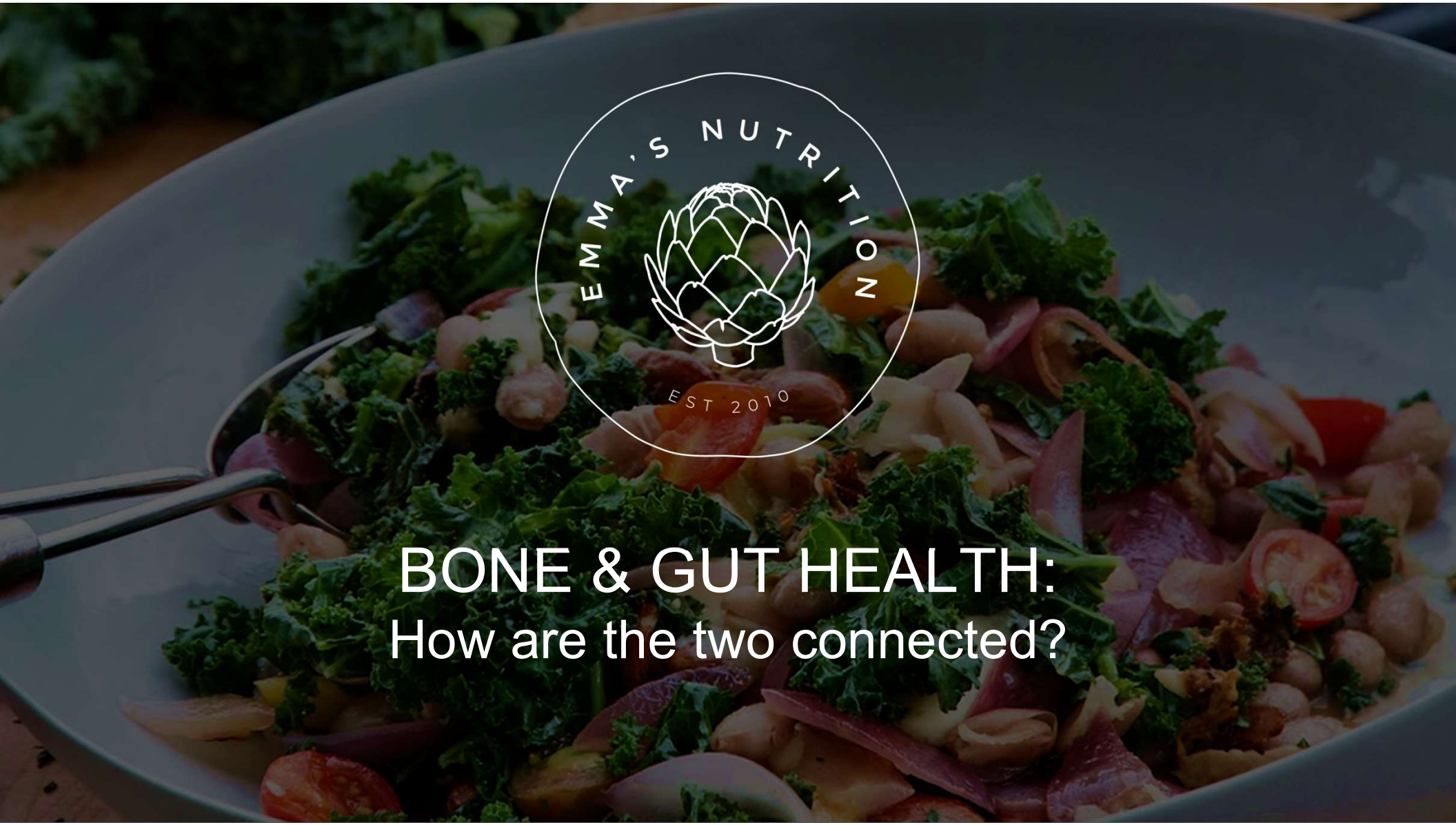
