Module 2

Vitamins and Co-Enzymes

Muscles and their meridian relationship.

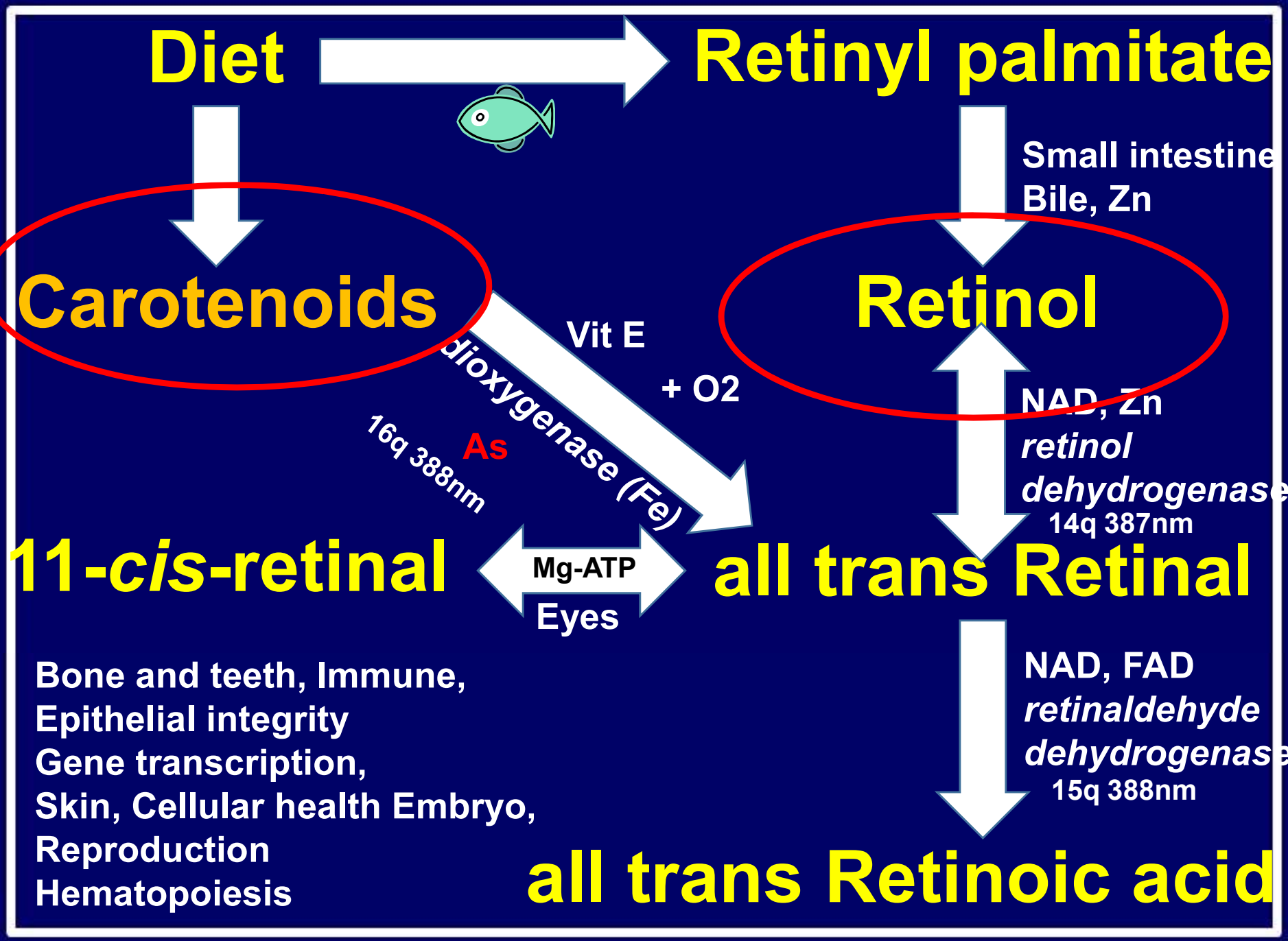
Meridian	Muscles
Bladder	Tibialis ant, Tibialis post, Peroneus long/ brevis, Peroneus tertius
Kidney	Psoas, Iliacus, Upper trap
Gall bladder	Popliteus
Liver	PMS, Rhomoids
Large Intestine	TFL, Hamstrings, QL
Lung	Deltoid, Serratus ant, Coracobrachialis
CV	Supraspinatus, Diaphragm
GV	Teres major
Triple warmer	Teres minor, Infraspinatus
Circulation / sex	Glut max, Glut med/min, Piriformis, Adductors, Sartorius, Gracilis
Stomach	PMC, Neck flexors, Biceps, Brachialis, Pronator teres, Pronator quadratus
Spleen	Lat dorsi, Mid trap, Lower trap, Triceps
Small intestine	Quads, Abdominals
Heart	Subscapularis

Nutrition / Muscle relationship.

Vitamin A - Latissimus dorsi, Pectoralis major clavicular, Pectoralis minor, Piriformis, Popliteus, Psoas, Quadratus lumborum, Rhomboids,Sacrospinalis, Tibialis anterior.
B. Complex - Pectoralis major clavicular, Pectoralis minor, Peroneals, Quadriceps, Subscapularis, Upper trapezius, Supinator.
Vitamin B1
Vitamin B2 - Neck extensors
Vitamin B3 - Gracilis, Neck flexors, Pectoralis minor
Vitamin B5 - Sartorius
Vitamin B6 - Opponens digiti minimi
Folic acid
Vitamin B12
Biotin
Vitamin C - Coracobrachialis, Deltoid, Diaphragm, Quadratus lumborum, Sacrospinalis, Sartorius, Serratus anterior, Middle trapezius, Lower trapezius
Vitamin D - Quadriceps, Tensor fascia lata, ICV
Vitamin E - Abdominals, Adductors, Gluteus maximus, Gluteus medius, Hamstrings, Quadratus lumborum, Sacrospinalis, Subscapularis
Vitamin K
Co-enzyme Q10
SAMe

Fat Soluble Vitamins

Vitamin A


Diet
Retinyl palmitate
Small intestine
Bile, Zn
Carotenoids
Retinol
Vit E
+ O2
dioxygenase (Fe)
As
16q 388nm
NAD, Zn
retinol
dehydrogenase
14q 387nm
11-cis-retinal
Mg-ATP
Eyes
all trans Retinal
Bone and teeth, Immune,
Epithelial integrity
Gene transcription,
Skin, Cellular health Embryo,
Reproduction
Hematopoiesis
NAD, FAD
retinaldehyde
dehydrogenase
15q 388nm
all trans Retinoic acid

Vitamin A found in foods that come from animals and is called ‘preformed vitamin A’ or ‘retinol’; it's one of the most active forms of vitamin A.*

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 227

Vitamin A found in fruits and vegetables is called ‘provitamin A carotenoid’, which can be cleaved into retinol in the body; the carotenoid ‘beta-carotene’ is most efficiently converted into retinol, making it an important vitamin A.*

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 227

Vitamin A (retinol) intake is essential for:

Better vision (especially night vision)

Growth and development – it's involved in the genetic regulation of cell and tissue formation, programming, and communication needed for reproduction; and for the proper development of the embryo in the womb.

Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 231

Immune function – it helps to protect against infections by ensuring the effectiveness of mechanical barriers (like skin), and increasing the production and efficacy of protective cells (eg lymphocytes)

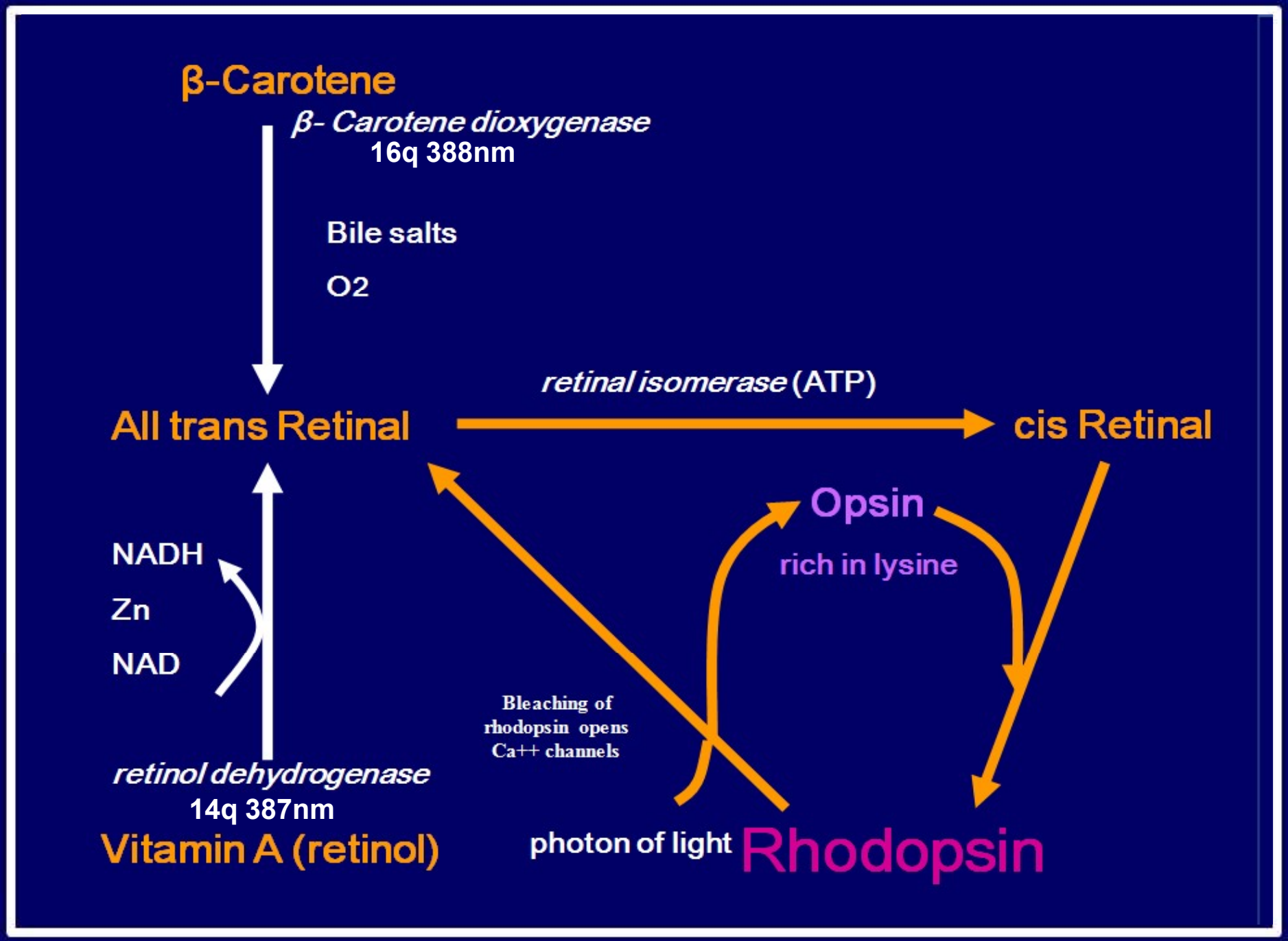
Male and female reproductive organs.

Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 236

Vitamin A (retinol) is a fat-soluble compound. It is a generic term referring to all substances from animal sources (retinol, retinal and retinoic acid) that exhibit the biological activity of vitamin A. Only retinol has full activity of vitamin A;
the others fulfil some, but not all, vitamin A functions.

Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 227

It is stored mainly in the liver as an ester bound to intracellular lipoproteins. Outside the liver, vitamin A is bound and stored by a cellular retinol-binding protein. The term "retinoids" is used to describe both the natural forms and synthetic analogues of retinol.

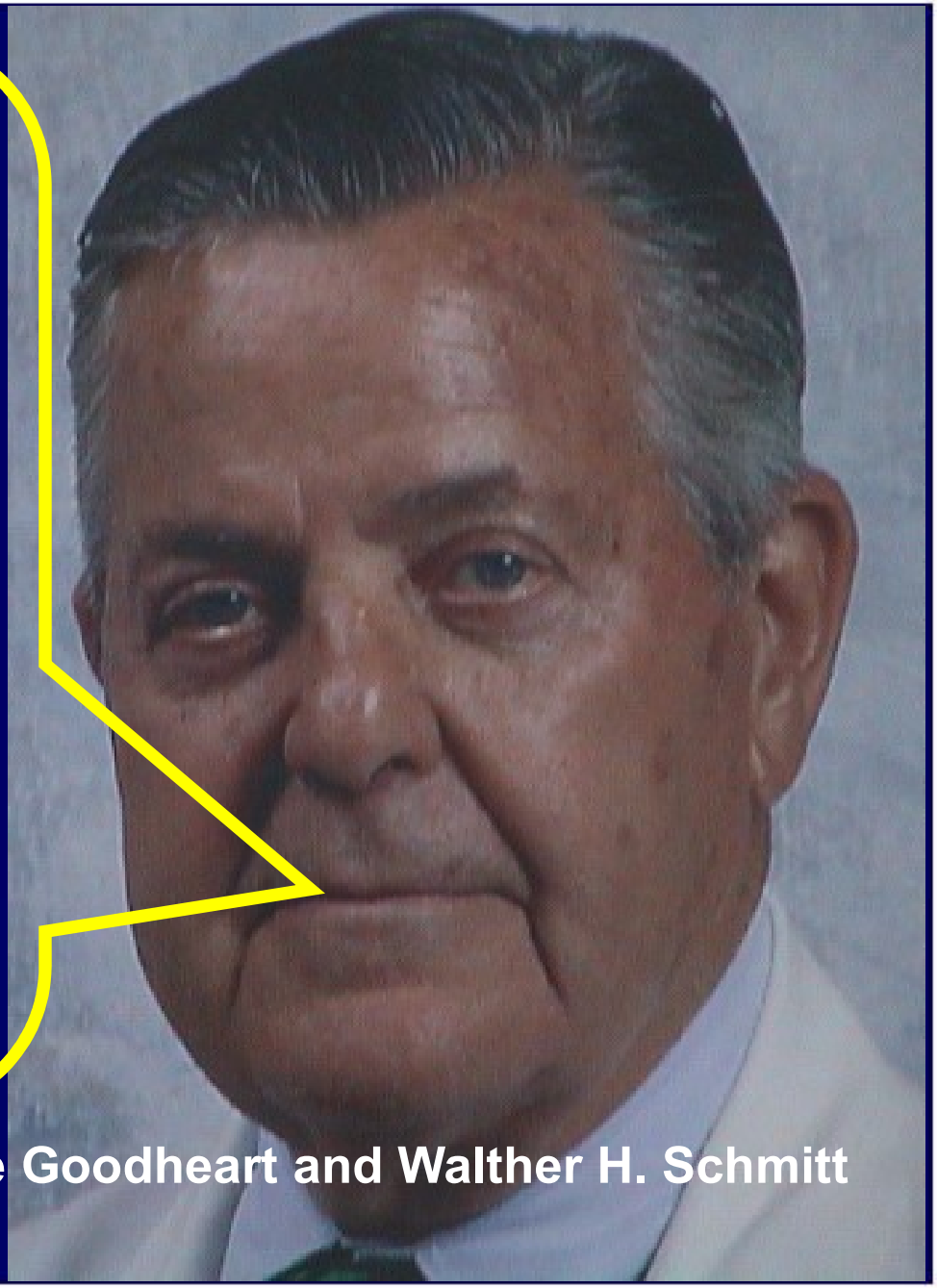

β-Carotene
β- Carotene dioxygenase
16q 388nm
Bile salts
O2
retinal isomerase (ATP)
All trans Retinal
cis Retinal
Opsin
rich in lysine
NADH
Zn
NAD
Bleaching of rhodopsin opens Ca++ channels
retinol dehydrogenase
14q 387nm
Vitamin A (retinol)
photon of light
Rhodopsin

New findings have become available on the effects of thoroughly selected doses of Vitamin A in the prevention of cardiovascular conditions. Vitamin A is present exclusively in animal foods, especially fish liver oils and animal livers (e.g. Chicken pate).

May need pancreatic enzymes to aid the absorption of Vitamin A. Good for thick heavy calluses. Check for need in sinusitis.

