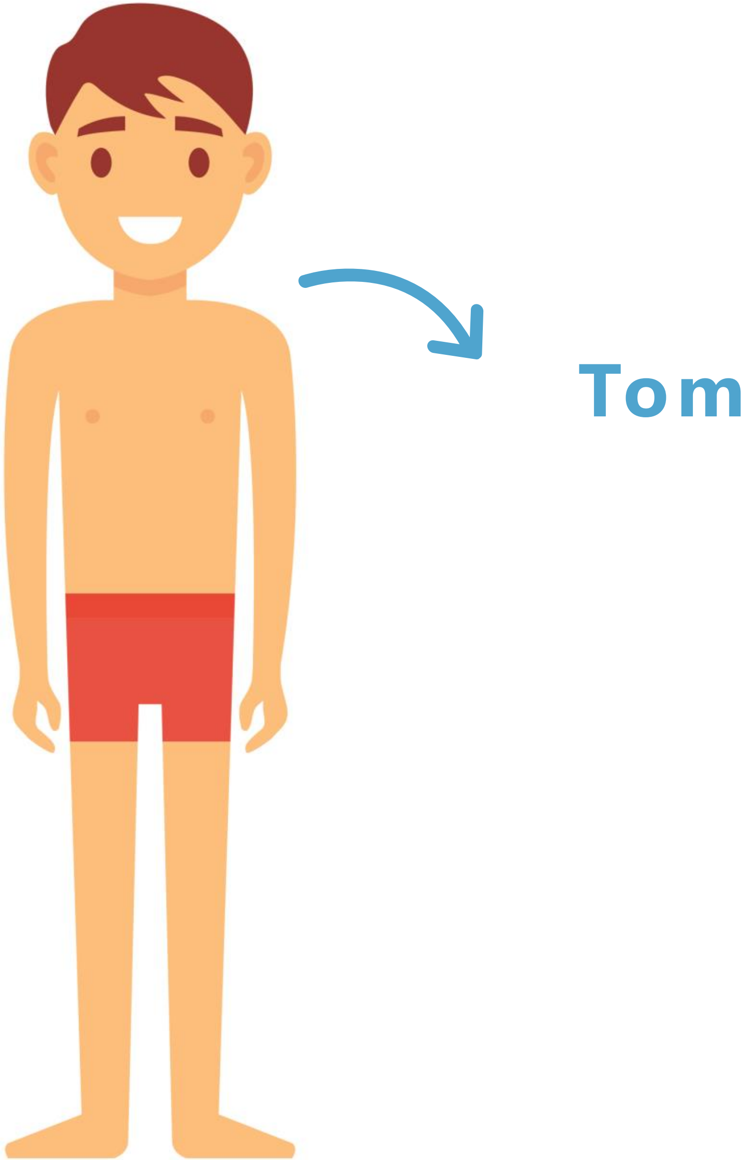
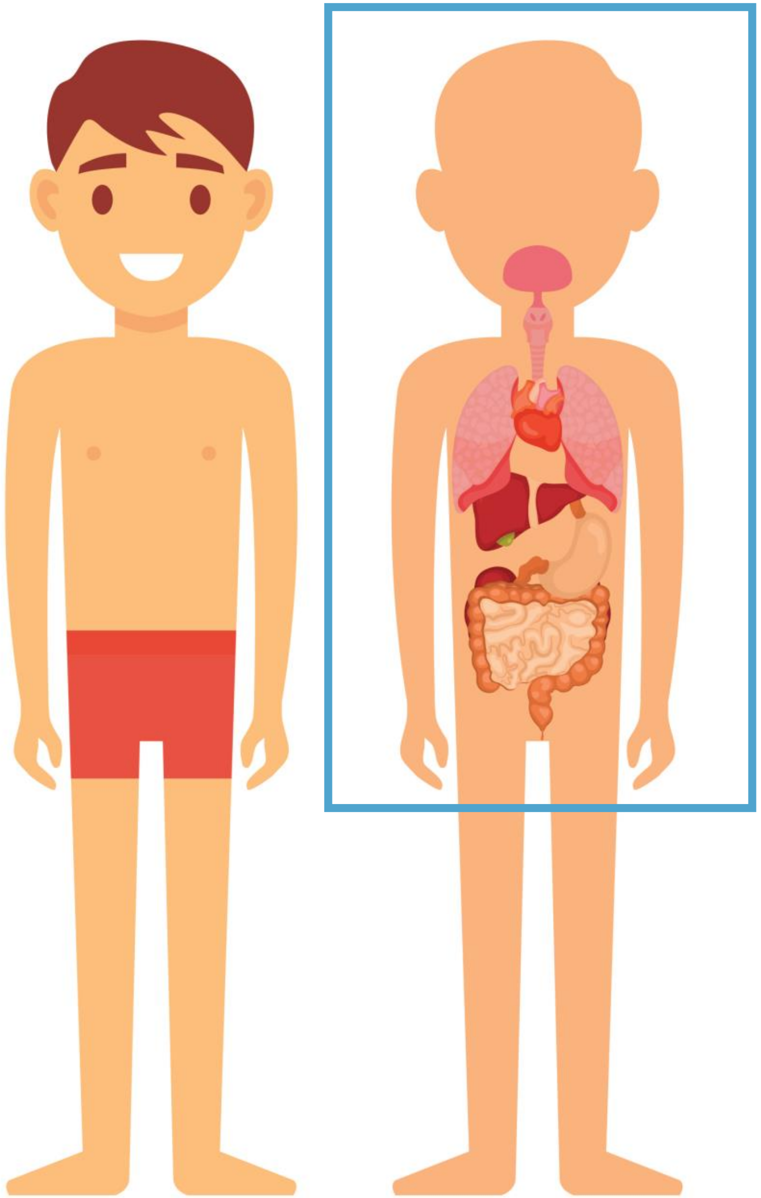
protein digested?