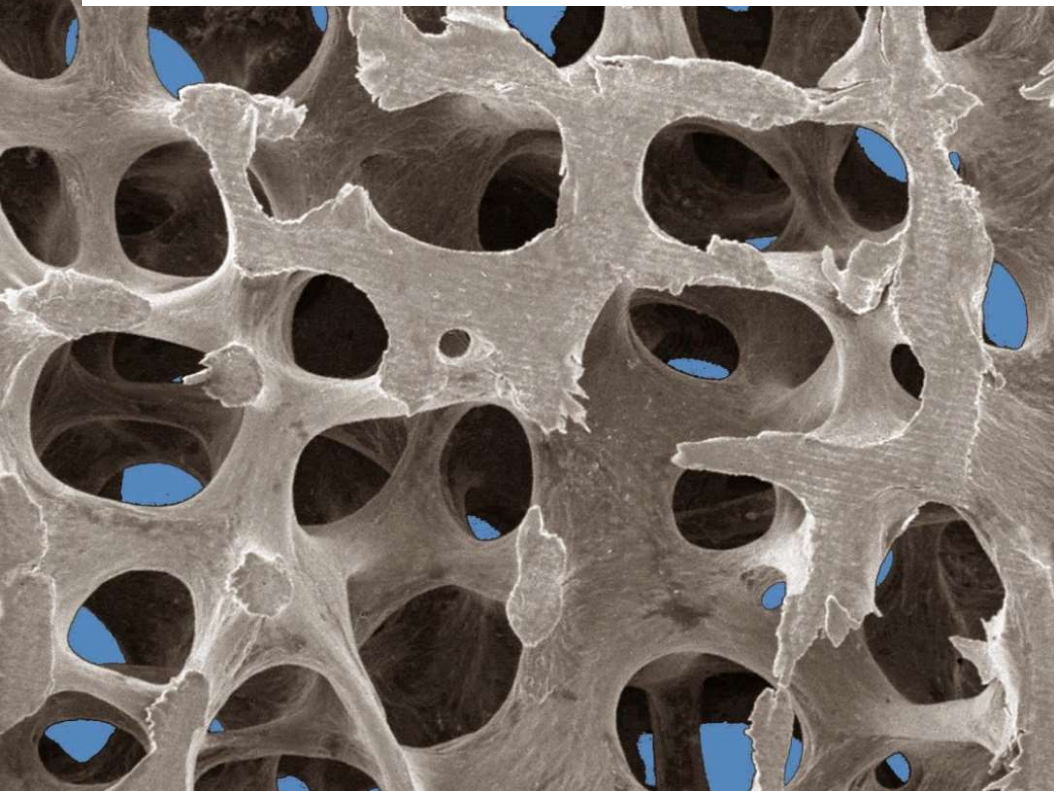