Being a Family Doctor by George Goodheart and Walther H. Schmitt published by Lance West DC

Dr Goodheart says take 1500 IU Vitamin A every 15 minutes when hay fever attacks the eyes + HCl)



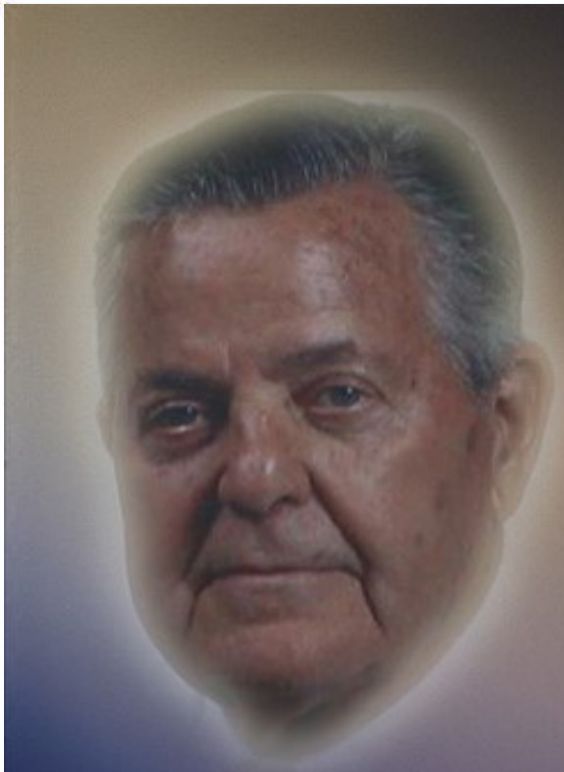
Being a Family Doctor by George Goodheart and Walther H. Schmitt published by Lance West DC

Patient may have daytime frequency, not night time.

Rough skin on the extensor surface of the arm or lower legs.

Can be used locally in cases of epistaxis.

Being a Family Doctor by George Goodheart and Walther H. Schmitt published by Lance West DC



Dr Goodheart says

Don’t use mineral oil because Vitamin A is soluble in it.

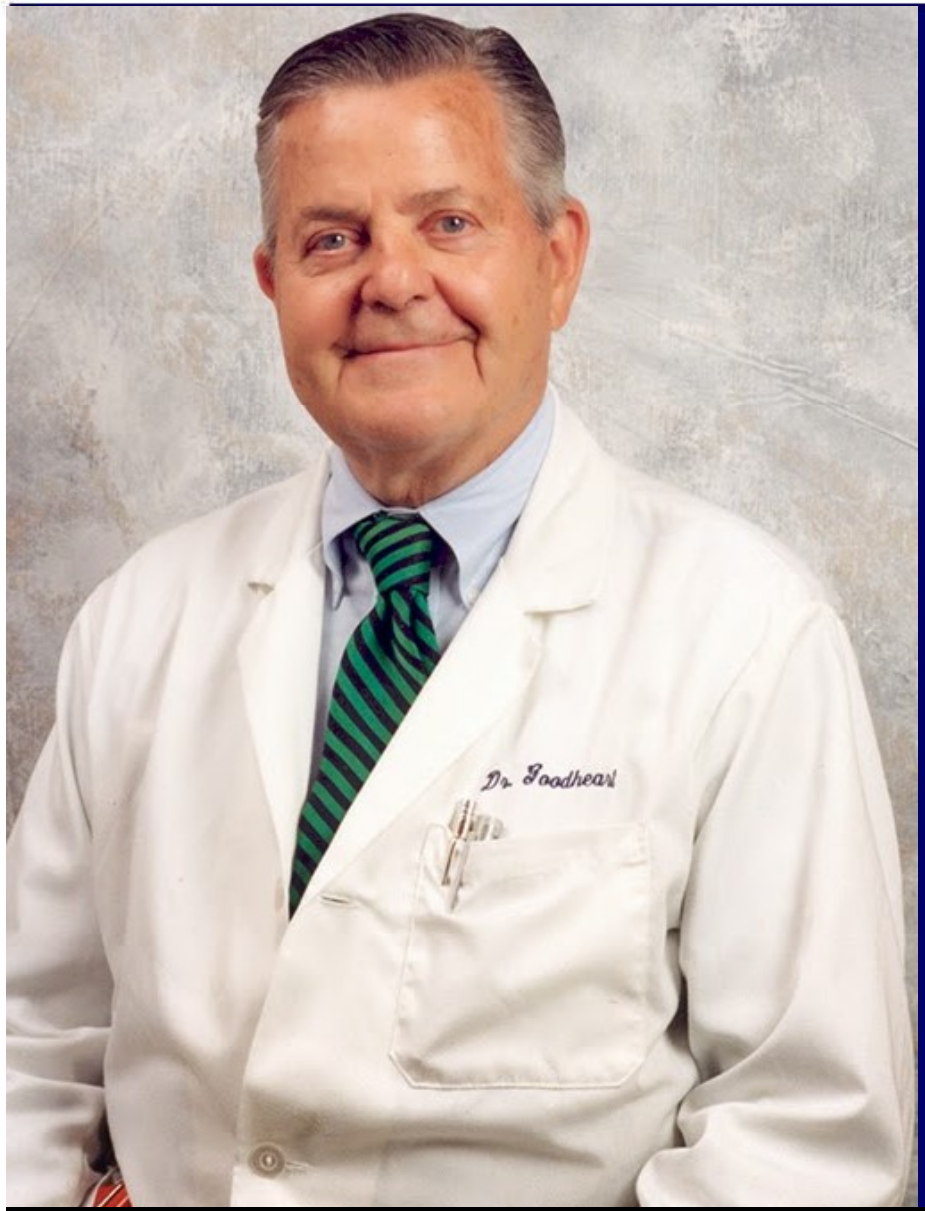
Vitamin A cannot be reclaimed and Vitamin A tends to protect against arthritis.

Being a Family Doctor by George Goodheart and Walther H. Schmitt published by Lance West DC

Dr Goodheart says

Use Vitamin A in cystitis cases

Being a Family Doctor by George Goodheart and Walther H. Schmitt published by Lance West DC



Dr Goodheart says

Use Vitamin A, B6, Essential fatty acids, Vitamin E and Selenium for dandruff.

Dry eyes

Being a Family Doctor by George Goodheart and Walther H. Schmitt published by Lance West DC

Dr Goodheart says

Use Vitamin A, B6 and Magnesium for kidney stones

Being a Family Doctor by George Goodheart and Walther H. Schmitt published by Lance West DC

Sources

Fish liver oils

Beef, Pork liver

Butter from pasture fed cows

Whole milk

FDA Daily Value (RDA)

5000 IU (1.5mg)

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

Muscles associated with Vitamin A*

Latissimus dorsi
Pectoralis major sternal
Pectoralis minor
Piriformis
Popliteus
Psoas
Quadratus lumborum
Rhomboids
Sacrospinalis
Tibilais anterior

*Applied Kinesiology Synopsis 2nd Edition by David Walther DC

Carotenoids are a family of more than 600 pigments found in nature that give colour to egg yolks, tomatoes, fungi, all green leaves, fruits, and flowers.

Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 227

Carotenoids

Lycopene
Astaxanthine
Beta carotene
Zeaxanthine*
Lutein*

Mixed carotenoids

*Both macular pigments are required for optimal eye health. Beta carotene is a direct precursor to retinal and thus to rhodopsin.

Sources

• Cantaloupe • Carrots • Dairy products • Eggs • Fortified cereals • Green leafy vegetables (e.g., spinach and broccoli) • Pumpkin • Red peppers • Sweet potatoes

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

Lutein absorbs in the 415-435nm range

Zeaxanthine absorbs in the 425-435nm range

β-Carotene absorbs in the 440-465nm range

Lycopene absorbs in the 470-515nm range

Thus making them all photo-sensitive in the blue spectrum.

Lutein levels linked to a more agile and 'youthful' brain: Study

By Will Chu

25-Jul-2017 - Last updated on 26-Jul-2017 at 15:59 GMT

Source: *Frontiers in Aging Neuroscience*
Published online ahead of print: **doi.org/10.3389/fnagi.2017.00183**
"The Role of Retinal Carotenoids and Age on Neuroelectric Indices of Attentional Control among Early to Middle-Aged Adults."
Authors: Anne Walk, *et al*

A high intake of lutein appears to slow down cognitive decline, a US study suggests, as findings appear to support previous outcomes linking this nutrient to improved mental health.

Anthocyanidins*

Most frequently occurring in nature are the glycosides of cyanidin, delphinidin, malvidin, pelargonidin (rich in strawberries), peonidin, and petunidin.

Present in Bilberry, Blueberry, Strawberry, Cranberry, Blackberry, Blackcurrant, Raspberry, Red grapes.

Flavonoids : chemistry, biochemistry, and applications. Andersen, Øyvind M., Markham, Kenneth R. CRC, Taylor & Francis. 2006. ISBN0849320216

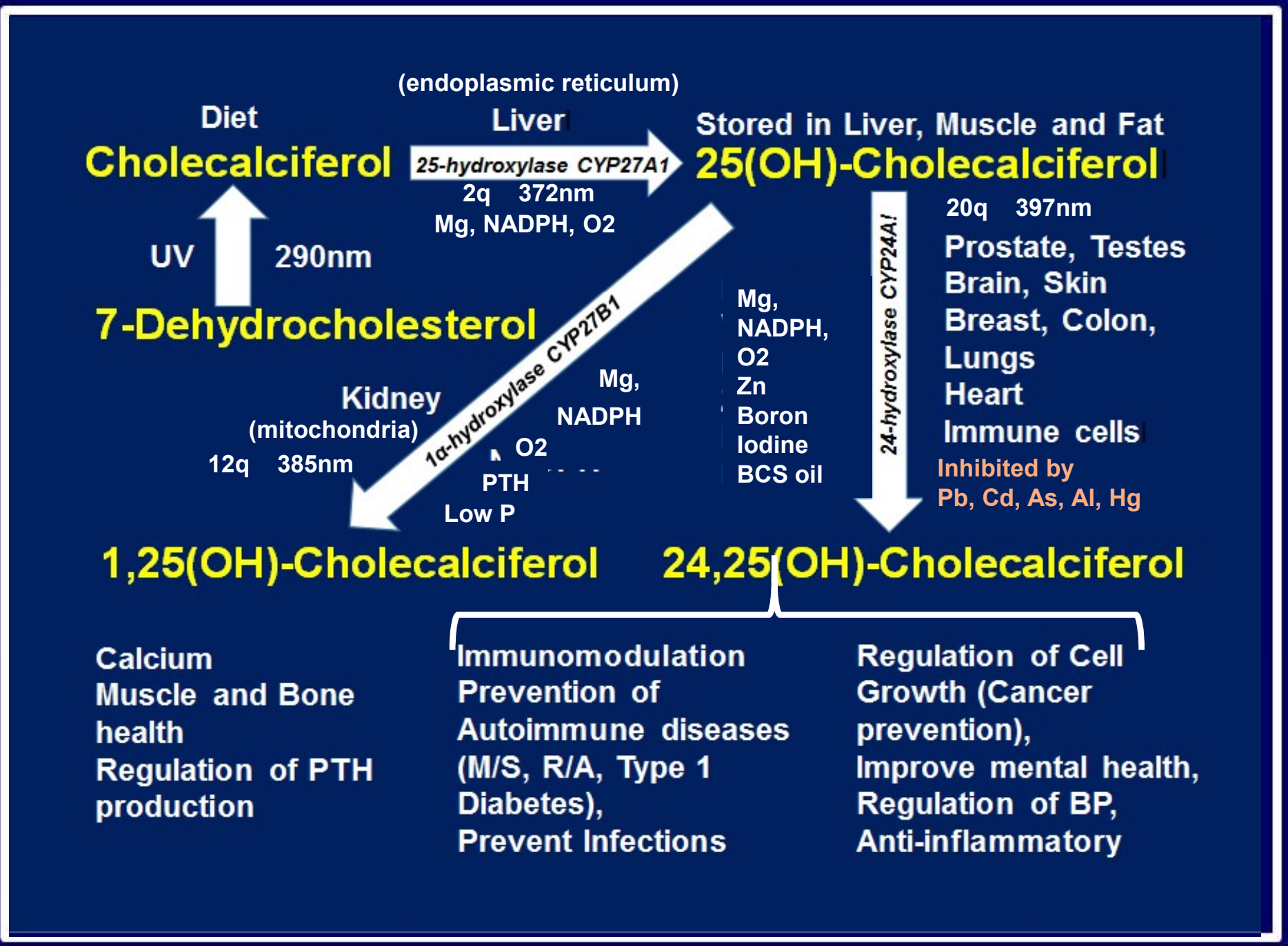
Anthocyanins* can be used as pH indicators because their colour changes with pH; they are pink in acidic solutions (pH < 7), purple in neutral solutions (pH ~ 7), greenish-yellow in alkaline solutions (pH > 7), and colourless in very alkaline solutions, where the pigment is completely reduced.

*Davies, Kevin M. (2004). *Plant pigments and their manipulation*. Wiley-Blackwell. p. 6. ISBN 1-4051-1737-0

Muscles associated with Carotenoids

Upper trapezius (ears and eyes)

Vitamin D
Cholecalciferol


(endoplasmic reticulum)
Diet
Liver
Stored in Liver, Muscle and Fat
Cholecalciferol
25-hydroxylase CYP27A1
25(OH)-Cholecalciferol
2q 372nm
Mg, NADPH, O2
UV
290nm
7-Dehydrocholesterol
1α-hydroxylase CYP27B1
Mg,
NADPH
O2
PTH
Low P
Kidney
(mitochondria)
12q 385nm
Mg,
NADPH,
O2
Zn
Boron
Iodine
BCS oil
24-hydroxylase CYP24A1
20q 397nm
Prostate, Testes
Brain, Skin
Breast, Colon,
Lungs
Heart
Immune cells
Inhibited by
Pb, Cd, As, Al, Hg
1,25(OH)-Cholecalciferol
24,25(OH)-Cholecalciferol
Calcium
Muscle and Bone
health
Regulation of PTH
production
Immunomodulation
Prevention of
Autoimmune diseases
(M/S, R/A, Type 1
Diabetes),
Prevent Infections
Regulation of Cell
Growth (Cancer
prevention),
Improve mental health,
Regulation of BP,
Anti-inflammatory

1,25(OH)-Cholecalciferol

20q 397nm

Mg,
NADPH,
O2
Zn
Boron
Iodine
BCS oil

24-hydroxylase CYP24A1

Inhibited by
Pb
Cd
As
Al
Hg

24,25(OH)-Cholecalciferol

12q 385nm

1-hydroxylase CYP27B1

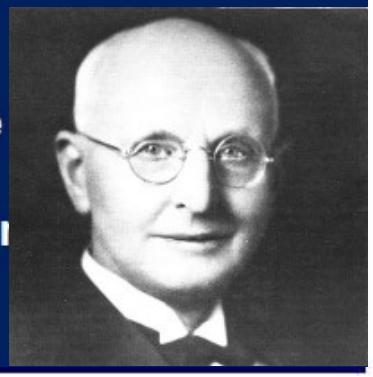
Mg,
NADPH,
O2

Vitamin
K2

1, 24, 25(OH)-Cholecalciferol
Calcitetrol
(Activator X)

Calcitetrol (1α, 24, 25-Trihydroxy D3) is the hormonally active form of vitamin D with three hydroxyl groups. Hormone modulator

Weston Price



Types of Vitamin D*

- Vitamin D2 Ergocalciferol
- Vitamin D3 Cholecalciferol
- Calcifediol (25- hydroxycholecalciferol)
- Calcitriol (1,25- hydroxycholecalciferol)
- 1,24,-hydroxycholecalciferol
- Calcitetrol (1,24,25- hydroxycholecalciferol)

*Holick MF, Schnoes HK, DeLuca HF, Suda T, Cousins RJ (July 1971). "Isolation and identification of 1,25-dihydroxycholecalciferol. A metabolite of vitamin D active in intestine". *Biochemistry*. 10 (14): 2799–804

Vitamin D comprises a group of fat-soluble compounds essential for maintaining the mineral balance in the body; the vitamin D form synthesized in humans is called ‘cholecalciferol’ (vitamin D3).* Because cholecalciferol is synthesized in the skin by the action of ultraviolet light (UVB), vitamin D doesn’t fit the classical definition of a vitamin - although this doesn’t stop it being recognized as an essential dietary nutrient.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 239

The sun is our major vitamin D source. However, several factors reduce the production of vitamin D in the skin,* including: Sunscreen with a sun protection factor above eight, age, darker skin pigmentation, northern latitude above 40 degrees and winter. Most vulnerable to low vitamin D status are breast-fed infants, elderly and institutionalized people, obese individuals and people of African origin of all ages.