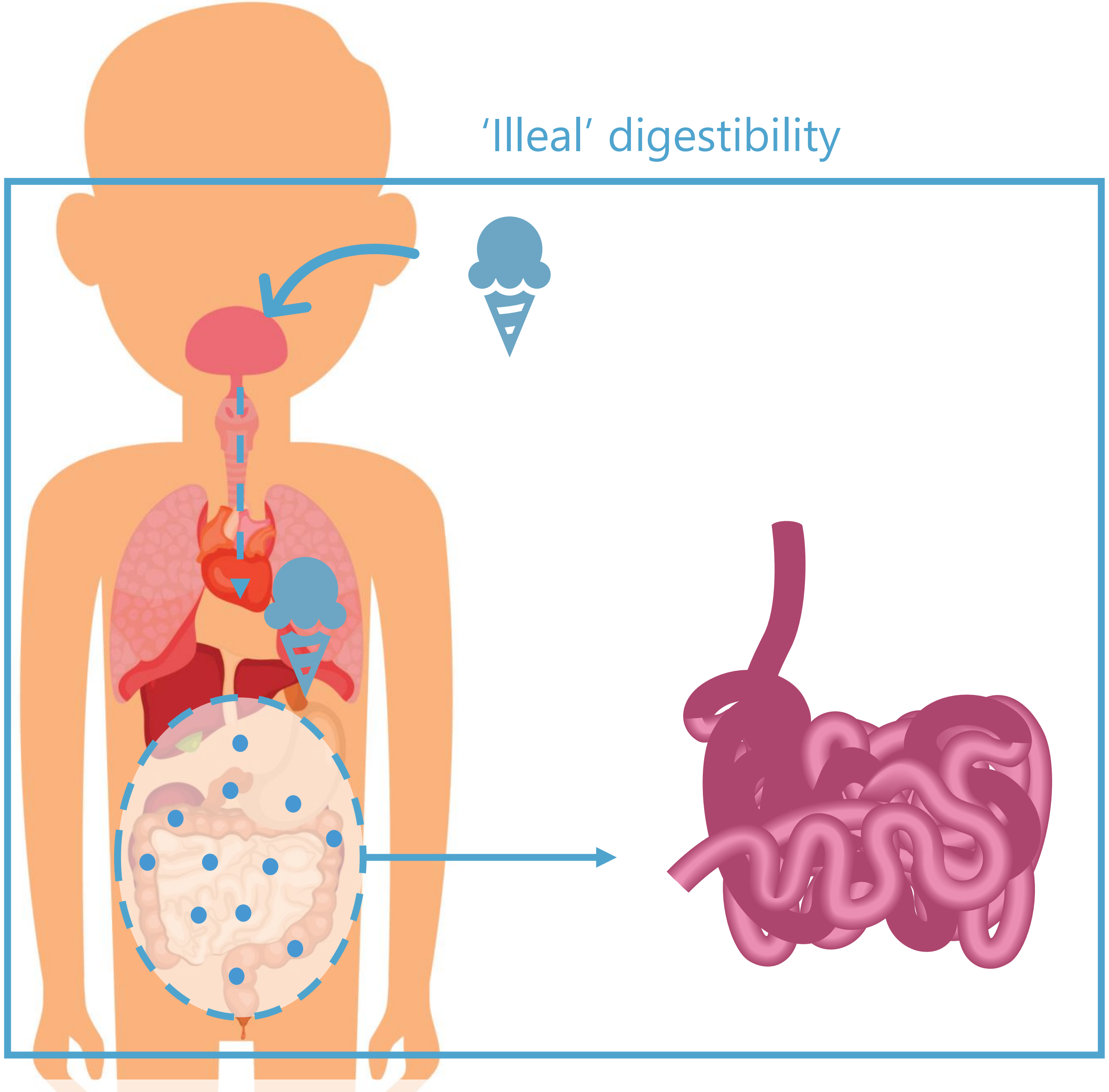



(Image: Shaw Academy Professional Diploma in Nutrition- Lesson 3)