BONE & GUT HEALTH:
How are the two connected?

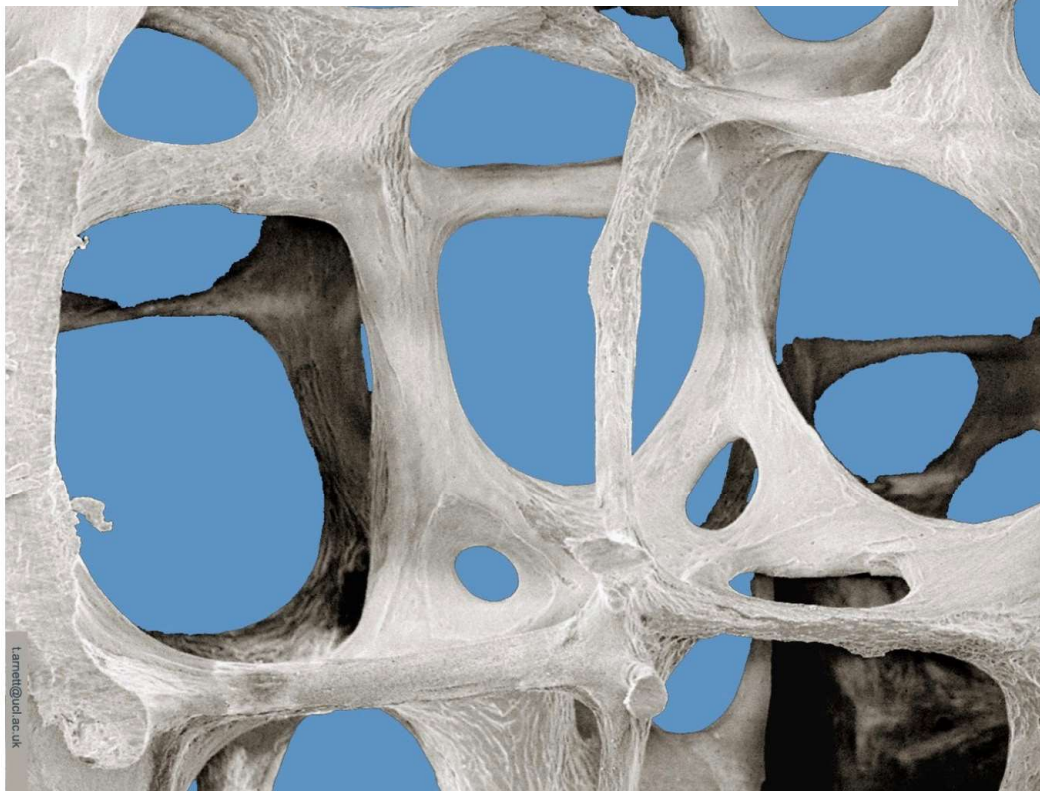
Bone Structure

Scanning Electron Microscopy: Tim Arnett, University College London(37)

Normal Bone



Osteoporotic Bone



Why Do We Care?

Est that 500 million people globally will have osteoporosis by 2025 (38)

3,775,000 individuals with osteoporosis in the UK in 2019 (36)

Cost of osteoporotic fractures in the UK in 2019, was 2.4% health care spending(36)

Direct cost of fractures:
Hip £47,601
Wrist £9744(38)

20-24% mortality within 1st yr after osteoporosis-related hip fracture(39)

What do we know negatively affects bone health?

- Age, men/women ≥ 50 years
- Socioeconomic deprivation
- Ethnicity
- Smoking tobacco
- Sex: Female
- Genetics
- Low BMI <18
- Alcohol >2 units alcohol/d
- Female <Oestrogen/ No HRT use
- Exercise
- Female <40yrs menopause/POI
- Some medical conditions e.g. inflammatory, endocrine, neurological
- Low Calcium intake <700mg/d
- Sleep <5hrs/night and >8hrs/night
- Geographic location
- Some prescription medications e.g. glucocorticoids
- Nutritional deficiencies
- Low Vitamin D, serum 25-OH D <30nmol/l

The Gut-Bone Axis

An imbalance in the gut microbiota* (GM), known as dysbiosis, has been observed in individuals with osteoporosis[21–27]

GM acts as a regulator of bone mineral density[24]

*Gut Microbiota “collection of microbes that inhabit the human gastrointestinal tract”[10]

In What Ways Gut Microbiota Affect Bone Health?

- Metabolites
- Intestinal Permeability
- Immune System
- Endocrine System
- Absorption of nutrients

Metabolites

GM regulates bone remodelling directly through its microbial metabolites, such as Short Chain Fatty Acids SCFAs(49)

- e.g. Acetate, Propionate, Butyrate
- SCFAs produced through microbial fermentation of dietary fibre(24)
- SCFAs have systemic, as well as localised, anti inflammatory benefits
- Butyrate has ability to promote bone formation(24)

Calcium

Magnesium

Nutrients

GM affects intestinal absorption/activation of:

Vitamin K2

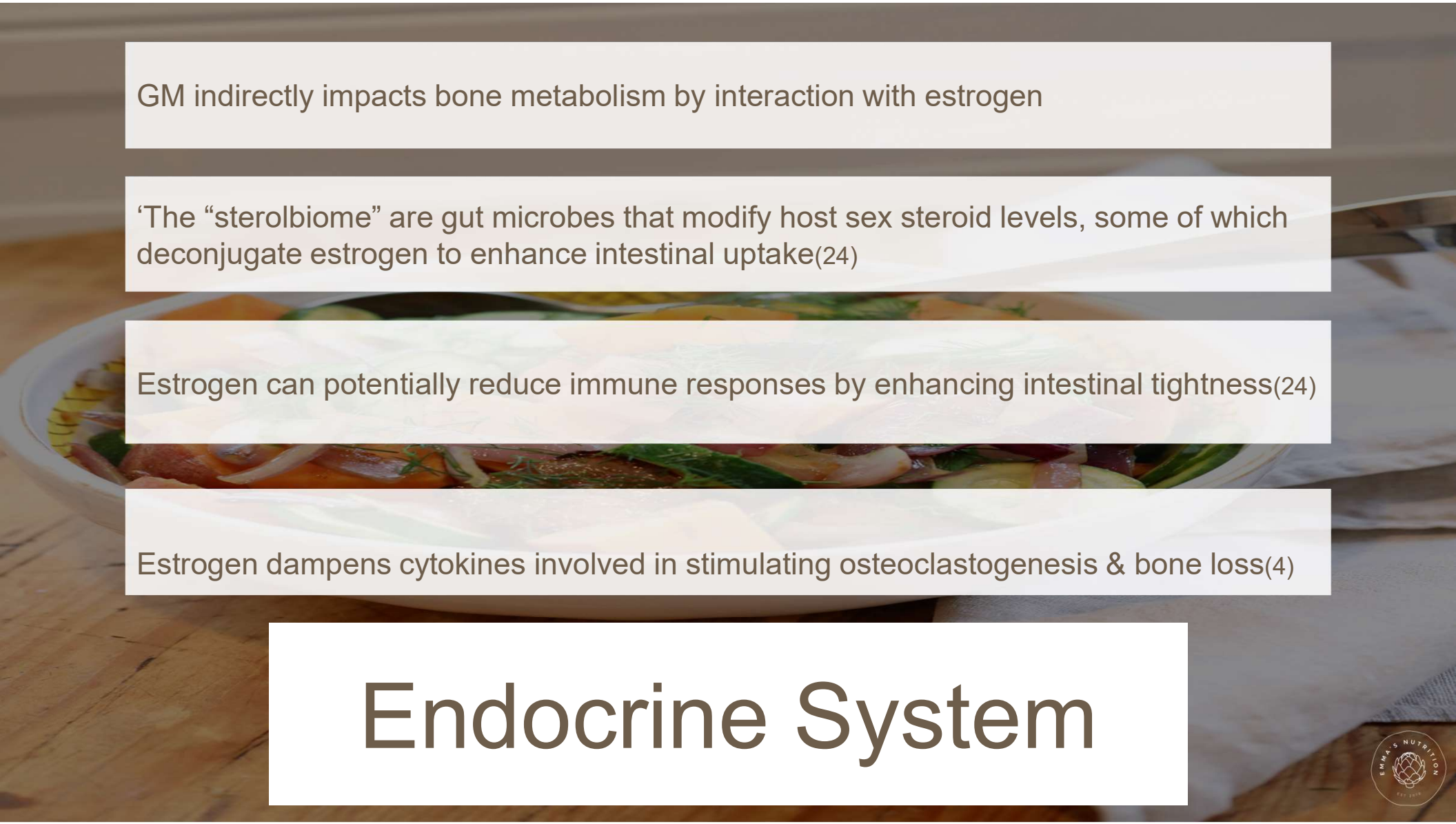
Vitamin D

Immune System

‘GM indirectly impacts bone metabolism by interacting with the immune system’(24)

Intestinal permeability > prolonging osteoclastogenisis(50)

Accumulation of immune cells in bone marrow , disrupts skeletal micro architecture(50)