**O'Connor MY, Thoreson CK, Ramsey NL, Ricks M, Sumner AE (2013). "The uncertain significance of low vitamin D levels in African descent populations: a review of the bone and cardiometabolic literature". Progress in Cardiovascular Diseases (Review). 56 (3): 261–9.*

In addition to bone health, emerging science reveals a non-skeletal benefit of vitamin D for several other health outcomes.*

**O'Connor MY, Thoreson CK, Ramsey NL, Ricks M, Sumner AE (2013). "The uncertain significance of low vitamin D levels in African descent populations: a review of the bone and cardiometabolic literature". Progress in Cardiovascular Diseases (Review). 56 (3): 261–9.*

Vitamin D3 is not really a vitamin. Rather it is a seco hormone that modulates, in a pleiotropic way, through nuclear orphan receptor activities, multiple gene expression effects to influence cellular physiology through altered gene expression.*

*Jeff Bland Functional Medicine Update April 2010

This is probably why so many clinical symptoms associated with cholecalciferol insufficiency. Because of the multiple effects this hormonal form of vitamin D (1,24, 25-dihydroxycholecalciferol) has on gene expression patterns, more than one sign or symptom can be seen.*

*Jeff Bland Functional Medicine Update April 2010

A sufficient intake of vitamin D (calciferol) is important as it helps the body to:

Maintain healthy blood levels of calcium and phosphorus

Build and maintain healthy bones

Control cell division and specialization

Modulate the immune system.*

**"Vitamin D". NIH Office of Dietary Supplements. February 11, 2016. Retrieved 6 June 2017.*

Applied Kinesiology Challenges

From a weakness for strengthening

1. Challenge with Cholecalciferol
2. Challenge with 25 (OH) Vit D3
3. Challenge with 1.25 (OH) Vit D3
4. Challenge with 24.25 (OH) Vit D3
5. Challenge with 1.24.25 (OH) Vit D3

Precursor, where applicable will weaken a strong muscle if enzyme inhibited.

Heme dependant enzymes

Hemoglobin – Carries Oxygen in red blood cells
Myoglobin – Stores Oxygen in muscle fibres
Catalase - Reduces H_2O_2 to water
Cyclo-oxygenase – Synthesizes PgE1, PgE2 and PgE3
Cystathionine synthase – Converts Homocysteine to Cysteine
Cytochrome C – Transfers electroms from Complex III to Complex IV
Cytochrome C oxidase – Tansfers electrons in Complex IV to Oxygen
Cytochrome p450 - Detoxifies endogenous and exogenous chemicals
Myeloperoxidase – Synthesises Hypochlorite from H_2O_2
Nitric oxide synthase – Synthesises Nitric oxide from Arginine
Peroxidases – Reduce H_2O_2 to water
Sulfite oxidase – Synthesises Sulfate from Cysteine sulphite

Low Heme synthesis

↓

Low 24 hydroxylase CYP 24A1 expression

↓

Low synthesis of 24, 25 (OH) Vitamin D3

↓

Low synthesis of 1, 24, 25 (OH) D3

Cheng JB, Levine MA, Bell NH, Mangelsdorf DJ, Russell DW (May 2004). "Genetic evidence that the human CYP2R1 enzyme is a key vitamin D 25-hydroxylase". *Proceedings of the National Academy of Sciences of the United States of America*. 101 (20): 7711–5.

Vitamin D is not really a vitamin since it can be synthesised in the skin but more of a steroid hormone, and under most conditions that is the major source of the vitamin.*
Only when sunlight exposure is inadequate is a dietary source required.

*Norman AW (August 2008). "From vitamin D to hormone D: fundamentals of the vitamin D endocrine system essential for good health". *The American Journal of Clinical Nutrition*. 88 (2): 491S–499S.

It is generally recognized that 1,25-dihydroxyvitamin D3 ties to multiple different tissue targets, including vascular endothelial function, neuronal function, joint-space immune function, islet cells with the release of insulin function, insulin sensitivity at peripheral tissues, and the osteoblast-to-osteoclast -

equilibrium as it relates to bone formation and reabsorption and bone turnover. We would also couple it together with things like general immunity and anti-cancer effects that have been increasingly identified to be important to vitamin D sufficiency.*

*Jeff Bland Functional Medicine Update April 2010

Vitamin D is converted to calcitriol, which is a hormone turning on 900 genes.

*Jeff Bland Functional Medicine Update April 2010 interviewing Bruce Ames

In humans, the most important compounds are vitamin D_3 (also known as cholecalciferol) and vitamin D_2 (ergocalciferol).*

******Dorland's Illustrated Medical Dictionary*, under Vitamin (Table of Vitamins)**

Its main function is in the regulation of calcium, magnesium, iron, phosphate and zinc absorption and homeostasis, NOT JUST CALCIUM.* Most of its actions are mediated by of nuclear receptors that regulate gene expression.

** Holick MF (December 2004). "Sunlight and vitamin D for bone health and prevention of autoimmune diseases, cancers, and cardiovascular disease". The American Journal of Clinical Nutrition. 80 (6 Suppl): 1678S–88S.*

Calcitriol (1.25 OH D3) circulates as a hormone in the blood, regulating the concentration of calcium and phosphate in the bloodstream and promoting the healthy growth and remodeling of bone. ***Calcitriol (1.25 OH D3)** also affects neuromuscular and immune function.

*"Vitamin D". NIH Office of Dietary Supplements. February 11, 2016. Retrieved 6 June 2017.

Diets in decline: Vitamin and nutrient deficiencies on the rise

By Nikki Cutler

07-Feb-2019 - Last updated on 07-Feb-2019 at 10:54 GMT

NUTRA ingredients.com

Vitamin D

It's expected that vitamin D levels will be lower in winter months but what's more surprising is that this vitamin deficiency is getting worse.

In the period between January and March, nearly 20% of children aged 4 to 10, 37% of children aged 11 to 18 and nearly a third of all adults were at risk of vitamin D deficiency.

Intake dropped over the nine year period with this being statistically significant for boys aged 11 to 18 years (2% per year) and adults aged 19 to 64 years (1%).

Government advice was updated in 2016 to recommend that everyone over the age of 5 years should consider taking a daily supplement containing 10µg vitamin D during the autumn and winter months. Those younger than five were recommended to take a supplement every day throughout the year.

It seems consumers are starting to head this advice. Mintel recently revealed vitamin D has, for the first time, taken over vitamin C as the nation's favourite single vitamin supplement. The research shows that its use has rocketed to see it taken by 33% of all supplement users in the UK - up 6% since 2016.

Sun exposure*

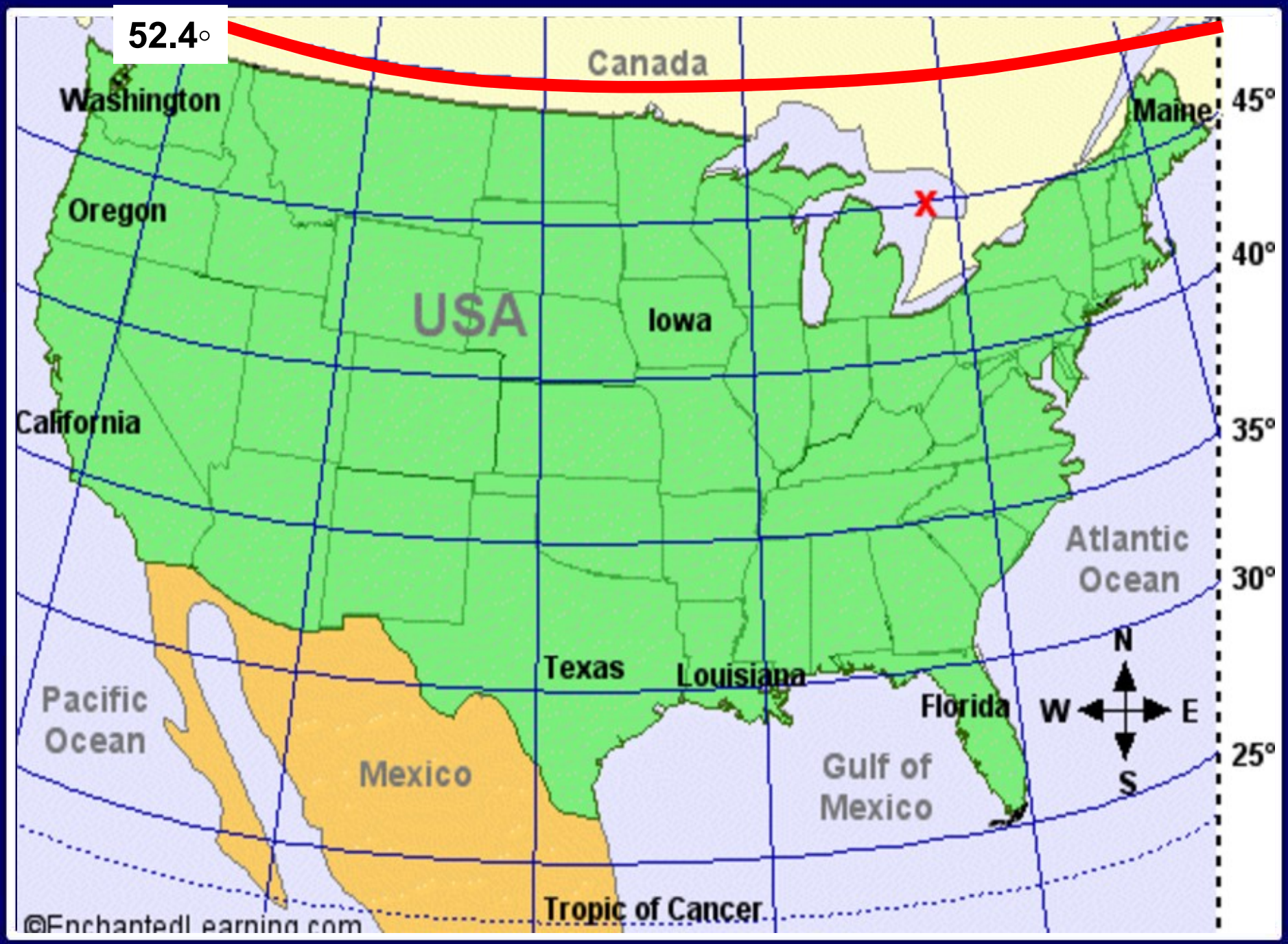
1. 1 MED (Minimal Erythermal Dose) enough sun time to give a slight pinkness to the skin.
2. Up to 20,000IU often within 30 minutes depending on skin tone.
3. No lotion. SPF 15 blocks 95%, SPF 30 and above blocks 99%.
4. Aim for 20mins of 40% skin exposure per day.

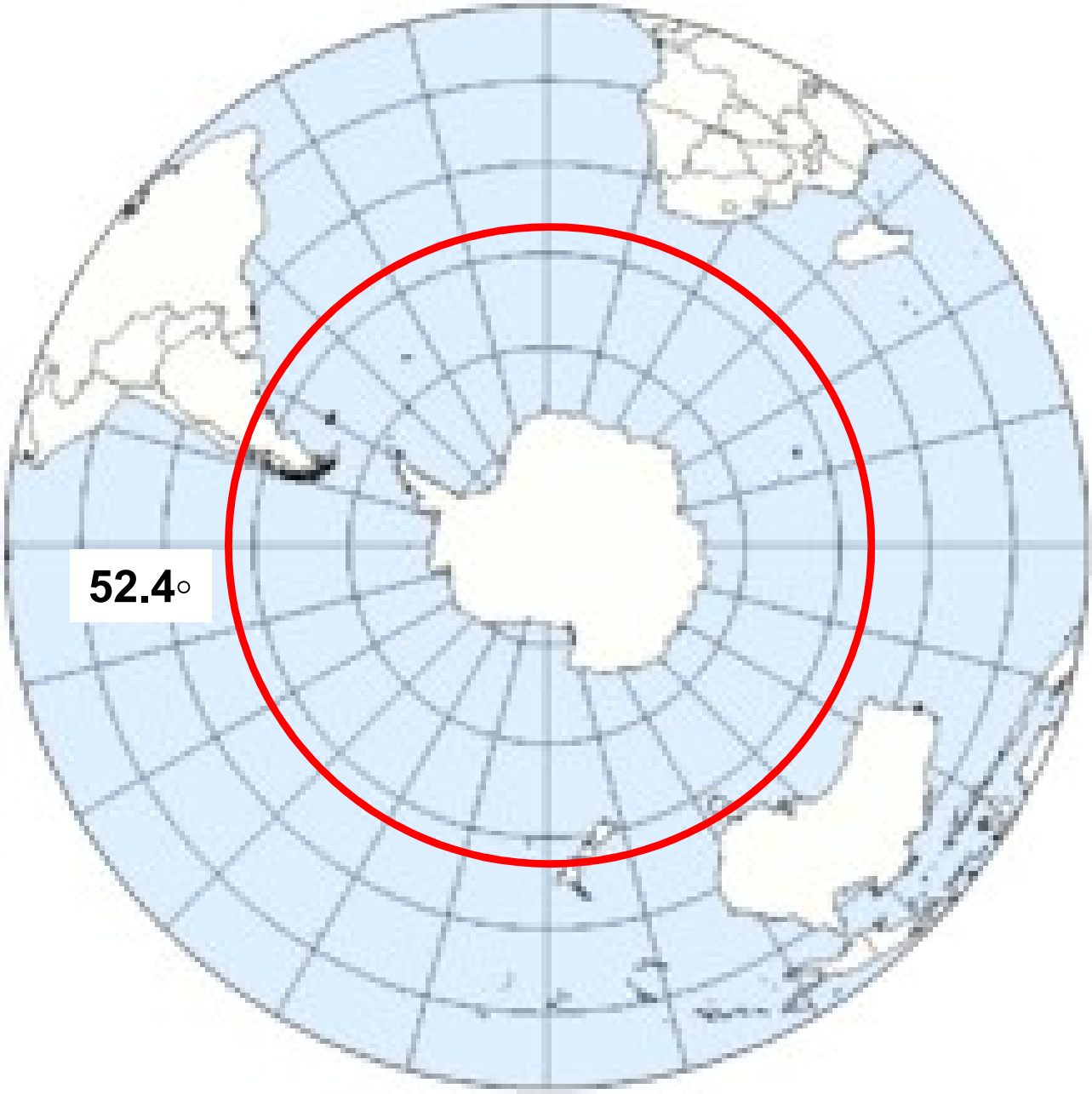
*Institute of Medicine (US) Committee to Review Dietary Reference Intakes for Vitamin D and Calcium (2011). "8, Implications and Special Concerns". In Ross AC, Taylor CL, Yaktine AL, Del Valle HB. *Dietary Reference Intakes for Calcium and Vitamin D*. Washington DC: National Academies Press. ISBN 0-309-16394-3.

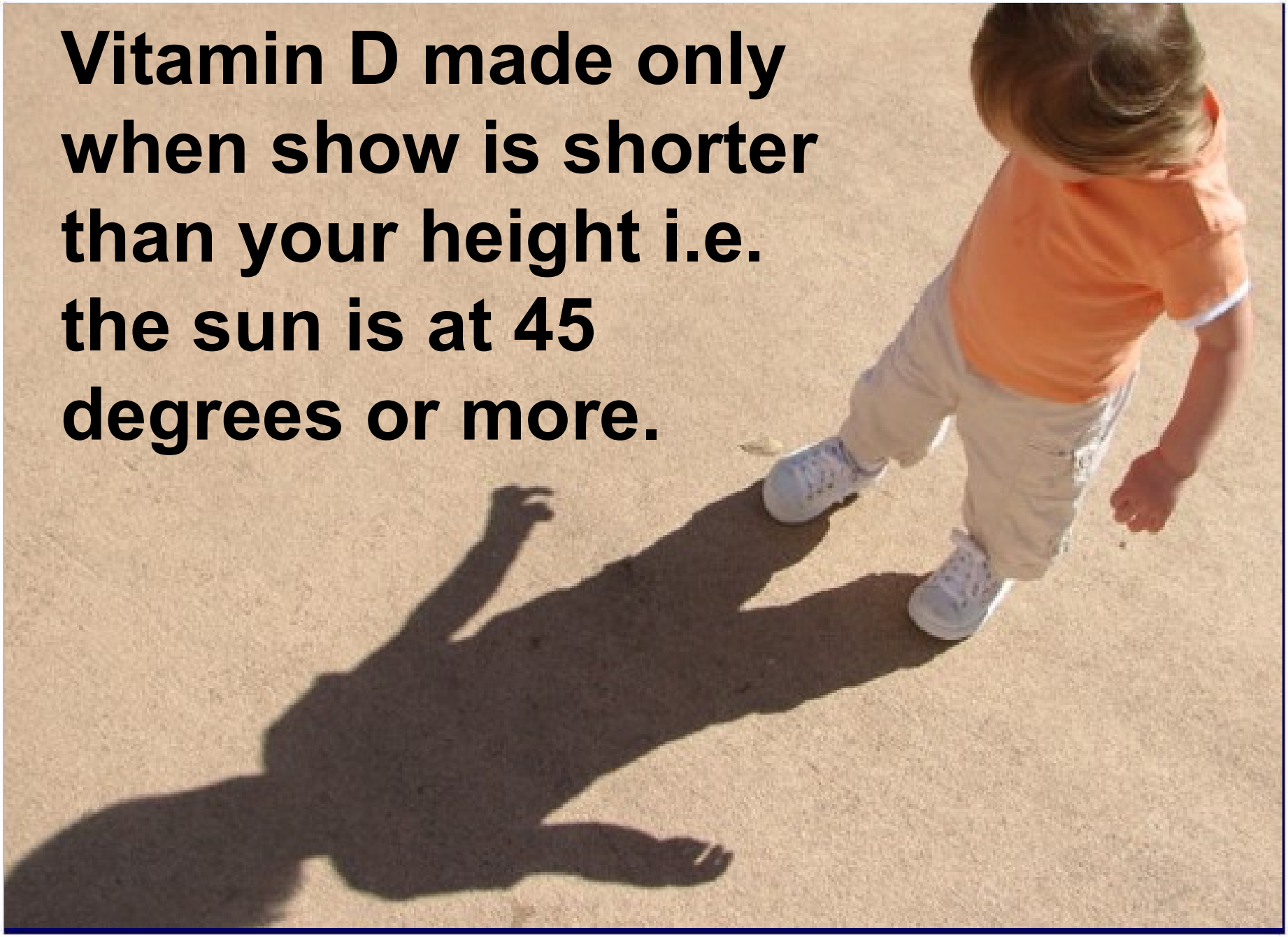
In UK September 21st to March 21st no UVA so no Vit D produced. Solely reliant upon summer production and dietary intake.* Vitamin D slowly released from fat stores over the winter. Sunshine Vitamin D half life is 2 weeks.**

*Cashman KD (2007). "Vitamin D in childhood and adolescence" *Postgraduate Medical Journal* (Review). 83(978): 230–5.
**NIH Office of Dietary Supplements. Dietary supplement fact sheet: vitamin D. http://ods.od.nih.gov/factsheets/vitamind.asp. Accessed August, 4, 2010.