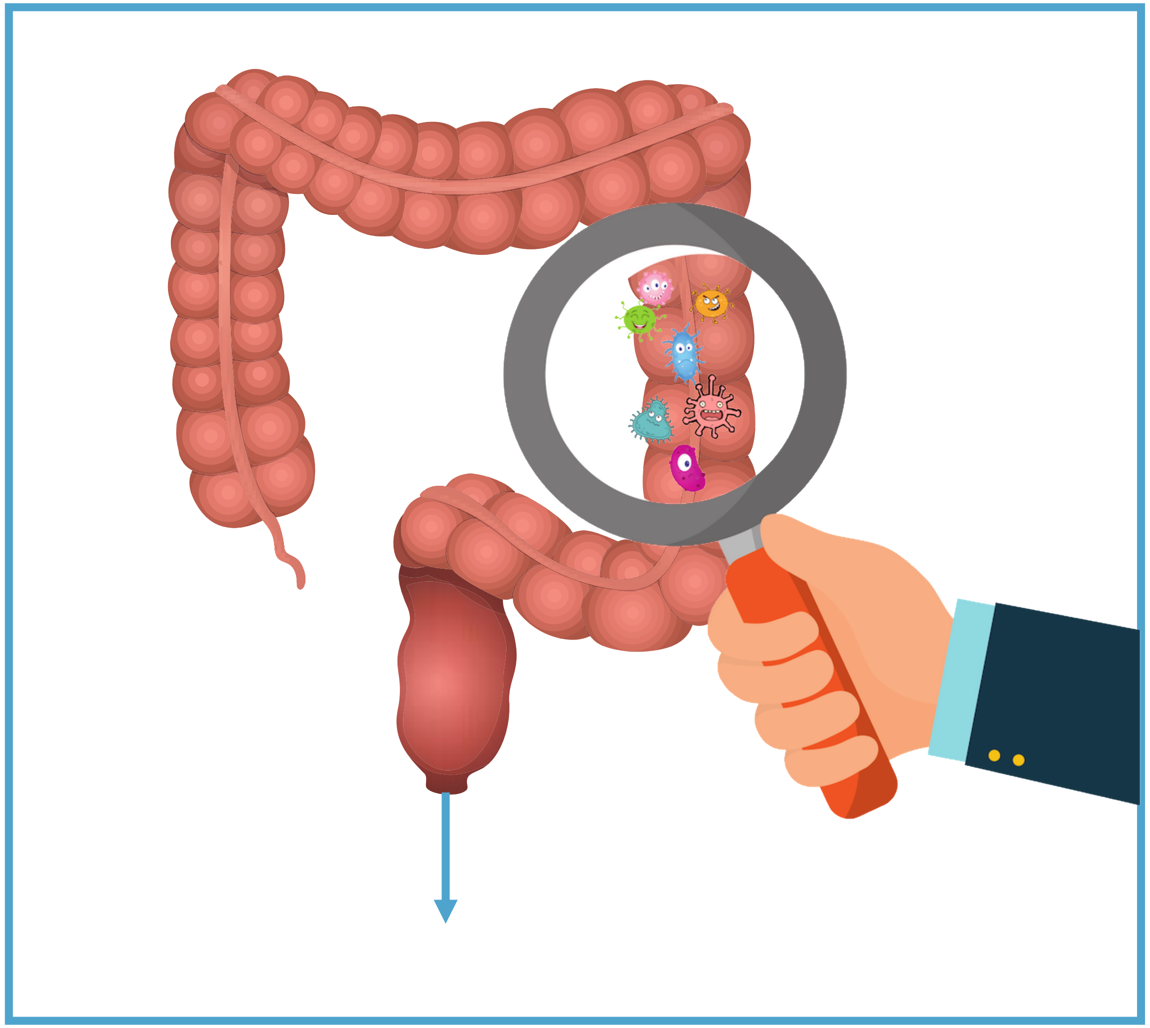


(Image: Shaw Academy Professional Diploma in Nutrition- Lesson 3)

‘Illeal’ digestibility



‘Faecal’ digestibility



(Rediscoverdairy.co.za) (Wada & Lönnerdal, 2014) (Image: Shaw Academy Professional Diploma in Nutrition- Lesson 3)

# Milk composition

### 1. Carbohydrates

- Lactose
- Galactose
- Glucose
- Oligosaccharides

### 2. Protein

- Whey
- Casein

### 3. Fats

- Saturated
- Mono-unsaturated
- Poly-unsaturated

(Rediscoverdairy.co.za, 2019; Nongonierma and FitzGerald, 2015)

# Milk protein composition

HBV* protein

**Soluble** → Whey (18%) → Branch chain amino acids

- Leucine, isoleucine & valine
- Lysine

**Insoluble** → Casein (82%) →

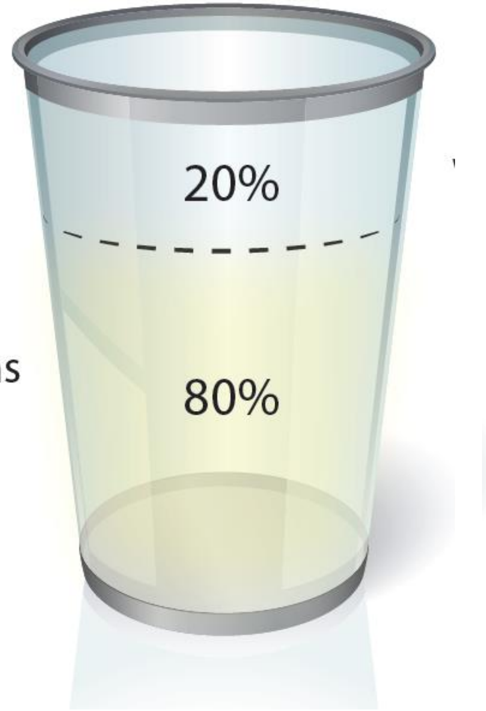
- Histidine
- Methionine
- Phenylalanine

(Rediscoverdairy.co.za, 2019; Pereira 2013; Severin & Wenshiu, 2005)

*High biological value

*High biological value

## Bovine milk




Total milk proteins 100%

Whey proteins

Caseins

Whey proteins, as a percentage of total whey proteins and caseins, as a percentage of total caseins:

| | |
|---|---|
| β-lactoglobulin | 52% |
| α-lactalbumin | 17% |
| immunoglobulins (IgG, IgA, IgM) | 10% |
| serum albumin | 5% |
| lactoferrin | 1.5% |
| lysozyme | <0.1% |
| lactoperoxidase | 0.5% |
| glycomacropetide | 12% |
| proline rich polypeptides | <0.1% |
| other proteins and peptides | 2% |
| β-casein | 36% |
| κ-casein | 14% |
| $\alpha_{s1}$-casein | 40% |
| $\alpha_{s2}$-casein | 10% |

(Artym and Zimecki, 2013)