GM indirectly impacts bone metabolism by interaction with estrogen

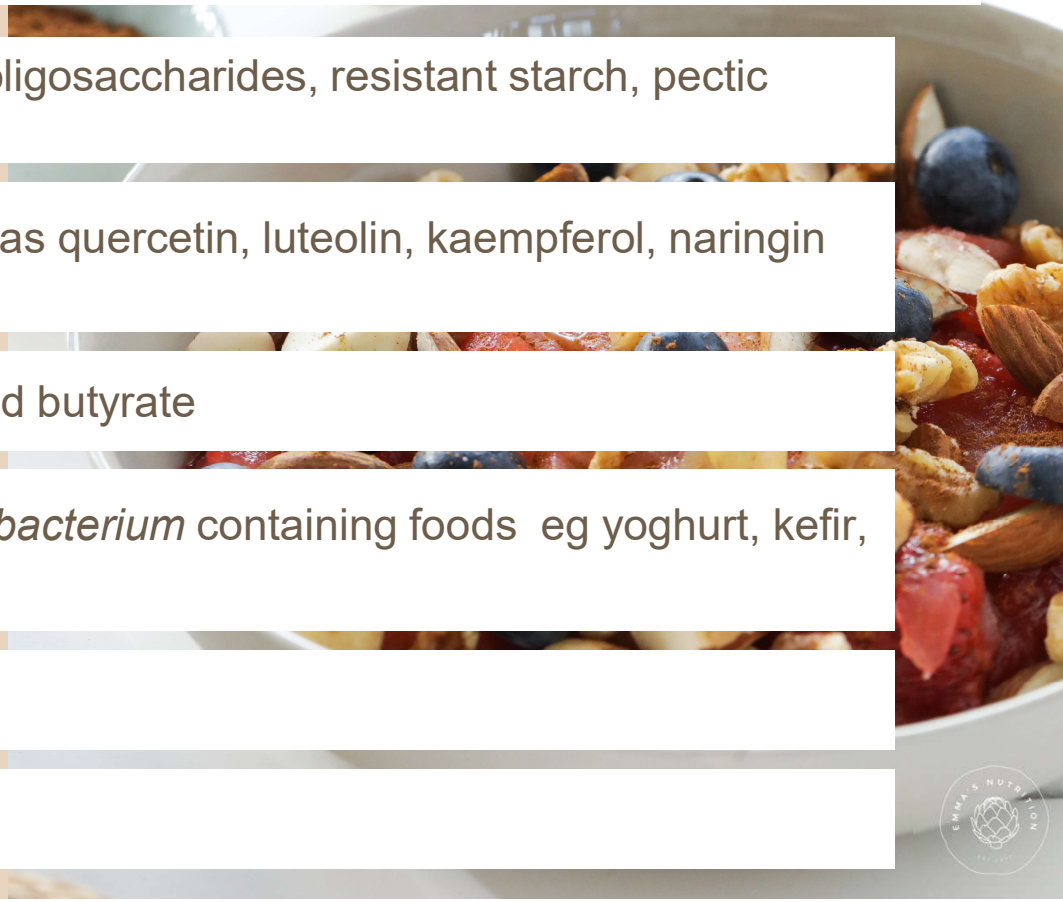
‘The “sterolbiome” are gut microbes that modify host sex steroid levels, some of which deconjugate estrogen to enhance intestinal uptake(24)

Estrogen can potentially reduce immune responses by enhancing intestinal tightness(24)

Estrogen dampens cytokines involved in stimulating osteoclastogenesis & bone loss(4)

Endocrine System

What Can We Do To Support The Health of Gut Microbiome?



Variety of Prebiotics eg: Fructans, galacto-oligosaccharides, resistant starch, pectic oligosaccharide

Variety of Polyphenols eg Flavonoids such as quercetin, luteolin, kaempferol, naringin (27)

Postbiotics - SCFA: acetate, propionate, and butyrate

Fermented foods - *Lactobacillus* and *Bifidobacterium* containing foods eg yoghurt, kefir, fermented soy milk, sauerkraut, kimchi.

< antibiotics

Probiotics?

Supplementing?

Dietary fibre supplements:
Mixed results on SCFAs outcomes (30), dose dependant/type/duration.

Small study showed eating 10-20g soluble corn fiber/d increased bone calcium retention in postmenopausal women after 50 days(28)

Probiotics - Studies remain challenging:
Lactobacillus paracasei DSM 13434/15312/15313; VSL#3(24); *Lactobacillus plantarum* 1 R 1.3.2(41); *Lactobacillus reuteri* 6475(3); *Bifidobacterium longum*(9); *Bacillus subtilis* C-3102(48)

Small study showed 8 g chicory fructan fibre/d for 3 mnths > decrease in serum levels of bone-resorption markers(44)

Mediterranean Diet (MD)

MD supports diversity in, and health of, GM(51).