Europe, North Africa, and the Middle East


52.4◦
Canada
Washington
Maine
Oregon
USA
Iowa
California
Atlantic Ocean
Pacific Ocean
Texas
Louisiana
Florida
Mexico
Gulf of Mexico
Tropic of Cancer
45°
40°
35°
30°
25°
N
W
E
S
©EnchantedLearning.com


52.4◦


Vitamin D made only when show is shorter than your height i.e. the sun is at 45 degrees or more.

Darker skin. More melanin = less Vitamin D production

Obesity – Vitamin D stored in adipose tissue (up to 40% more Vitamin D required)*

Elderly – Partly less sun exposure and reduced skin ability to synthesise Vitamin D.

*Pereira-Santos, M.; Costa, P. R. F.; Assis, A. M. O.; Santos, C. a. S. T.; Santos, D. B. (1 April 2015). "Obesity and vitamin D deficiency: a systematic review and meta-analysis". *Obesity Reviews*. 16 (4): 341–349

Optimal levels *

1 ng = 40 IU

2.5 nmol/l = 1ng/ml

<25nmol/L (10ng/ml – 400IU) Deficient

50-87.4 nmol/L (20-35ng/ml – 800-1400IU) Insufficient

125-250nmol/L (50-100ng/ml – 2000-4000IU) Optimal

*Ross AC, Taylor CL, Yaktine AL, Del Valle HB (2011). *Dietary Reference Intakes for Calcium and Vitamin D*. Washington, D.C: National Academies Press.

45 year olds across the UK (latitude 52.4º) between 2002-2004 Using <75nmol/L as reference range.

Nearly 90% of subjects deficient in the winter.

60% of subjects deficient all year.

Common Clinical Symptoms

Low back pain

Diffuse body aches and pains

Growing pains

Tender bones on palpation

Shin pain, Hair loss

Depression*, Frequent infections.

Fatigue, Sweating

Steroid hormone imbalances

*Shaffer JA, Edmondson D, Wasson LT, Falzon L, Homma K, Ezeokoli N, Li P, Davidson KW (April 2014). "Vitamin D supplementation for depressive symptoms: a systematic review and meta-analysis of randomized controlled trials". *Psychosomatic Medicine*.

How does deficiency cause symptoms.

1. Less calcium absorbed
   - i) Increased PTH
   - ii) Release of calcium from bone
   - iii) Unable to mineralise collagen matrix
   - iv) Hydrates and expands periosteal coverings

How does deficiency cause symptoms.

2. Central hypersensitivity

i) Nociceptors express Vitamin D receptors

ii) Deficiency leads to hyper-innervation of skeletal muscle leading to muscle hypersensitivity and pain.

How does deficiency cause symptoms.

3. Pro-inflammatory state

i) Deficiency shown to create higher scores on Severity Scale for Somatic Symptoms (SSS)

ii) Vitamin D shown to reduce hs-CRP levels

Rickets,is characterized by impeded growth and soft, weak, deformed long bones that bend and bow under their weight as children start to walk. This condition is characterized by bow legs, which can be caused by calcium or phosphorus deficiency, as well as a lack of vitamin D.*

**Brown JE, Isaacs J, Krinke B, Lechtenberg E, Murtaugh M (28 June 2013). Nutrition Through the Life Cycle. Cengage Learning.*


Rickets


Osteomalacia

Osteomalacia is a disease in adults that results from vitamin D deficiency. Characteristics of this disease are softening of the bones, leading to bending of the spine, bowing of the legs, proximal muscle weakness, bone fragility, and increased risk for fractures.*

*Insel P, Ross D, Bernstein M, McMahon K (18 March 2015). *Discovering Nutrition*. Jones & Bartlett Publishers.

Osteomalacia reduces calcium absorption and increases calcium loss from bone, which increases the risk for bone fractures. Osteomalacia is usually present when 25-hydroxyvitamin D levels are less than about **10 ng/mL**. The effects of osteomalacia are thought to contribute to chronic musculoskeletal pain.*

*Insel P, Ross D, Bernstein M, McMahon K (18 March 2015). *Discovering Nutrition*. Jones & Bartlett Publishers.

Vitamin D toxicity is rare.* The threshold for vitamin D toxicity has not been established. Vitamin D toxicity is not caused by sunlight exposure (self regulating), but can be caused by supplementing with very high doses of vitamin D.

*"Vitamin D deficiency". *The New England Journal of Medicine*. 357 (3): 266–81.

In healthy adults, sustained intake of more than 1250 µg/day (50,000 IU) can produce overt toxicity after several months and can increase serum 25-hydroxyvitamin D levels to 150 ng/ml and greater.*

****Vitamin D* at Merck Manual of Diagnosis and Therapy Professional Edition**

Hypercalcemia* **is a strong indication of vitamin D toxicity, noted with an increase in urination and thirst.**

"Vitamin D supplementation, 25-hydroxyvitamin D concentrations, and safety" (PDF). *The American Journal of Clinical Nutrition*

If hypercalcemia is not treated, it results in excess deposits of calcium in soft tissues and organs such as the kidneys, liver, and heart, resulting in pain and organ damage.

Test with calcium phosphate.

"Vitamin D supplementation, 25-hydroxyvitamin D concentrations, and safety" (PDF). *The American Journal of Clinical Nutrition*

Exposure to sunlight for extended periods of time does not normally cause vitamin D toxicity. Within about 20 minutes of ultraviolet exposure in light-skinned individuals the concentrations of vitamin D precursors produced in the skin reach an equilibrium, and any further vitamin D produced is degraded.*

*Holick MF (July 2007). "Vitamin D deficiency". *The New England Journal of Medicine*

Vitamin D_3 (cholecalciferol) is produced through the action of ultraviolet irradiation (270-300nm) on it's precurser

7-dehydrocholesterol.

This molecule occurs naturally in the skin of animals and in milk.

Vitamin D_3 can also be made by exposing milk directly to UV (one commercial method).

Vitamin D_3 is also found in oily fish, cod liver oil, hempseed oil and coco husks.

*Holick MF (November 2005). "The vitamin D epidemic and its consequences"(PDF). *The Journal of Nutrition*. 135(11): 2739S–48S. PMID 16251641. [Vitamin D3] is produced commercially by extracting 7-dehydrocholesterol from wool fat, followed by UVB irradiation and purification [...] [Vitamin D2] is commercially made by irradiating and then purifying the ergosterol extracted from yeast

Vitamin D_2 is a derivative of ergosterol, which is produced by some kinds higher fungi such as mushrooms. The vitamin ergocalciferol (D_2) is produced from ergosterol, in response to UV irradiation.*

*Holick MF (November 2005). "The vitamin D epidemic and its consequences"(PDF). *The Journal of Nutrition*. 135(11): 2739S–48S. PMID 16251641. [Vitamin D3] is produced commercially by extracting 7-dehydrocholesterol from wool fat, followed by UVB irradiation and purification [...] [Vitamin D2] is commercially made by irradiating and then purifying the ergosterol extracted from yeast

The biological fate for producing 25(OH)D from vitamin D_2 is expected to be the same as for 25(OH)D_3, although some controversy exists over whether or not D_2 can fully substitute for vitamin D_3 in the human diet.

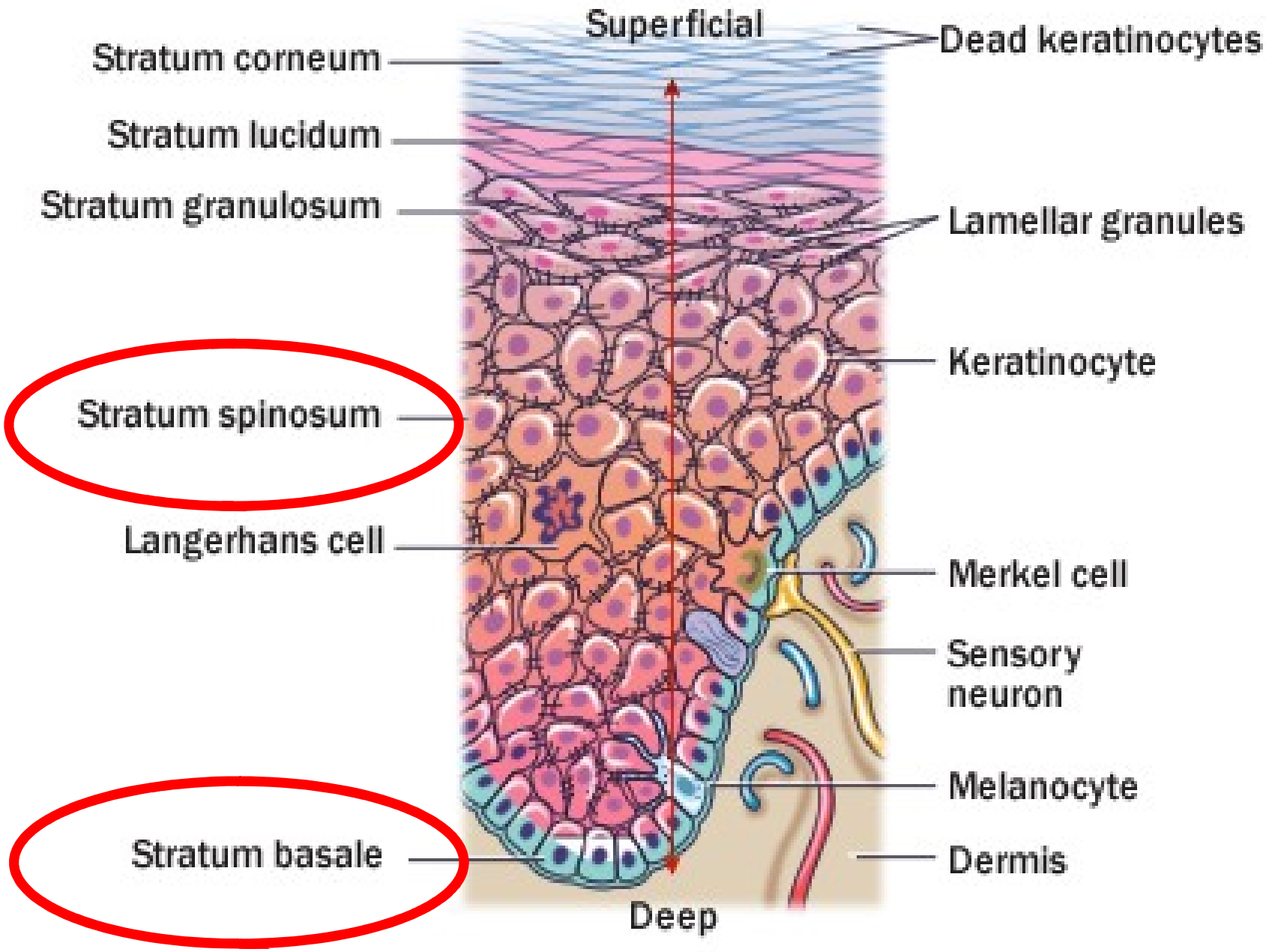
Exposure to light through windows is insufficient because glass almost completely blocks UVB light.*

**C. Claiborne Ray (May 17, 2005). "Sunshine Vitamin D". The New York Times. Archived from the original on February 21, 2013. Retrieved March 8, 2013.*

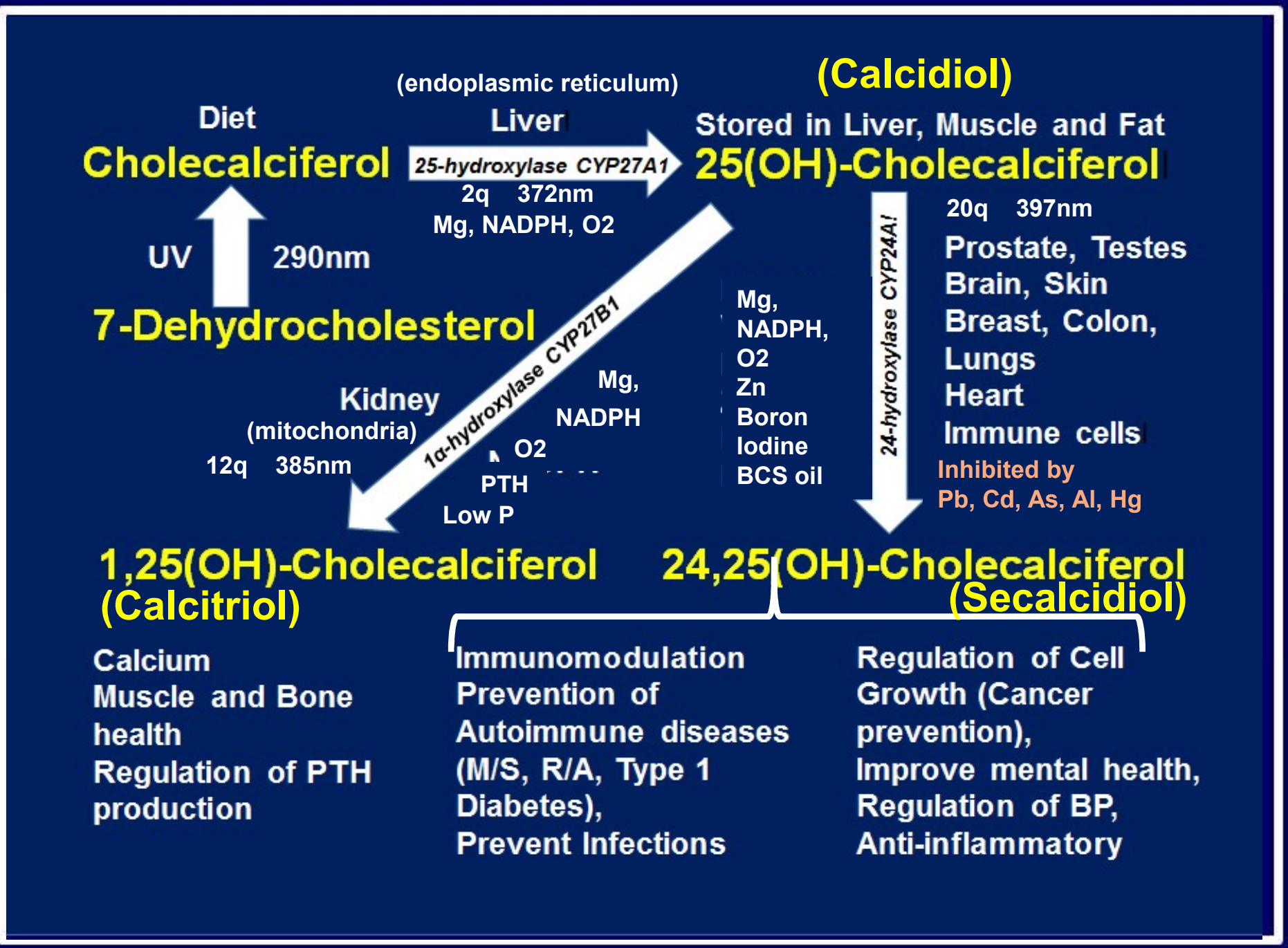
*Jump up^ *Bolton J. "UV FAQs". International Ultraviolet Association. Archived from the original on May 30, 2013.*

In the epidermal strata of the skin, production is greatest in the stratum basal and stratum spinosum.*

*Holick MF, Smith E, Pincus S (December 1987). "Skin as the site of vitamin D synthesis and target tissue for 1,25-dihydroxyvitamin D3. Use of calcitriol (1,25-dihydroxyvitamin D3) for treatment of psoriasis". *Archives of Dermatology*. 123 (12): 1677–1683a.