# Non- specific milk proteins & health

- Hypertension
- Dyslipidaemia

→

- Whey as an ACE inhibitor
- Cardiometabolic effect: specifically **leucine**

- Mild hyperglycaemia
- Weight management

→

- Satiety
- Body composition
- Functions synergistically with physical activity

- Osteoporosis & bone health

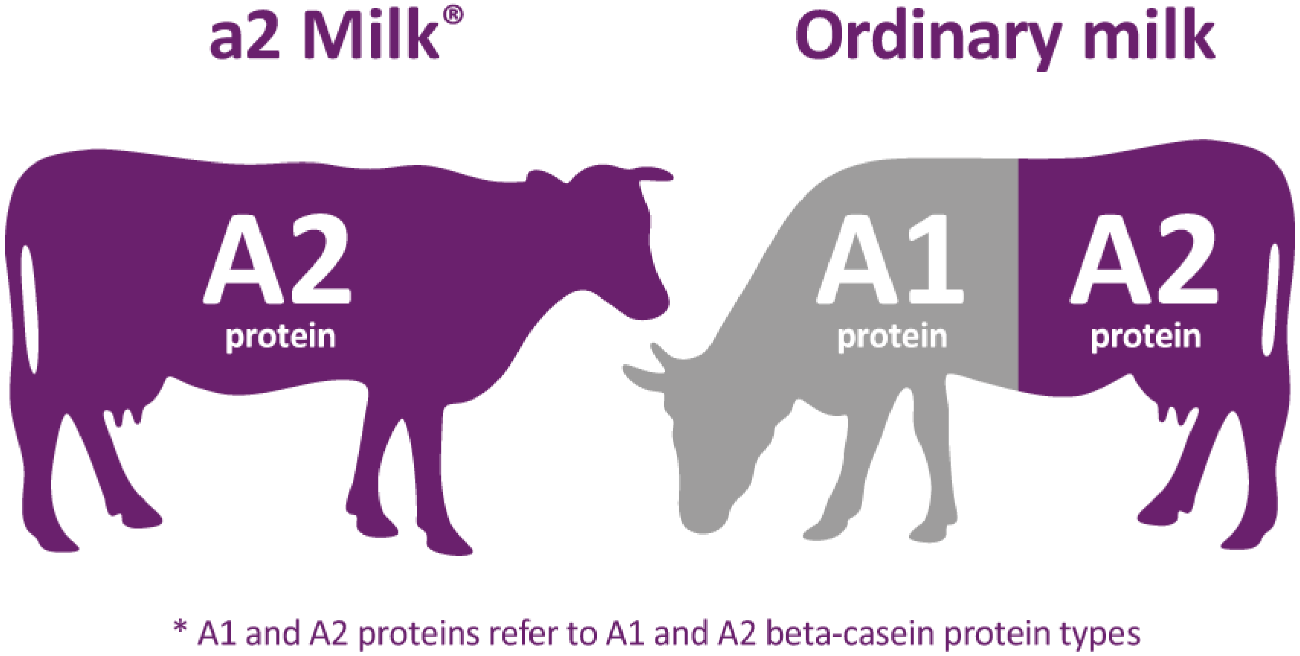
(McGregor & Poppitt, 2013; Boye, 2012; Pal & Radavelli-Bagatini, 2013; Heaney & Layman, 2008)

# Casein protein


- Predominant form of milk protein
- Alpha, **beta A1, beta A2** & kappa
- Beta-casein widely studied
  - **A1/ A2 hypothesis**
- A1 & A2 digested differently
  - A1 = Betacasomorphin 7 (**BCM-7**)
  - A2 = Betacasomorphin 9 (**BCM-9**)

(Rediscoverdairy.co.za; 2019; Pereira 2013; Aslam et al., 2019) (Image: https://www.africanewshub.com/news/4619399-milk-youve-never-heard-of-is-rocking-the-dairy-world) *Bioactive peptides

# Beta casein: A1/ A2 hypothesis




- **A1** = histidine (His67)
- **A2** = proline (Pro67)
- A1 mutation from **Pro67 to His67**
- Most milk = A1 & A2 (depending on cattle's genetics)
  - Absent in **purebred Asian and African cattle**
  - Presence of HIs67 mutation in other mammals (including humans) is **rare**

(Brooke-Taylor et al., 2017) (Image: https://www.a2milk.com/)

# South African dairy cattle & A2 milk production

- Guernsey (70%)
- Brown Swiss Jersey & Fleckvieh (50-60%)
- Holstein, Friesland & Ayshire (lowest)

(http://www.a2dairy.co.za/a2-cows/) (Image: http://www.a2dairy.co.za/a2-cows/)

**Table 1 – Peptide sequences detected in human biological fluids (plasma, serum and milk) following the ingestion of bovine milk or dairy products.**

| Parent protein | Peptide fragment | Peptide sequence[a] | Locus | Bioactive properties | Reference |
|---|---|---|---|---|---|
| $\alpha_{s1}$-CN | 1–21 | RPKHPIKHQGLPQEVLNENLL | Plasma | n.d. | (Chabance et al., 1998) |
| | 1–23 | RPKHPIKHQGLPQEVLNENLLRF (isracidin) | Plasma | Antibacterial | (Chabance et al., 1998) |
| β-CN | 51–58 | YPFVEPIP (human β-casomorphin-8) | Plasma | Opioid | (Koch et al., 1988) |
| | 51–58 | YPFVEPIP (human β-casomorphin-8) | Milk | Opioid | (Renlund et al., 1993) |
| | 51–58 | YPFVEPIP (human β-casomorphin-8) | Serum and milk | Opioid | (Righard et al., 2014) |
| | 51–57 | YPFVEPI (human β-casomorphin-7) | Plasma | Opioid | (Kost et al., 2009) |
| | 60–66 | YPFPGPI (bovine β-casomorphin-7) | Plasma | Opioid | (Kost et al., 2009) |
| κ-CN | 106–117 | MAIPPKKNQDKT | Plasma | n.d. | (Chabance et al., 1998) |
| | 106–169 | Glycomacropeptide | Plasma | Antithrombic | (Chabance et al., 1995) |
| LF | 81–82 and 399–400 | IY | Serum | ACE inhibitor | (Foltz et al., 2007) |
| CN and whey | Diverse | LW | Serum | ACE inhibitor | (Foltz et al., 2007) |
| | Diverse | FY | Serum | ACE inhibitor | (Foltz et al., 2007) |
| | Diverse (α-La and BSA) | IW | Serum | ACE inhibitor | (Foltz et al., 2007) |
| | Diverse | AW | Serum | ACE inhibitor | (Foltz et al., 2007) |
| | Diverse | VY | Serum | ACE inhibitor | (Foltz et al., 2007) |
| | Diverse (β- and κ-CN) | IPP | Serum | ACE inhibitor | (Foltz et al., 2007) |
| | Diverse | LPP | Serum | ACE inhibitor | (Foltz et al., 2007) |
| | Diverse | IL | Plasma | n.d. | (Morifuji et al., 2010) |
| | Diverse | VL | Plasma | n.d. | (Morifuji et al., 2010) |
| | Diverse | LL | Plasma | n.d. | (Morifuji et al., 2010) |

[a] Peptide sequence with the one letter amino acid code.
n.d.: not disclosed; ACE: angiotensin converting enzyme; BSA: bovine serum albumin; CN: casein; α-La: α-lactalbumin; LF: lactoferrin.