Traditional MD - high intake of vegetables, legumes, fruits, nuts/seeds, whole grains, olive oil, a moderately high intake of fish, a low-to-moderate intake of dairy products (mostly fermented), a low intake of meat & poultry(17)

A varied diet based on Mediterranean diet patterns may be beneficial in the prevention of osteoporosis in both pre- and post-menopausal women(33)

Consumption of vegetables and fruit was found to be significantly related to BMD

Antioxidant intake, polyphenol-rich foods beneficially correlates to reduction in risk for osteoporosis in middle aged/older population(11)

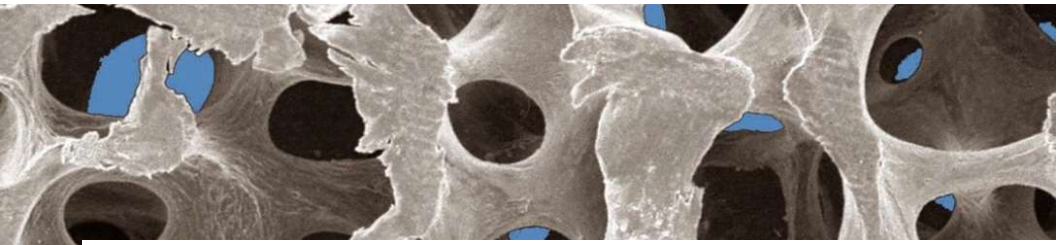
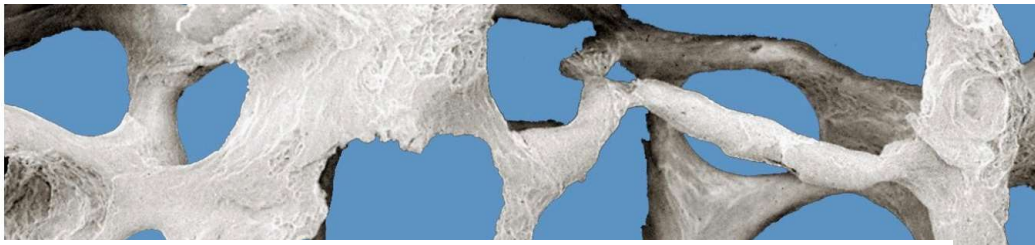
Changes Can Make A Difference

Bone tissue undergoes continuous renewal through bone remodelling

Osteocyte cells make up most of the bone tissue

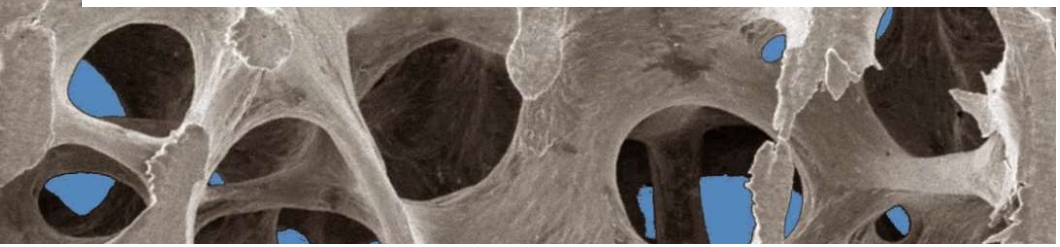
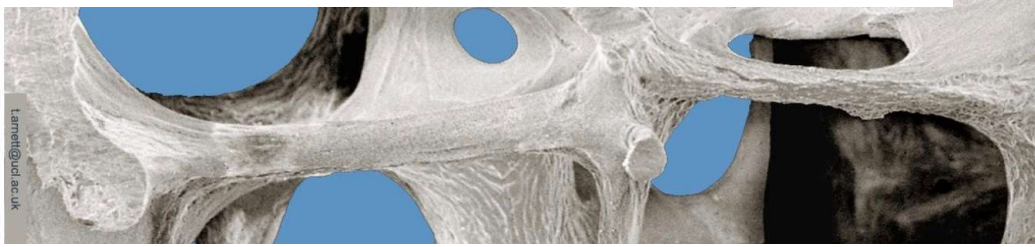
~9 million of them are replaced daily

In studies on fracture, adherence to the "Healthy" dietary pattern reduced the risk, particularly in older people(42)

Key Takeaways

- Gut-Bone Axis is now established
- GM supportive supplements?
- Mediterranean style diet is the most protective to bone health

t.arnett@ucl.ac.uk

THANK YOU FOR LISTENING

BONE & GUT HEATH