Superficial
Dead keratinocytes
Stratum corneum
Stratum lucidum
Stratum granulosum
Lamellar granules
Keratinocyte
Stratum spinosum
Langerhans cell
Merkel cell
Sensory neuron
Melanocyte
Stratum basale
Dermis
Deep

Activation of Vitamin D


(endoplasmic reticulum)
(Calcidiol)
Diet
Liver
Stored in Liver, Muscle and Fat
Cholecalciferol
25-hydroxylase CYP27A1
25(OH)-Cholecalciferol
2q 372nm
Mg, NADPH, O2
UV
290nm
20q 397nm
Prostate, Testes
Brain, Skin
Breast, Colon,
Lungs
Heart
Immune cells
Inhibited by
Pb, Cd, As, Al, Hg
7-Dehydrocholesterol
1α-hydroxylase CYP27B1
24-hydroxylase CYP24A1
Mg,
NADPH,
O2
Zn
Boron
Iodine
BCS oil
Kidney
(mitochondria)
12q 385nm
Mg,
NADPH
O2
PTH
Low P
1,25(OH)-Cholecalciferol
(Calcitriol)
24,25(OH)-Cholecalciferol
(Secalcidiol)
Calcium
Muscle and Bone
health
Regulation of PTH
production
Immunomodulation
Prevention of
Autoimmune diseases
(M/S, R/A, Type 1
Diabetes),
Prevent Infections
Regulation of Cell
Growth (Cancer
prevention),
Improve mental health,
Regulation of BP,
Anti-inflammatory

1,25(OH)-Cholecalciferol

20q 397nm

Mg,
NADPH,
O2
Zn
Boron
Iodine
BCS oil

24-hydroxylase CYP24A1

Inhibited by
Pb
Cd
As
Al
Hg

24,25(OH)-Cholecalciferol

12q 385nm

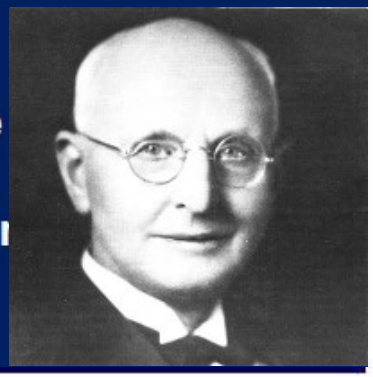
1-hydroxylase CYP27B1

Mg,
NADPH,
O2

1, 24, 25(OH)-Cholecalciferol
Calcitetrol
(Activator X)

Calcitetrol (1α, 24, 25-Trihydroxy D3) is the hormonally active form of vitamin D with three hydroxyl groups. Hormone modulator

Vitamin K2
Weston Price



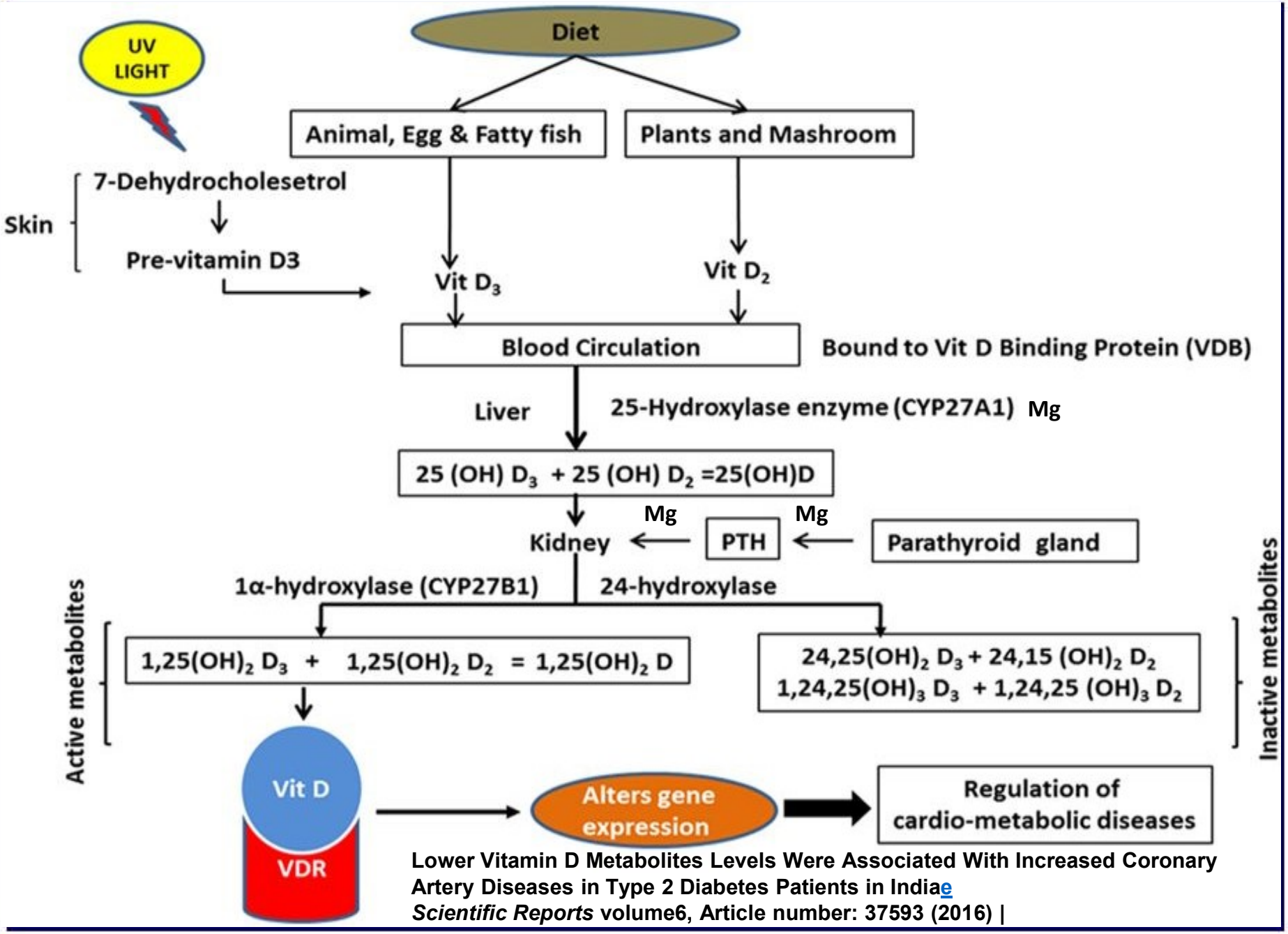
Vitamin D 25-hydroxylase **is a member of the cytochrome P450 superfamily of enzymes. An inherited mutation in the *CYP27A1* gene which eliminates the enzyme activity and is associated with low circulating levels of 25-hydroxyvitamin D and classic symptoms of vitamin D deficiency.**

Calcidiol is transported to the proximal tubules of the kidneys, where it is hydroxylated at the 1-α position to form **calcitriol** (1,25-dihydroxycholecalciferol and abbreviated to 1,25$(OH)_2$D). This product is a potent ligand of the vitamin D receptor, which mediates some of the physiological actions of the vitamin.*

*Adams JS, Hewison M (February 2010). "Update in vitamin D". *The Journal of Clinical Endocrinology and Metabolism*. 95 (2): 471–8.

The conversion of 25 OH D3 to 1.25 OH D3 is catalyzed by the enzyme *25-hydroxyvitamin D_3 1-alpha-hydroxylase*, the levels of which are increased by parathyroid hormone (and additionally by low calcium or phosphate) and modulated by magnesium.*

*Adams JS, Hewison M (February 2010). "Update in vitamin D". *The Journal of Clinical Endocrinology and Metabolism*. 95 (2): 471–8.



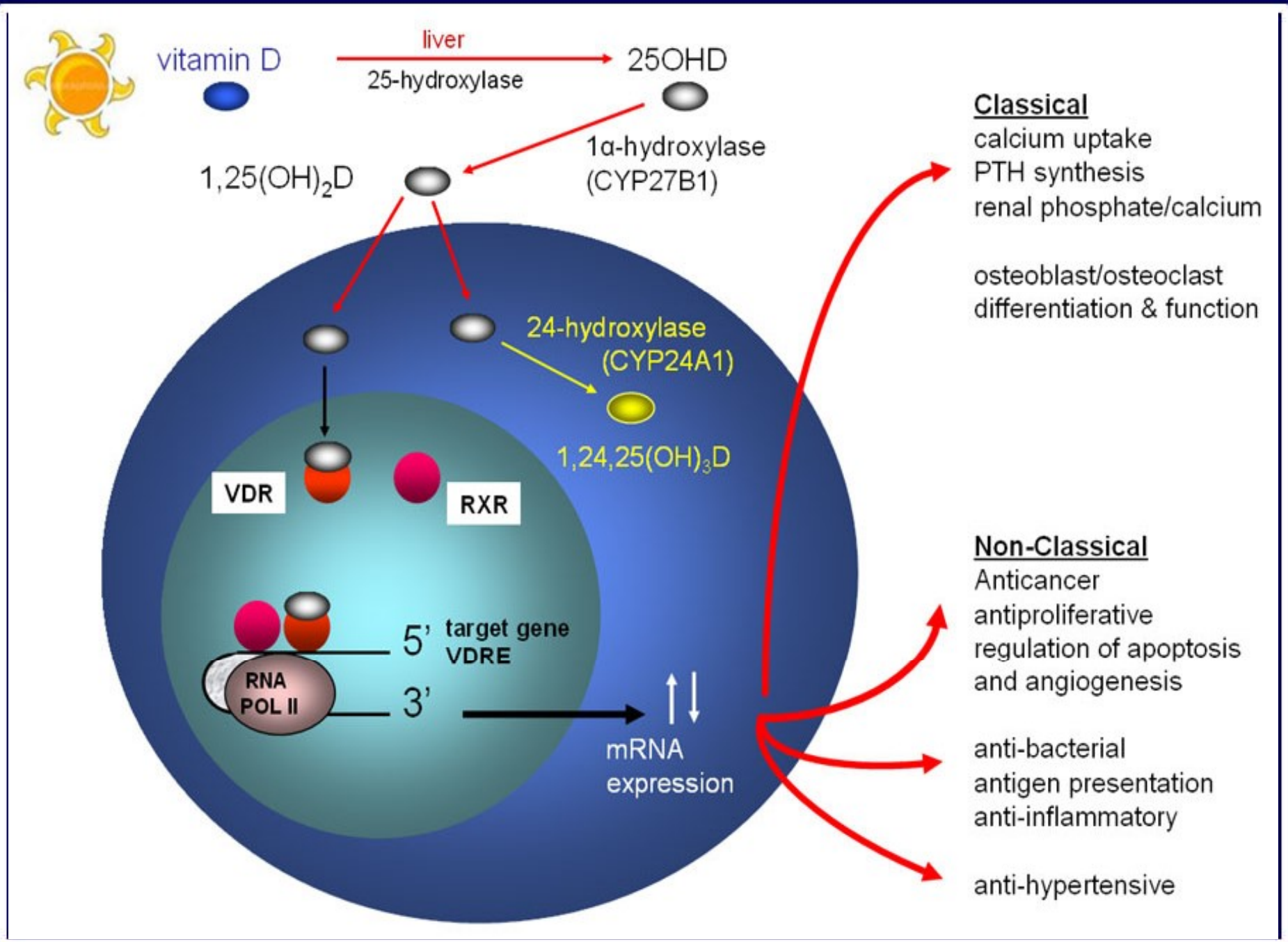
Lower Vitamin D Metabolites Levels Were Associated With Increased Coronary Artery Diseases in Type 2 Diabetes Patients in Indiae
Scientific Reports volume6, Article number: 37593 (2016) |

25-Hydroxyvitamin D_3 1-alpha-hydroxylase **is also known as cytochrome p450 (CYP27B1). is located in the proximal tubule of the kidney and a variety of other tissues, including skin (keratinocytes), immune cells, and bone (osteoblasts).**

Calcidiol + NADPH + H_+ + O2 = Calcitriol + NADP + H2O

The active vitamin D metabolite calcitriol mediates its biological effects by binding to the vitamin D receptor (VDR), which is principally located in the nuclei of target cells.*

*Adams JS, Hewison M (February 2010). "Update in vitamin D". *The Journal of Clinical Endocrinology and Metabolism*. 95 (2): 471–8.


vitamin D
liver
25-hydroxylase
25OHD
1α-hydroxylase
(CYP27B1)
1,25(OH)2D
24-hydroxylase
(CYP24A1)
1,24,25(OH)3D
VDR
RXR
5'
target gene
VDRE
RNA
POL II
3'
mRNA
expression
Classical
calcium uptake
PTH synthesis
renal phosphate/calcium
osteoblast/osteoclast
differentiation & function
Non-Classical
Anticancer
antiproliferative
regulation of apoptosis
and angiogenesis
anti-bacterial
antigen presentation
anti-inflammatory
anti-hypertensive

The binding of calcitriol to the VDR allows the VDR to act as a transcription factor that modulates the gene expression of transport proteins, which are involved in calcium absorption in the intestine.*

*Adams JS, Hewison M (February 2010). "Update in vitamin D". *The Journal of Clinical Endocrinology and Metabolism*. 95 (2): 471–8.

The Vitamin D receptor belongs to the nuclear receptor superfamily of steroid / thyroid hormone receptors, and VDRs are expressed by cells in most organs, including the brain, heart, skin, gonads, prostate, and breast.*

**Moore DD, Kato S, Xie W, Mangelsdorf DJ, Schmidt DR, Xiao R, Kliewer SA (December 2006). "International Union of Pharmacology. LXII. The NR1H and NR1I receptors: constitutive androstane receptor, pregnene X receptor, farnesoid X receptor alpha, farnesoid X receptor beta, liver X receptor alpha, liver X receptor beta, and vitamin D receptor". Pharmacol. Rev. 58 (4): 742–59.*

VDR activation in the intestine, bone, kidney, and parathyroid gland cells leads to the maintenance of calcium and phosphorus levels in the blood (with the assistance of parathyroid hormone and calcitonin) and to the maintenance of bone content.*

*Adams JS, Hewison M (February 2010). "Update in vitamin D". *The Journal of Clinical Endocrinology and Metabolism*. 95 (2): 471–8.

Osteoclasts reabsorb bone

Stimulated by	Inhibited by
Vitamin A	Calcitonin
Parathyroid hormone	Estrogens
1,25 OH D3	TGF-β
IL1 and IL6	INFα
TNF	PgE2
TGF-α	

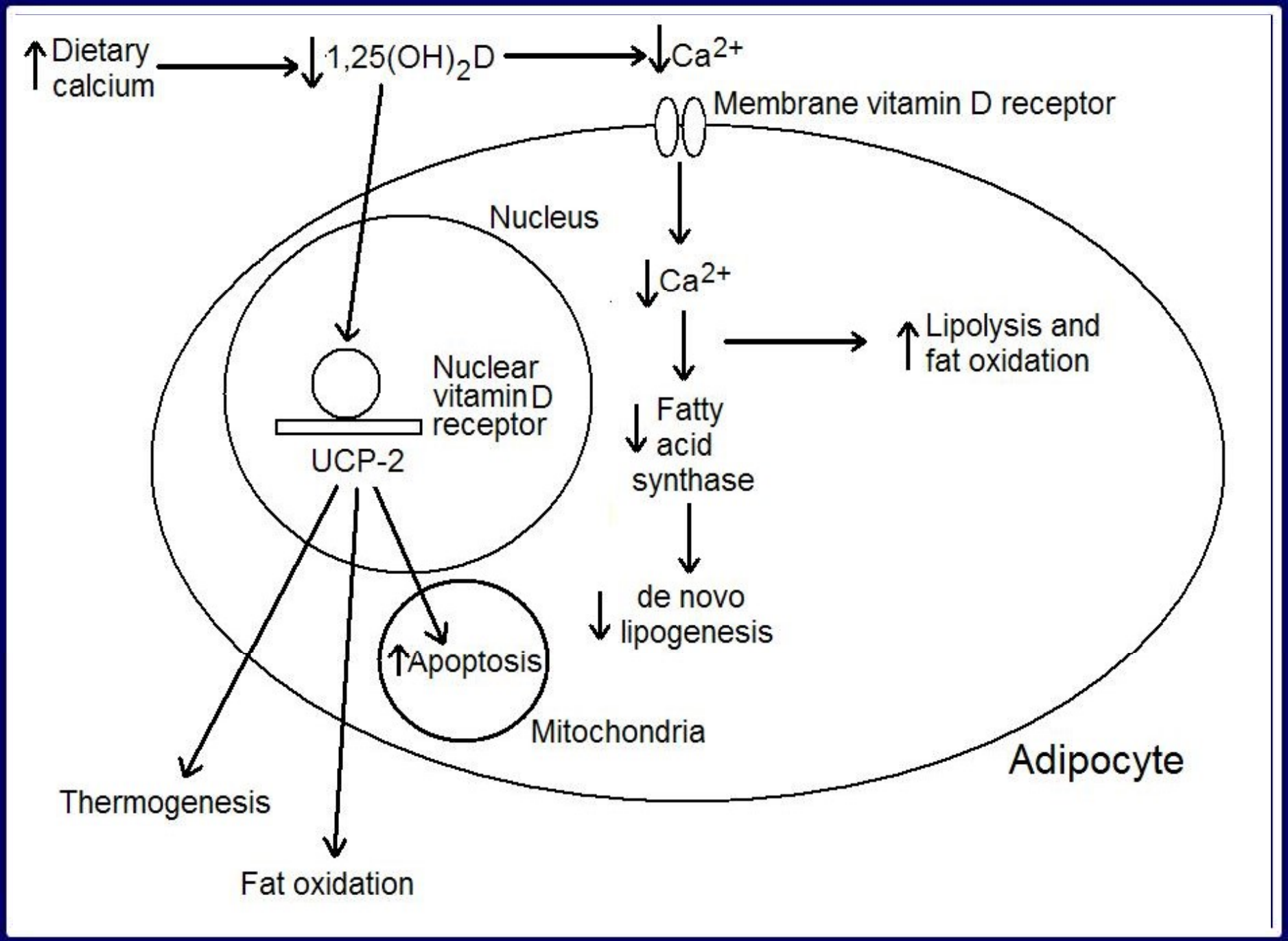
Osteoblasts form bone.