(Nongonierma and FitzGerald, 2015)

# Bioactive peptides (BAPs)

- **Short chain peptides** with **multiple physiological functions**
- Milk & dairy are **largest contributor of BAPs** among food derived peptides
- Not biologically active in parent protein
  - Released through **enzymatic hydrolysis**
- Digestion depends on **BAP sequence**
  - May reach small intestine and be absorbed intact
  - Or degraded by GI enzymes or serum peptidase (in circulation)

(Aslam et al., 2019, Nongonierma and FitzGerald, 2011, Nongonierma and FitzGerald, 2015)

# Potential benefits of BAPs

- May be used as **preventative/ prophylactic** agent to alleviate symptoms of various diseases
- **Potential benefit** would be high if benefits similar to drug counterparts
  - With **fewer/ no side effects**
- Notable examples include:
  - Angiotensin converting enzyme (ACE) inhibitory peptides **Ile-Pro-Pro** and **Val-Pro-Pro**
  - Antimicrobial **[lactoferrin- LF f(1–11)]** peptides
- Promising results, however with **multiple limitations**

(Rediscoverdairy.co.za; 2019; Pereira 2013)

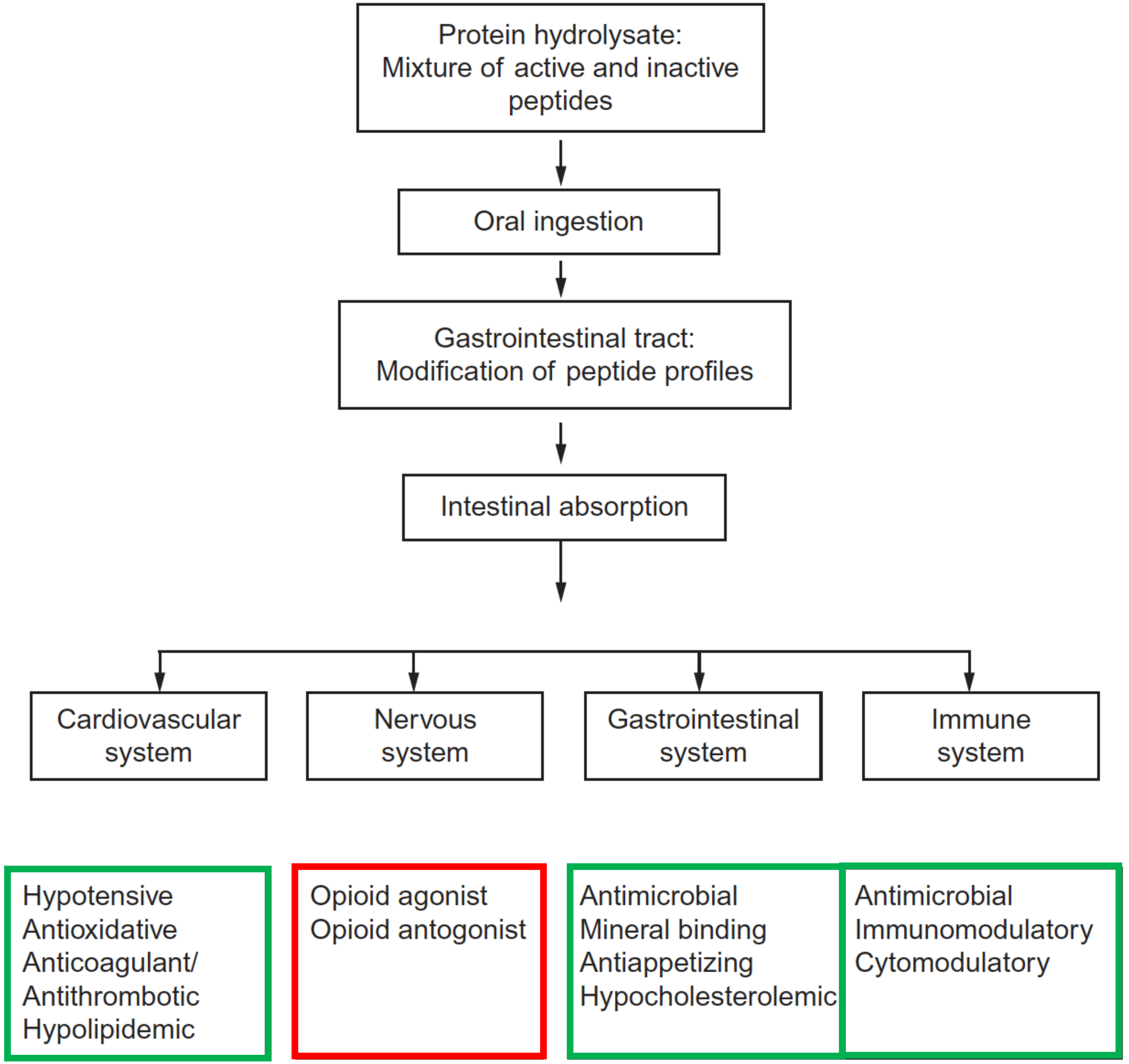



**Fig. 1** Physiological effects of biologically active peptides derived from food proteins on major body systems.

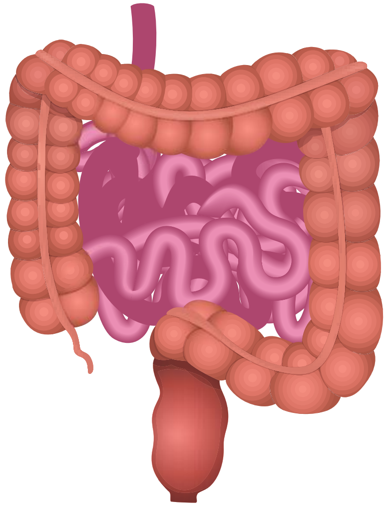
(Nasri, 2017)

# Opioid receptors: Neurologic & enteric response

**First brain:** a.k.a Central Nervous System

Constant **communication**

& similar **receptors**

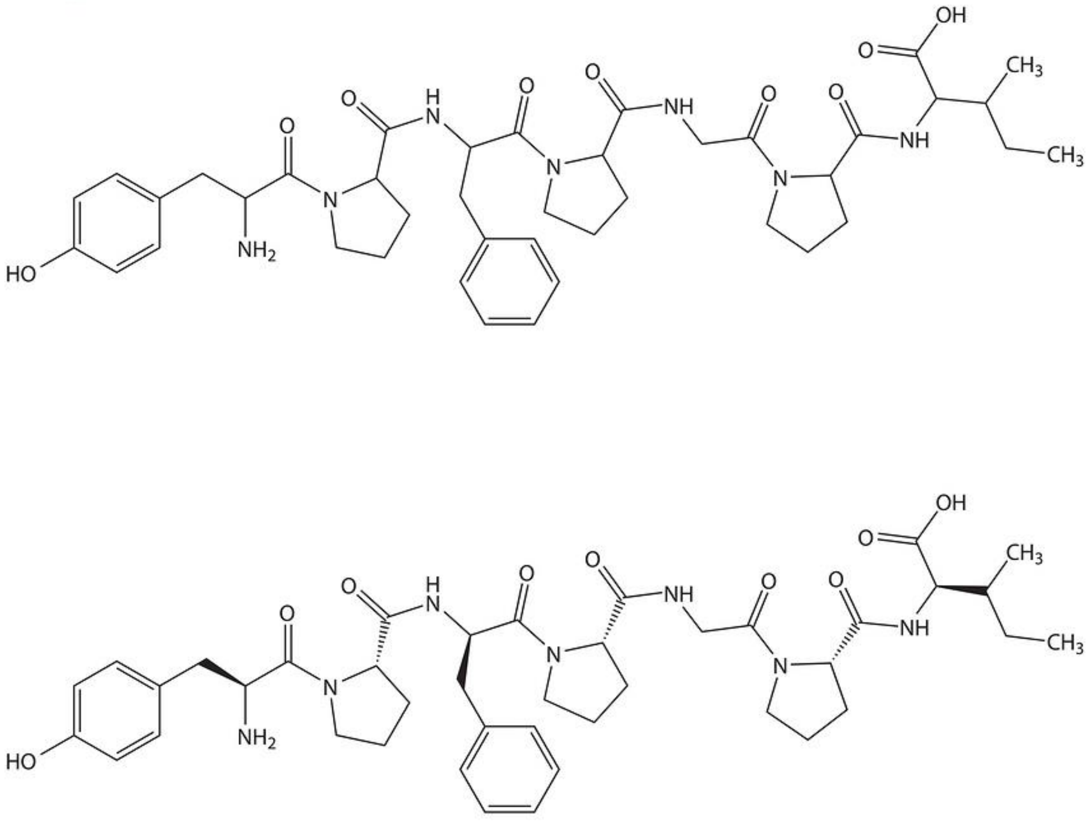


**Second brain**

a.k.a Enteric Nervous System

(Aslam et al., 2019)

# Opioid peptides i.e. A1 / BCM-7




BCM-7 peptide

- **Epidemiological/ animal** data
- May be linked to pathophysiology of various **disease**
- E.g. CVD, T1DM & neurological ds
- GIT **disturbances**:
  - Resemble lactose intolerance:
  - Reduced gut motility, inflammation, post-dairy digestive discomfort & reduced cognitive processing

(Aslam et al., 2019; Jianqin et al., 2015)

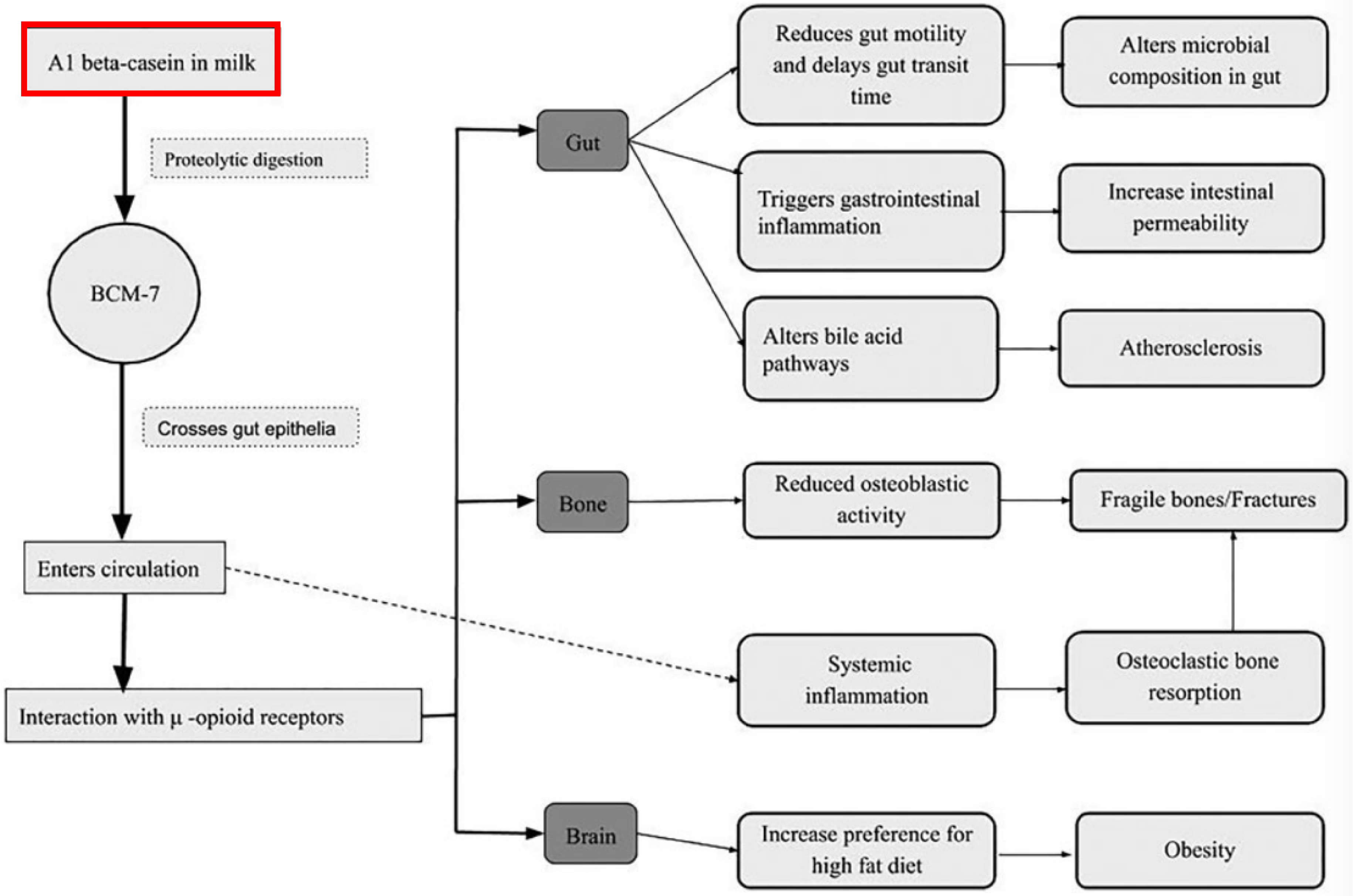



**Figure 1.** Potential pathways by which milk opioid peptides may influence physiological functions.

(Aslam et al., 2019)