Stimulated by

Parathyroid hormone
1,25-OH D3
T3 and T4
hGF and IGF-1
PgE2
TGF-β
Progesterone
DHEA
Testosterone
Dihydrotestosterone in women

Inhibited by

Corticosteroids


↑Dietary calcium
↓1,25(OH)2D
↓Ca2+
Membrane vitamin D receptor
Nucleus
↓Ca2+
↑Lipolysis and fat oxidation
Nuclear vitamin D receptor
UCP-2
↓Fatty acid synthase
↓de novo lipogenesis
↑Apoptosis
Mitochondria
Adipocyte
Thermogenesis
Fat oxidation

Thus, although it may initially appear paradoxical, Vitamin D is also critical for bone re-modeling through its role as a potent stimulator of bone resorption.

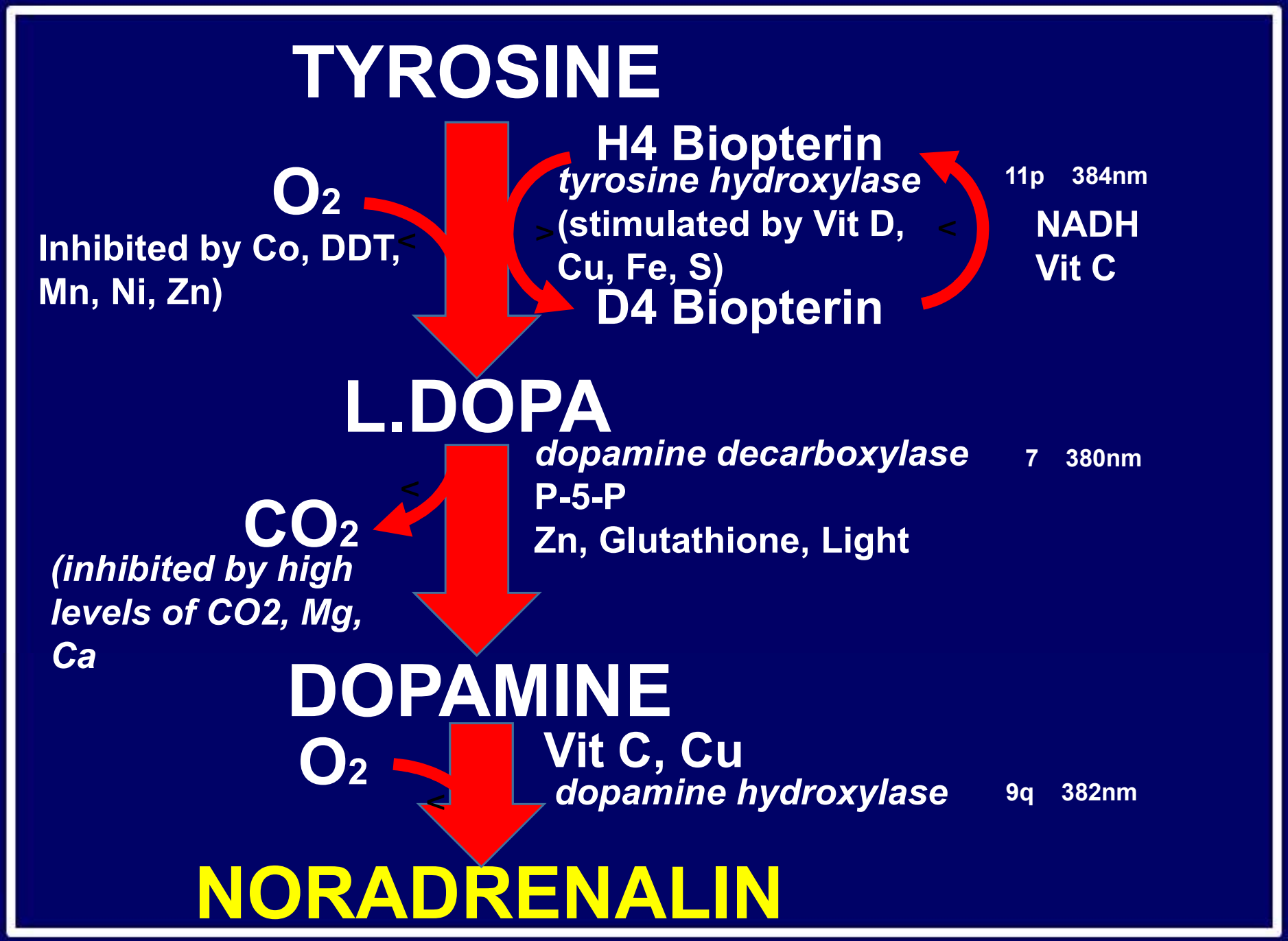
The VDR is known to be involved in cell proliferation and differentiation.

Glucocorticoids are known to decrease expression of VDR, which is expressed in most tissues of the body and regulate intestinal transport of calcium, iron and other minerals.*

*Fleet JC, Schoch RD (August 2010). "Molecular Mechanisms for Regulation of Intestinal Calcium Absorption by Vitamin D and Other Factors". *Crit Rev Clin Lab Sci*. 47 (4): 181–195.

Vitamin D also affects the immune system, and VDRs are expressed in several white blood cells, including monocytes, macrophages and activated T and B cells.

Vitamin D increases expression of the ***tyrosine hydroxylase*** gene in adrenal medullary cells.


TYROSINE
H4 Biopterin
tyrosine hydroxylase
(stimulated by Vit D, Cu, Fe, S)
D4 Biopterin
11p 384nm
NADH
Vit C
O2
Inhibited by Co, DDT, Mn, Ni, Zn)
L.DOPA
dopamine decarboxylase
P-5-P
Zn, Glutathione, Light
7 380nm
CO2
(inhibited by high levels of CO2, Mg, Ca
DOPAMINE
O2
Vit C, Cu
dopamine hydroxylase
9q 382nm
NORADRENALIN

It also is involved in the biosynthesis of

1. Neurotrophic (small peptides) factors

2. Synthesis of nitric oxide synthase

3. Increased glutathione levels.*

** Puchacz E, Stumpf WE, Stachowiak EK, Stachowiak MK (February 1996). "Vitamin D increases expression of the tyrosine hydroxylase gene in adrenal medullary cells". Brain Research. Molecular Brain Research. 36 (1): 193–6.*

Daily dosage

United States		
Age group	**RDA (IU/day)**	**(µg/day)**[56]
Infants 0–6 months	400*	10
Infants 6–12 months	400*	10
1–70 years	600	15
71+ years	800	20
Pregnant/Lactating	600	15
Age group	**Tolerable upper intake level (IU/day)**	**(µg/day)**
Infants 0–6 months	1,000	25
Infants 6–12 months	1,500	37.5
1–3 years	2,500	62.5
4–8 years	3,000	75
9+ years	4,000	100
Pregnant/lactating	4,000	100 [56]

"Federal Register May 27, 2016 Food Labeling: Revision of the Nutrition and Supplement Facts Labels. FR page 33982"

Canada		
Age group	RDA (IU)	Tolerable upper intake (IU)[110]
Infants 0–6 months	400*	1,000
Infants 7–12 months	400*	1,500
Children 1–3 years	600	2,500
Children 4–8 years	600	3,000
Children and Adults 9–70 years	600	4,000
Adults > 70 years	800	4,000
Pregnancy & Lactation	600	4,000

"Vitamin D and Calcium: Updated Dietary Reference Intakes". Nutrition and Healthy Eating. Health Canada. Retrieved April 28, 2018

Australia and New Zealand		
Age group	Adequate Intake (µg)	Upper Level of Intake (µg)[111]
Infants 0–12 months	5*	25
Children 1–18 years	5*	80
Adults 19–50 years	5*	80
Adults 51–70 years	10*	80
Adults > 70 years	15*	80

Salleh A (June 12, 2012). "Vitamin D food fortification on the table". Australian Broadcasting Corporation

European Food Safety Authority		
Age group	Adequate Intake (µg)[112]	Tolerable upper limit (µg)[113]
Infants 0–12 months	10	25
Children 1–10 years	15	50
Children 11–17 years	15	100
Adults	15	100
Pregnancy & Lactation	15	100
* Adequate intake, no RDA/RDI yet established		

EFSA Panel on Dietetic Products, Nutrition and Allergies (NDA) (29 June 2016). "Dietary reference values for vitamin D". doi:10.2903/j.efsa.2016.4547. Retrieved 28 April 2018

Most of us have learned that 25-hydroxyvitamin D is an analyte in the serum that is useful for evaluating vitamin D status to see whether a patient needs to be supplemented, as a conditionally essential nutrient, with additional vitamin D3.*

*Jeff Bland Functional Medicine Update April 2010

Levels in the plasma that are below 20 nanograms per milliliter for 25-hydroxy D are suggestive of functional vitamin D insufficiency. Although not yet in the ricketic range, these individuals are not in the optimal range of availability of this extraordinary nuclear orphan receptor agonist called 1,25-dihydroxyvitamin D3.

*Jeff Bland Functional Medicine Update April 2010

Generally, the range of 30-50 nanograms per mL in the serum is recommended. With oral supplementation of vitamin D3, one can track the increasing levels in of the 25-hydroxy in the serum to monitor a patients sufficiency.*

*Jeff Bland Functional Medicine Update April 2010

Hearney and Holick contend the human physiology is fine-tuned to an intake of 4,000–12,000 IU/day from sun exposure with concomitant serum 25-hydroxyvitamin D levels of 40 to 80 ng/ml (100-200 nmol/l) and this is required for optimal health.

(1 ng/ml = 2.5 nmol/l)

A serum 25-hydroxyvitamin D level of 20-50 ng/ml (150 nmol/l) is desirable for bone and overall health.

The risk of cardiovascular disease is lower when vitamin D ranged from 8-24 ng/ml (20 to 60 nmol/l – 800-2400IU).

Health benefits*

Cancer

Cardiovascular disease

Hypertension

Diabetes

Mortality

Bone health

Multiple sclerosis

Immune system

Muscle function. Inflammatory response

*European Food Safety Authority (EFSA) Panel on Dietetic Products, Nutrition and Allergies (NDA) (2010). "Scientific opinion on the substantiation of health claims related to vitamin D and normal function of the immune system and inflammatory response (ID 154, 159), maintenance of normal muscle function (ID 155) and maintenance of normal cardiovascular function (ID 159) pursuant to Article 13(1) of Regulation (EC) No 1924/2006". *EFSA Journal*. 8(2): 1468–85.

Serum concentration of 25(OH)D is the best indicator of vitamin D status. It reflects vitamin D produced cutaneously and that obtained from food and supplements and has a fairly long circulating half-life of 15 days.

25(OH)D functions as a biomarker of exposure, but it is not clear to what extent 25(OH)D levels also serve as a biomarker of effect (i.e., relating to health status or outcomes).

Serum 25(OH)D levels do not indicate the amount of vitamin D stored in body tissues.

In contrast to 25(OH)D, circulating 1,25$(OH)_2$D is generally not a good indicator of Vitamin D status because it has a short half-life of 15 hours and serum concentrations are closely regulated by parathyroid hormone, calcium, and phosphate. *

*Calcitriol (1,25-dihydroxyvitamin D_3), the active form of vitamin D, has a half-life of about 15 hours, while calcidiol (25-hydroxyvitamin D_3) has a half-life of about 15 days. NIH Office of Dietary Supplements. Dietary supplement fact sheet: vitamin D. http://ods.od.nih.gov/factsheets/vitamind.asp. Accessed August, 4, 2010

Levels of 1,25$(OH)_2$D do not typically decrease until Vitamin D deficiency is severe.*

*Calcitriol (1,25-dihydroxyvitamin D_3), the active form of vitamin D, has a half-life of about 15 hours, while calcidiol (25-hydroxyvitamin D_3) has a half-life of about 15 days. NIH Office of Dietary Supplements. Dietary supplement fact sheet: vitamin D. http://ods.od.nih.gov/factsheets/vitamind.asp. Accessed August, 4, 2010

Enzymes that are induced by Vitamin D

The VDR regulates cell proliferation and differentiation. Vitamin D also affects the immune system, and VDRs are expressed in several white blood cells, including monocytes and activated T and B cells.*

*Watkins RR, Lemonovich TL, Salata RA (May 2015). "An update on the association of vitamin D deficiency with common infectious diseases". *Canadian Journal of Physiology and Pharmacology*. 93 (5): 363–8.

In vitro, vitamin D increases expression of the tyrosine hydroxylase gene in adrenal medullary cells, and affects the synthesis of neurotrophic factors, nitric oxide synthase, and glutathione.*

*Puchacz E, Stumpf WE, Stachowiak EK, Stachowiak MK (February 1996). "Vitamin D increases expression of the tyrosine hydroxylase gene in adrenal medullary cells". *Brain Research. Molecular Brain Research*. 36 (1): 193–6

Enzymes that are induced by Vitamin D*

Tyrosine hydroxylase
Tryptophan hydroxylase
Cholesterol to pregnenalone
Nitric oxide synthase
Increases Glutathione levels

** Puchacz E, Stumpf WE, Stachowiak EK, Stachowiak MK (February 1996). "Vitamin D increases expression of the tyrosine hydroxylase gene in adrenal medullary cells". Brain Research. Molecular Brain Research. 36 (1): 193–6.*