# A1/ A2 casein protein: Human studies


- A1 delays **intestinal transit**
- Digestive **discomfort**
  - For A1, not A2
- Looser **stool consistency**
- A2 = Greater increase in plasma **glutathione** production
- Further research needed
  - A1 relative to A2 in different populations & dietary settings

(Brooke-Taylor et al., 2017; Jianqin et al., 2015; Ho et al., 2014, Deth et al., 2015)

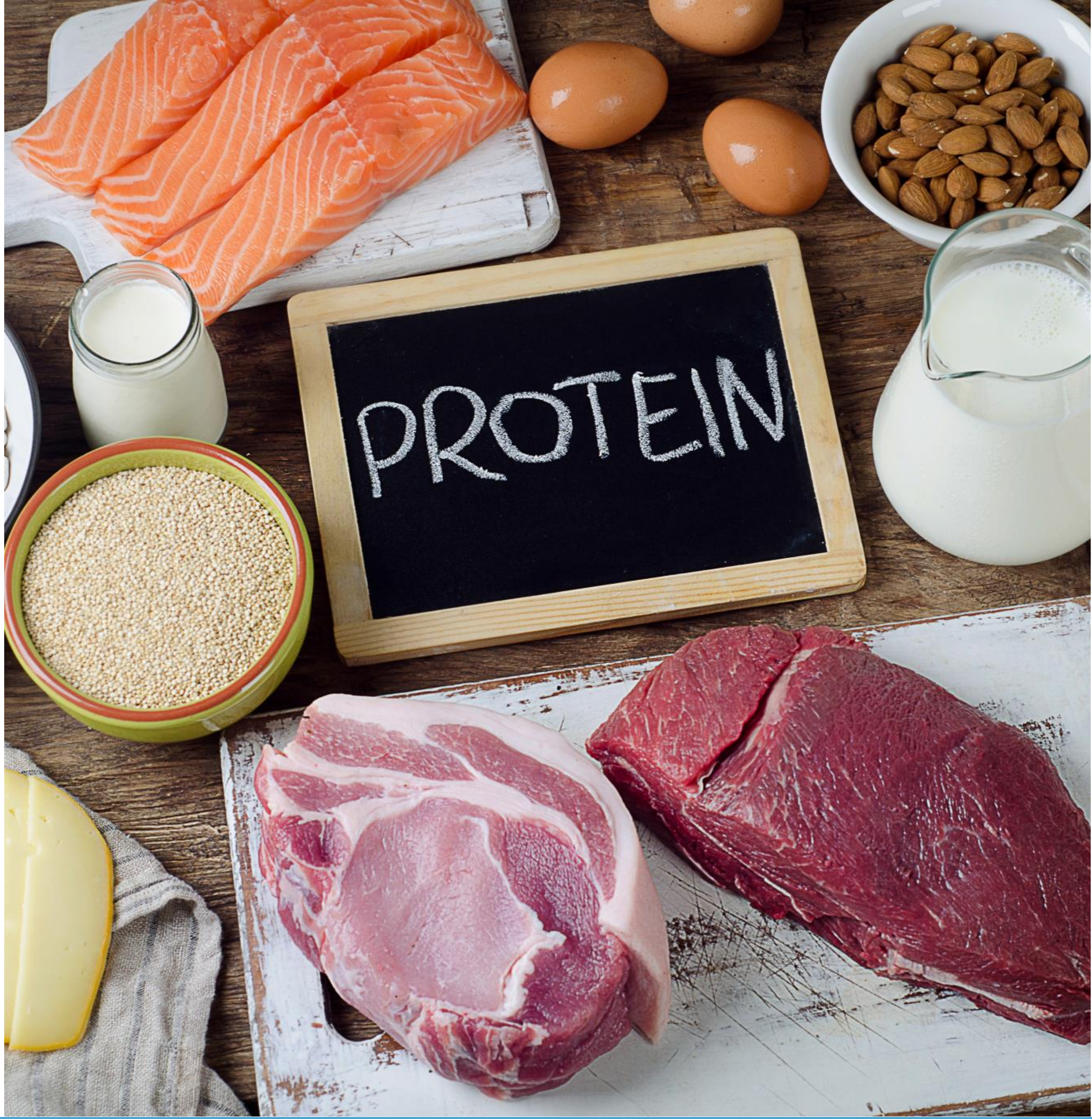
# Protein quality

**Define:**

"Ability of a food protein to meet the **metabolic demand** of the (human) body for **amino acids & nitrogen**"

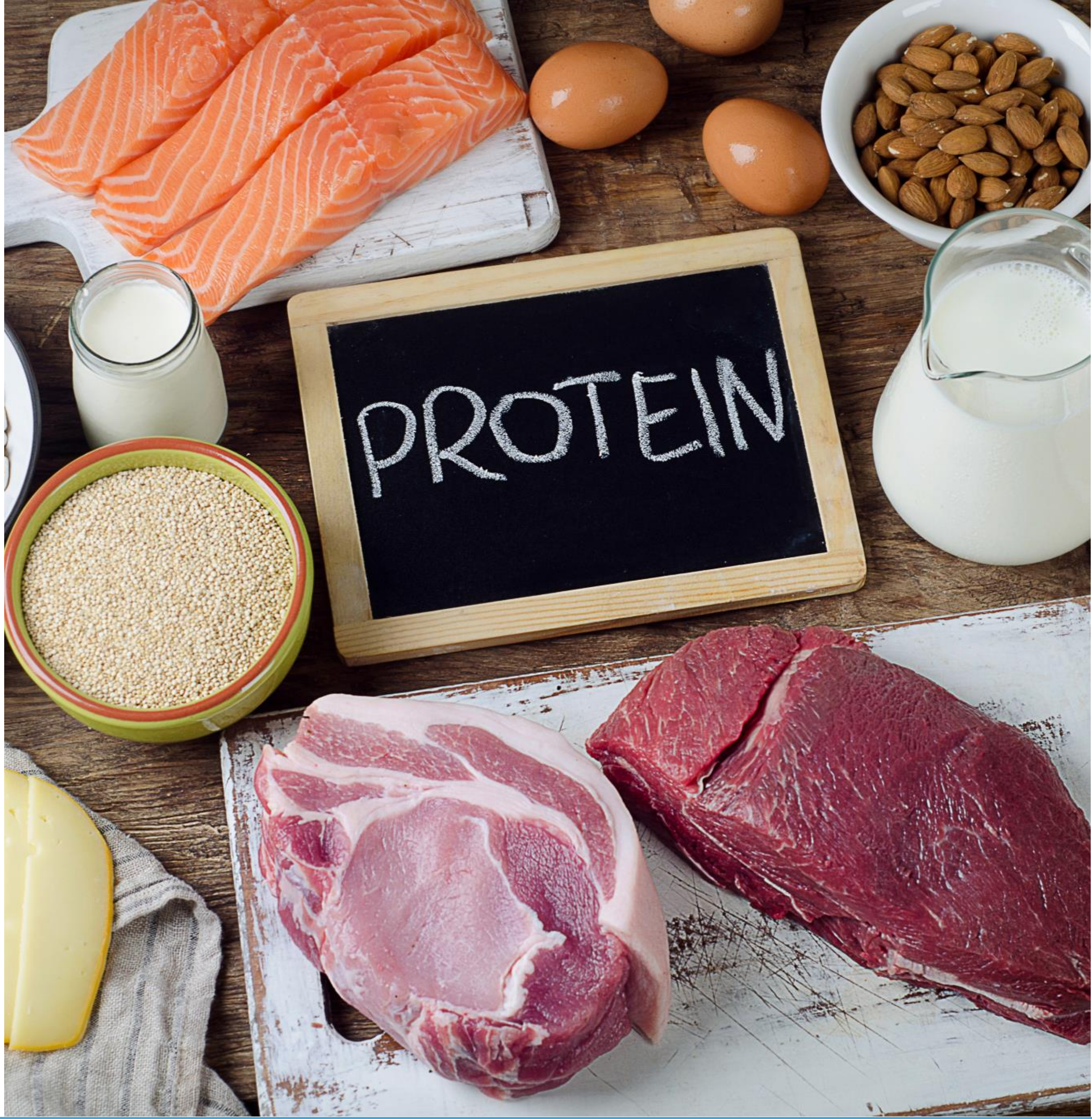
- Different criteria & markers can be used
- Physiological criteria such as digestibility & bioavailability are core concepts
- Protein digestibility-corrected amino acid score (PDCAAS) widely used

(Boye et al, 2012)



# PDCAAs limitations

- Does not account for **biological value > 1**
- Supplementation power values (**SP values**)
- Milk protein = **supply limiting AA**
- AA **availability** not accounted for
- **Anti-nutritional factors** not taken into consideration
- **THUS:** Milk protein **better quality** than originally predicted by uncorrected PDCCs




(Boye et al, 2012)

# Protein requirements

## Define:

"The **lowest level** of **dietary** protein intake that will **balance the losses of nitrogen** from the body and thus **maintain** the body's **protein mass** in persons at **energy balance** with **modest levels of physical activity**."

## Concerns:

- Poor protein quality = high energy intake
- Essential amino acid recommendations for children more than previously thought
- Based on 'ideal' conditions

(WHO/FAO/UNU, 2007; Uauy, 2013a:228; Pencharz, 2013:238; Millward & Jackson, 2003; Kurpad, 2013:235)

(Semba, 2016)

# Malnutrition

& protein

- 1955 = UN **Protein Advisory Group** (PAG)
- 1974 = The **Great Protein Fiasco** (The Lancet)
- Sufficient **energy** was proposed as main concern
- Newer research affirms **importance of protein** in preventing malnutrition
- **Micronutrient** malnutrition
  - Little/ no effect on linear growth

# Malnutrition in Southern Africa

- Protein deficiency is associated with the prevalence of **stunting**
  - Malawi: stunted children had 10-20% lower [serum] of all 9 EAA*
  - Considerably lower conditionally essential AA* (arginine, glycine & glutamine) & NEAA (asparagine, glutamate & serine)
- Staple foods in S.A like **maize** are deficient in **tryptophan & lysine**
  - Lysine requirements increase ~20% with intestinal parasitic infection

(Semba, 2016)

*EAA = Essential Amino Acids; AA = Amino Acids, NEAA = Non-essential Amino Acids

# Mechanistic Target of Rapamycin Complex 1 (mTORC1)

- Availability of amino acids is sensed via the master growth regulatory pathway of the cell the mechanistic target of rapamycin complex 1 (**mTORC1**)
- Integrates **environmental cues** to regulate growth and homeostasis
  - Nutrients, growth factors, oxygen & energy
  - Will **repress** protein & lipid synthesis and cell and organismal growth when amino acids are deficient

(Semba, 2016)

# Malnutrition

& cow's milk protein

- Improves protein **quality**
- **Metabolic** advantages
- Improved **linear growth** without excessive adipose deposition & improved **muscle mass** & **functional test scores**
- **Anti-nutritional effects** are reduced
- **Intolerance** to be a consideration (A1/ A2?)

(Michaelsen, 2013a:249 Tome, 2013; Uauy, 2013b:259; Allen, 2013:265; Gilani et al, 2012a; Hoppe et al, 2009)

# Thank you!

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*All articles available on request


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