Enzymes that are induced by Vitamin D

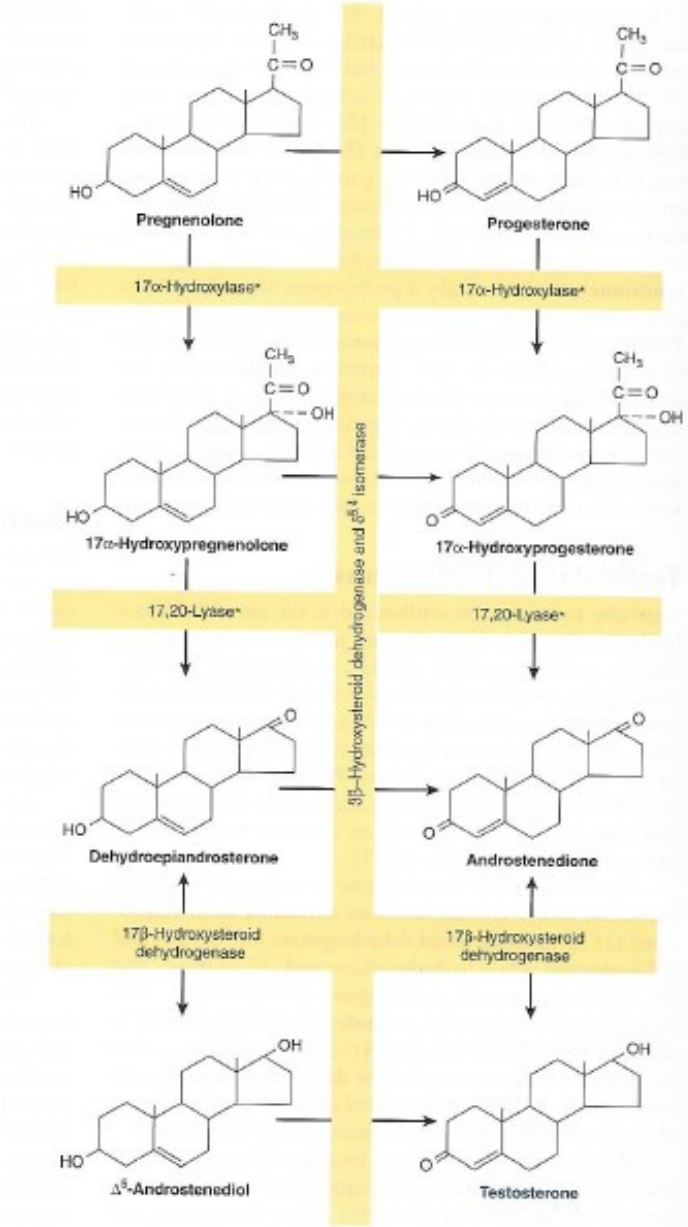
Tyrosine hydroxylase

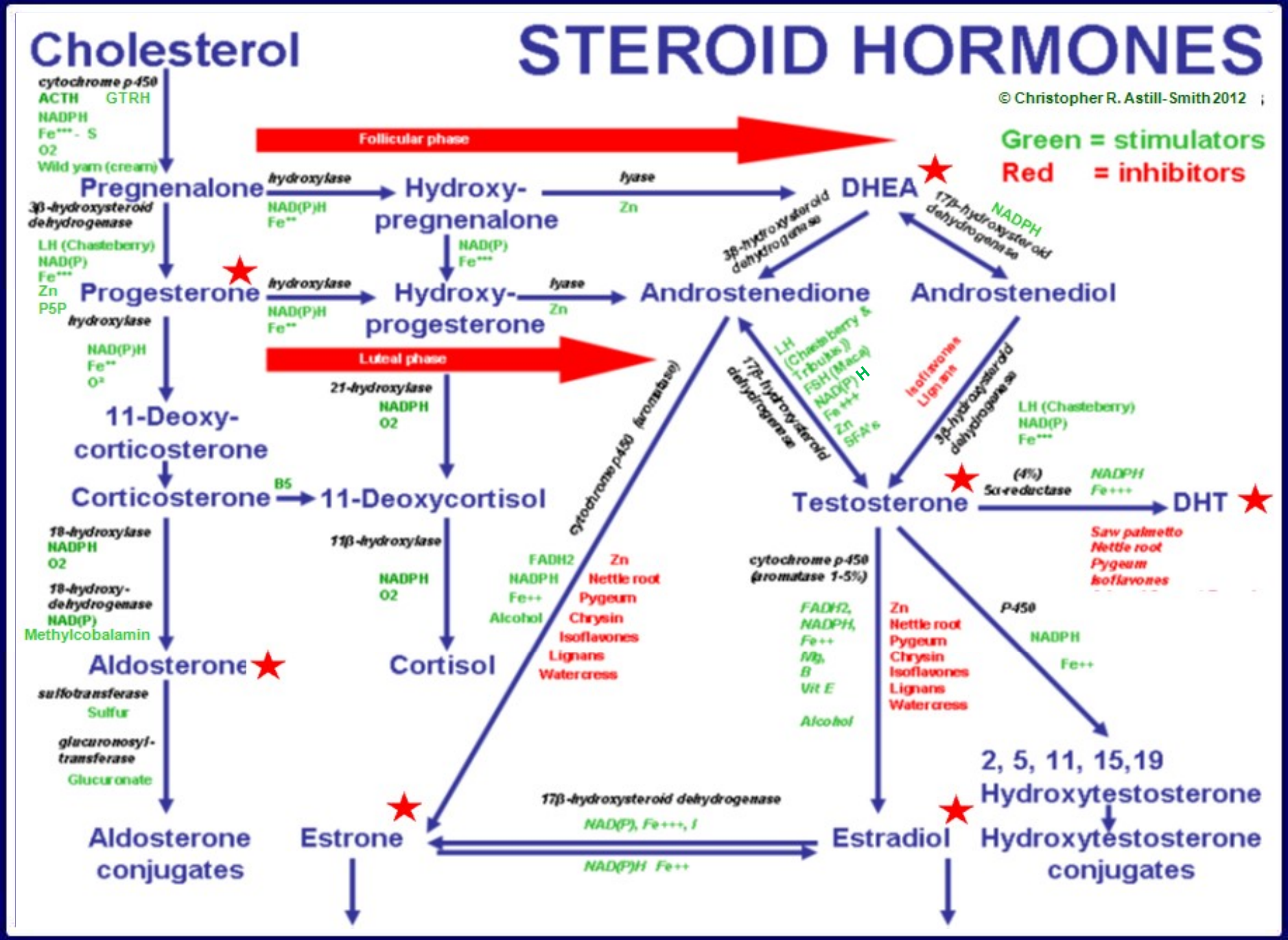
Tryptophan hydroxylase

Cholesterol to pregnenalone

Nitric oxide synthase

Increases Glutathione




STEROID HORMONES
© Christopher R. Astill-Smith 2012
Green = stimulators
Red = inhibitors
Cholesterol
cytochrome p-450
ACTH GTRH
NADPH
Fe*** - S
O2
Wild yam (cream)
Pregnenalone
3β-hydroxysteroid dehydrogenase
LH (Chasteberry)
NAD(P)
Fe***
Zn
P5P
Progesterone
hydroxylase
NAD(P)H
Fe**
O²
11-Deoxy-corticosterone
Corticosterone
B5
18-hydroxylase
NADPH
O2
18-hydroxy-dehydrogenase
NAD(P)
Methylcobalamin
Aldosterone
sulfotransferase
Sulfur
glucuronosyl-transferase
Glucuronate
Aldosterone conjugates
Follicular phase
hydroxylase
NAD(P)H
Fe**
Hydroxy-pregnenalone
NAD(P)
Fe***
hydroxylase
NAD(P)H
Fe**
Hydroxy-progesterone
Luteal phase
21-hydroxylase
NADPH
O2
11-Deoxycortisol
11β-hydroxylase
NADPH
O2
Cortisol
hyase
Zn
DHEA
3β-hydroxysteroid dehydrogenase
17β-hydroxysteroid dehydrogenase
NADPH
Androstenedione
Androstenediol
cytochrome p-450 (aromatase)
FADH2
NADPH
Fe++
Alcohol
Zn
Nettle root
Pygeum
Chrysin
Isoflavones
Lignans
Watercress
17β-hydroxysteroid dehydrogenase
LH (Chasteberry & Tribulus)
FSH (Maca)
NAD(P)H
Fe+++
Zn
SFA's
Isoflavones
Lignans
3β-hydroxysteroid dehydrogenase
LH (Chasteberry)
NAD(P)
Fe***
Testosterone
(4%)
5α-reductase
NADPH
Fe+++
DHT
Saw palmetto
Nettle root
Pygeum
Isoflavones
cytochrome p-450 (aromatase 1-5%)
FADH2,
NADPH,
Fe++
Mg,
B
Vit E
Alcohol
Zn
Nettle root
Pygeum
Chrysin
Isoflavones
Lignans
Watercress
P-450
NADPH
Fe++
2, 5, 11, 15,19 Hydroxytestosterone
Hydroxytestosterone conjugates
Estrone
17β-hydroxysteroid dehydrogenase
NAD(P), Fe+++, I
NAD(P)H Fe++
Estradiol

In a recent paper in *Breast Cancer Research Treatments* in 2010, results from a clinical trial on women put on adjuvant aromatase inhibitor treatment (letrozole) for breast cancer were published. In this study, 42 women taking aromatase inhibiting drugs for breast cancer in which serum vitamin D levels were low were supplemented with 50,000 IUs of vitamin D3 weekly for 12 weeks.

After 16 weeks, their serum 25-hydroxyvitamin D levels went up, on average, from below 20 to greater than 66 nanograms per ml (median level). And, interestingly, in those women who had the vitamin D supplements, increasing their vitamin D 25-hydroxy levels resulted in significant reduction of disability from aromatase inhibitor-induced arthralgias.

Khan QJ, Reddy PS, Kimler BF, et al. Effect of vitamin D supplementation on serum 25-hydroxy vitamin D levels, joint pain,

Sources

Eggs • Fish (e.g., herring, mackerel, salmon, trout, and tuna) • Fish liver oil • Fortified cereals • Fortified dairy products • Fortified margarine • Fortified orange juice • Fortified soy beverages (soymilk)

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

Other Sources

Vitamin D2 – Mushrooms exposed to UV
Alfalfa
Cocao husks
Hemp seed

Vitamin D3 – Beef liver

FDA Daily Value (RDA)

400IU (10mcg)

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

Beware of people who need D3/K2 (1, 24, 25 OH Cholecalciferol) as they have inhibition of the CYP 24A1 pathway.

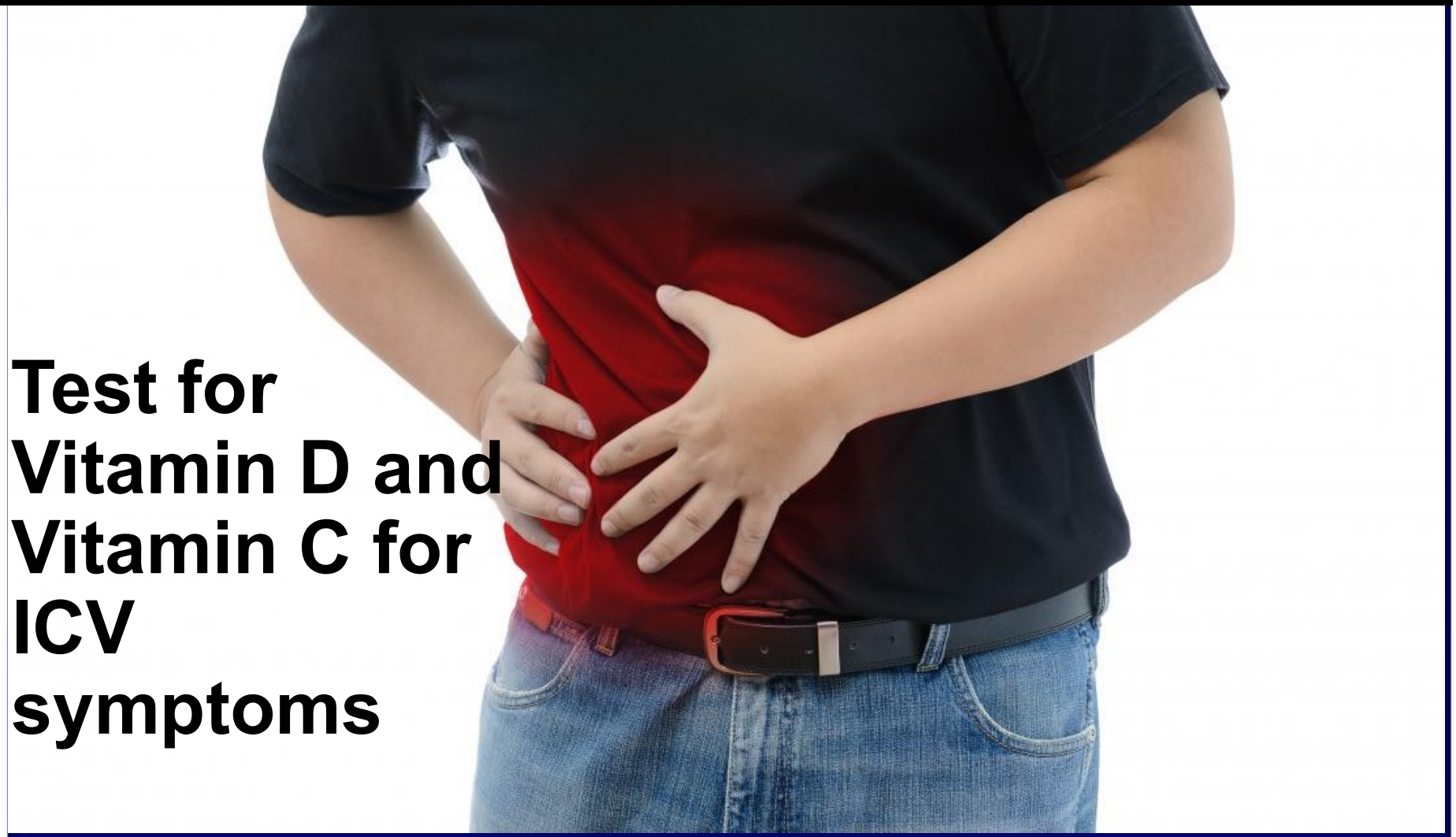
This leads to high calcium and thus calcification of soft tissues causing numerous conditions.

Dr Goodheart says

- Good for a patient who **sweats around the head** but not much about the rest of the body.
- Maybe indicated in **osseous type pains.**

Being a Family Doctor by George Goodheart and Walther H. Schmitt published by Lance West DC

Dr Goodheart says



Test for Vitamin D and Vitamin C for ICV symptoms

Being a Family Doctor by George Goodheart and Walther H. Schmitt published by Lance West DC

Muscles associated with Vitamin D*

Quadriceps

Tensor fascia lata

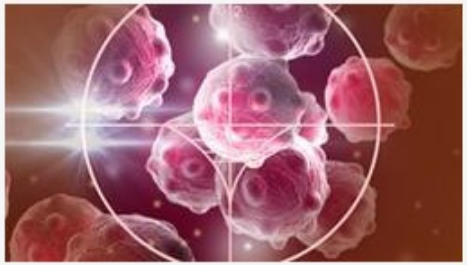
*Applied Kinesiology Synopsis 2nd Edition by David Walther DC

For Optimal Health, Make Sure You Have a Vitamin D Level of 60 ng/mL

11 Shares

July 04, 2018 • 24,960 views
Edition: English

Story at-a-glance



- Vitamin D is involved in the biology of all the cells and tissues in your body, including your immune cells. Your cells need the active form of vitamin D to gain access to the genetic blueprints stored inside
- While the American Medical Association considers 20 nanograms per milliliter (ng/mL) sufficient, a compelling body of research suggests 40 ng/mL is the cutoff for sufficiency and that 60 to 80 ng/mL is an ideal level for health and disease prevention
- Seventy-five percent of American adults and teens are deficient in vitamin D, based on a sufficiency level of 30 ng/mL. Since 30 ng/mL is still on the low end, most are bound to have insufficient levels for optimal health
- Avoiding all sun exposure to lower your risk of skin cancer will raise your risk of internal cancers and many other health problems instead. A vitamin D level of 40 ng/mL lowers your risk of cancer by 67 percent, compared to having a level below 20 ng/ml
- A vitamin D level above 60 ng/mL lowers your breast cancer risk by more than 80 percent, and a level of 40 ng/mL lowers the risk of premature birth by 60 percent. There's also a strong inverse relationship between vitamin D and other cancers, including colorectal cancer, which is the third leading cancer killer in the U.S.

Time to change vitamin D guidelines?

By David Anderson, 06-Jul-2017

Last updated on 11-Aug-2017 at 14:35 GMT

Post a comment

"This is a very exciting discovery which will revolutionise how the health and retail sector views vitamin D," said Professor Susan Lanham-New, head of the Department of Nutritional Sciences at the University of Surrey. *"Vitamin D deficiency is a serious matter, but this will help people make a more informed choice about what they can eat or drink to raise their levels through their diet."*

New research suggesting vitamin D3 is twice as effective as vitamin should turn current guidance 'on its head', say those behind the study.

Current guidance on the intake of vitamin D has been turned "on its head" following new research revealing that vitamin D3 is twice as effective as vitamin D2 in raising levels of the nutrient in the body.

'Complex link' between vitamin D2 and D3 supplementation

Source: *BMC Endocrine Disorders*
Published online ahead of print, doi: 10.1186/s12902-017-0163-9
"Differential effects of vitamin D2 and D3 supplements on 25-hydroxyvitamin D level are dose, sex, and time dependent: a randomized controlled trial"
Authors: Hammami, M.M.; Yusuf, A.

While all the active supplementation regimens raised blood serum 25(OH)D levels, the study found the two-weekly D3 protocol, followed by the 4-weekly D3 protocol and the daily D2, were the best at raising blood serum levels across the full length of the study period.

A new study may shed light on the differences in uptake of vitamin D variants, while also revealing absorption is higher in women than men, and two-weekly dose regimens are the most effective.

Should occupation be considered in vitamin D supplementation guidelines?

Source: *BMC Public Health*

Published online, Open Access, doi: 10.1186/s12889-017-4436-z

"Vitamin D levels and deficiency with different occupations: a systematic review"

Authors: Daniel Sowah, *et al*

Shift workers, healthcare workers and indoor workers are at a particularly high risk of deficiency, say researchers led by Dr Sebastian Straube at the University of Alberta, Canada.

"Our results suggest that occupation is a major factor that may contribute to suboptimal vitamin D levels," said Straube. *"Regular screening of vitamin D levels in at-risk groups should be considered for future clinical practice guidelines and public health initiatives."*

Vitamin D: Good for the heart or not?

Source: *Journal of the American College of Cardiology*

Volume 70, Issue 1, pages 89-100 *doi: 10.1016/j.jacc.2017.05.031*

Post a comment

"Vitamin D and Cardiovascular Disease Controversy Unresolved"

A recent review in the *Journal of the American College of Cardiology* highlights the contrasting findings between observational studies, which have reported a strong association between vitamin D deficiency and cardiovascular disease (CVD), and the lack of response in vitamin D supplementation trials.

The inverse correlation between blood levels of vitamin D and many elements of CVD has been established in Europeans as well as Caucasian and Afro-Caribbean Americans.

Studies showed an *"inverse relationship between 25-OH D levels and the prevalence of hypertension, insulin resistance, frank type 2 diabetes mellitus (DM), and dyslipidemia,"* wrote co-authors Ibhar Al Mheid and Arshed Quyyumi from Emory University School of Medicine in Atlanta.

Study underscores positive effect of vitamin D on female fertility

Source: *Nutrients*

Volume 9, issue 7. Published online doi:10.3390/nu9070719

"Acute Supplementation with High Dose Vitamin D3 Increases Serum Anti-Müllerian Hormone in Young Women"

Authors: Nicola Dennis, Lisa Houghton, Michael Pankhurst, Michelle Harper and Ian McLennan

By David Anderson, 21-Jul-2017

Last updated on 21-Jul-2017 at 14:42 GMT

Vitamin D status may play an important in female fertility and reproduction, according to new research linking levels to regulation of ovarian hormones.

The study, published in *Nutrients*, underscores the hypothesis of a positive role for vitamin D in the fertility of women by suggesting it may be involved in the regulation of ovarian anti-Müllerian hormone levels.

Anti-Müllerian hormone (AMH) is an ovarian regulator whose function is largely unknown to science.

Maternal vitamin D may be vital to childhood development

Source: *British Journal of Nutrition*

Published online ahead of print, doi: **10.1017/S0007114517001398**

"Association between maternal vitamin D status in pregnancy and neurodevelopmental outcomes in childhood: results from the Avon Longitudinal Study of Parents and Children (ALSPAC)"

Authors: Andrea L. Darling, *et al*

Preventing vitamin D deficiencies in pregnant women might be important for ensuring normal development in children, say UK researchers.

Expectant mothers with a deficiency in vitamin D may be putting their children at a greater risk of developmental issues, according to new research published in the *British Journal of Nutrition.*

A study looking at data from more than 7,000 mother-and-child pairs has found that maternal vitamin D deficiency has a negative effect on the social development and motor skills of pre-school children in the first four years of life.

‘Powerful’: Raising vitamin D levels may slash preterm birth risk

Source: *PLoS One*

2017, **12**(7):e0180483. doi: 10.1371/journal.pone.0180483

“Maternal 25(OH)D concentrations ≥40 ng/mL associated with 60% lower preterm birth risk among general obstetrical patients at an urban medical center”

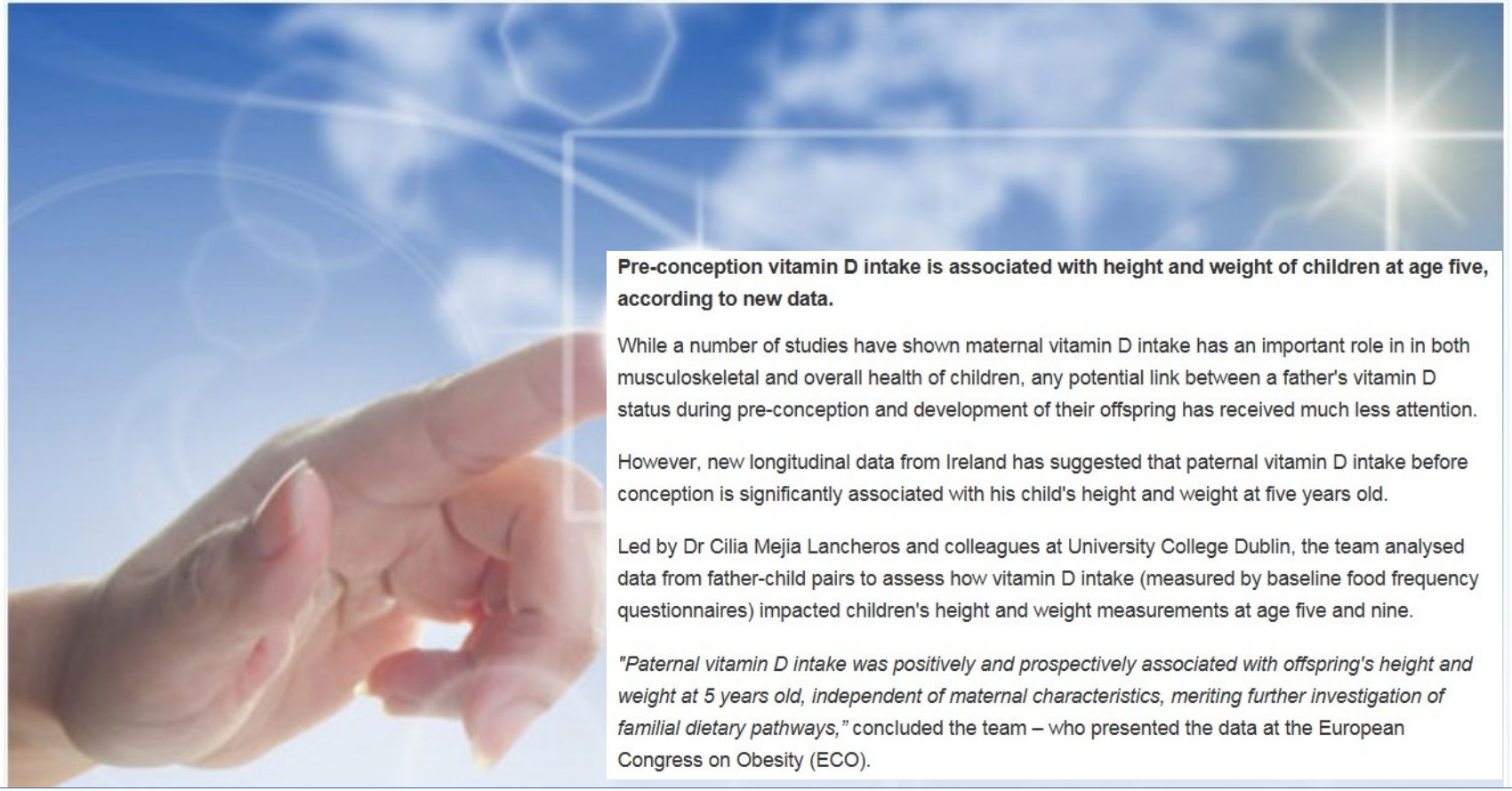
Authors: S.L. McDonnell et al.

Maintaining good blood levels of vitamin D during pregnancy may help reduce the risk of preterm birth by 60%, says a new study.

Data from over 1,000 women and babies confirm previous research at the Medical University of South Carolina, which found that blood levels of vitamin D of at least 40 ng/ml (100 nmol/L) lowered the pre-term risk by 59%, compared to women with concentrations less than 20 ng/ml (the current sufficient level recommended by the Institute of Medicine).

Dad's vitamin D has impact on childhood growth and obesity risk

"One reason this may occur is that father's nutrition status may somehow influence the health, quality and function of their germ cells, which are involved in reproduction," the team added. *"Thus, maternal nutrition may not be the only key factor in offspring's growth development and health."*



Pre-conception vitamin D intake is associated with height and weight of children at age five, according to new data.

While a number of studies have shown maternal vitamin D intake has an important role in in both musculoskeletal and overall health of children, any potential link between a father's vitamin D status during pre-conception and development of their offspring has received much less attention.

However, new longitudinal data from Ireland has suggested that paternal vitamin D intake before conception is significantly associated with his child's height and weight at five years old.

Led by Dr Cilia Mejia Lancheros and colleagues at University College Dublin, the team analysed data from father-child pairs to assess how vitamin D intake (measured by baseline food frequency questionnaires) impacted children's height and weight measurements at age five and nine.

"Paternal vitamin D intake was positively and prospectively associated with offspring's height and weight at 5 years old, independent of maternal characteristics, meriting further investigation of familial dietary pathways," concluded the team – who presented the data at the European Congress on Obesity (ECO).

Vitamin D and Statin-Related Myalgia

Philip J. Gregory, PharmD

Disclosures | March 10, 2017

Statin-Associated Side Effects

How to Manage Muscle Pain in Patients on Statins

The Case of the Patient With Myalgia on Every Statin

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Add "Lipids Management"

RELATED DRUGS & DISEASES

Lipid Management Guidelines

LDL Cholesterol

Botulinum Toxin in Pain Management

Question

Do low vitamin D levels increase the risk for myalgia in patients who are taking statins?

Response from Philip J. Gregory, PharmD
Associate Professor, Pharmacy Practice, Center for Drug Information & Evidence-Based Practice, Creighton University, Omaha, Nebraska

About 1%-2% of patients who take hydroxy-methyl-glutaryl-coenzyme A (HMG-CoA) reductase inhibitors or statins for hyperlipidemia develop muscle pain. This myalgia can feel like the aches and pains experienced with the flu. Muscles may feel sore or stiff and be sensitive to touch.[1] In some cases, statin-related myalgia can lead to poor adherence or discontinuation of the drug.[2]

The mechanism for statin-related myalgia is not fully understood, but vitamin D has been speculated to play a role.

Vitamin D deficiency itself is associated with symptoms of myalgia that resemble those caused by statins.[1,3] There has been speculation that statins themselves might affect vitamin D levels. Because low-density lipoprotein (LDL)-cholesterol is a vitamin D carrier and statins reduce LDL cholesterol, it has been proposed that statins could decrease vitamin D levels. On the other hand, both vitamin D and some statins are metabolized by the cytochrome P450 3A4 (CYP3A4) enzyme. Owing to competitive inhibition at CYP3A4, it has been proposed that statins could

Study underscores positive effect of vitamin D on female fertility

Source: *Nutrients*

Volume 9, issue 7. Published online doi:10.3390/nu9070719

"Acute Supplementation with High Dose Vitamin D3 Increases Serum Anti-Müllerian Hormone in Young Women"

Authors: Nicola Dennis, Lisa Houghton, Michael Pankhurst, Michelle Harper and Ian McLennan

By David Anderson

20-Jul-2017 - Last updated on 21-Jul-2017 at 12:42 GMT

© iStock/ Antonio Gravante

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The study, published in *Nutrients*, underscores the hypothesis of a positive role for vitamin D in the fertility of women by suggesting it may be involved in the regulation of ovarian anti-Müllerian hormone levels.

Vitamin D3 backed to prevent and repair heart damage

Source: *International Journal of Nanomedicine*
Published online ahead of print, doi: 10.2147/IJN.S152822
"Nanomedical studies of the restoration of nitric oxide/peroxynitrite balance in dysfunctional endothelium by 1,25-dihydroxy vitamin D3 – clinical implications for cardiovascular diseases."
Authors: Khan A, Dawoud H, Malinski T

By Will Chu
01-Feb-2018 - Last updated on 01-Feb-2018 at 10:59 GM

Nano sensors used to track how vitamin D3 affects cells have shown it is able repair damage to the heart brought on by metabolic conditions, including high blood pressure, diabetes and atherosclerosis.

Vitamin D and omega-3 together may help mental illness

By Niamh Michail
27-Feb-2015 - Last updated on 16-Apr-2018 at 10:44 GMT

Source: *The FASEB Journal*

Published online ahead of print February 24, 2015, doi: 10.1096/fj.14-268342, see link

"Vitamin D and the omega-3 fatty acids control serotonin synthesis and action, part 2: relevance for ADHD, bipolar, schizophrenia, and impulsive behavior"

Authors: Rhonda P. Patrick and Bruce N. Ames

Micronutrient deficiencies are prevalent among sufferers of mental illness, according to the researchers

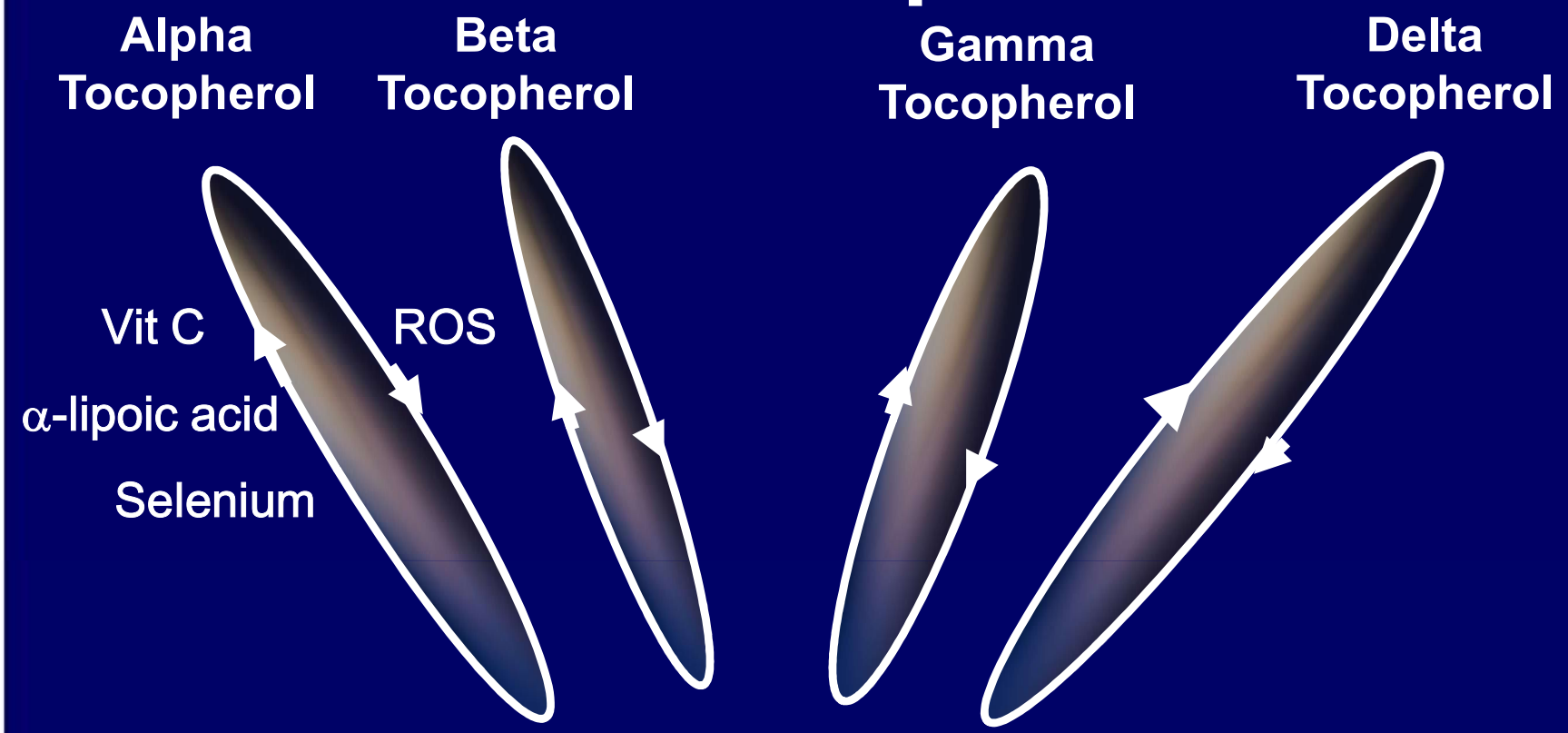
RELATED TAGS: Omega-3 fatty acids, Omega-3 fatty acid

Vitamin D and omega-3 could work together to improve cognitive function and social behaviour with particular relevance for battling ADHD, schizophrenia and bipolar disorder, say researchers.

Vitamin E
(Tocopherols and Tocotrienols)

Vitamin E

Mixed Tocopherols



TOCOPHEROL RADICAL

Vitamin E refers to a group of compounds that include both tocopherols and tocotrienols. Of the many different forms of vitamin E, γ-tocopherol is the most common form found in the diet.* γ-Tocopherol can be found in corn oil, soybean oil, margarine, and dressings.

**Manolescu B, Atanasiu V, Cercasov C, Stoian I, Oprea E, Buşu C (2008). "So many options but one choice: the human body prefers alpha-tocopherol. A matter of stereochemistry". J Med Life. 1 (4): 376–382.*

α-Tocopherol, the most biologically active form of vitamin E, is the second-most common form of vitamin E in the diet. This can be found most abundantly in wheat germ oil, sunflower, and safflower oils.*

**"USDA Food Composition Databases". United States Department of Agriculture, Agricultural Research Service. Release 28. 2015. Retrieved 18 August 2018.*

Plant source[38]	Amount (mg / 100g)
Wheat germ oil	150
Hazelnut oil	47
Canola/rapeseed oil	44
Sunflower oil	41.1
Safflower oil	34.1
Almond oil	39.2
Grapeseed oil	28.8
Sunflower seed kernels	26.1
Almonds	25.6
Almond butter	24.2
Wheat germ	19

Plant source[38]	Amount (mg / 100g)
Canola oil	17.5
Palm oil	15.9
Peanut oil	15.7
Margarine, tub	15.4
Hazelnuts	15.3
Corn oil	14.8
Olive oil	14.3
Soybean oil	12.1
Pine nuts	9.3
Peanut butter	9.0
Peanuts	8.3

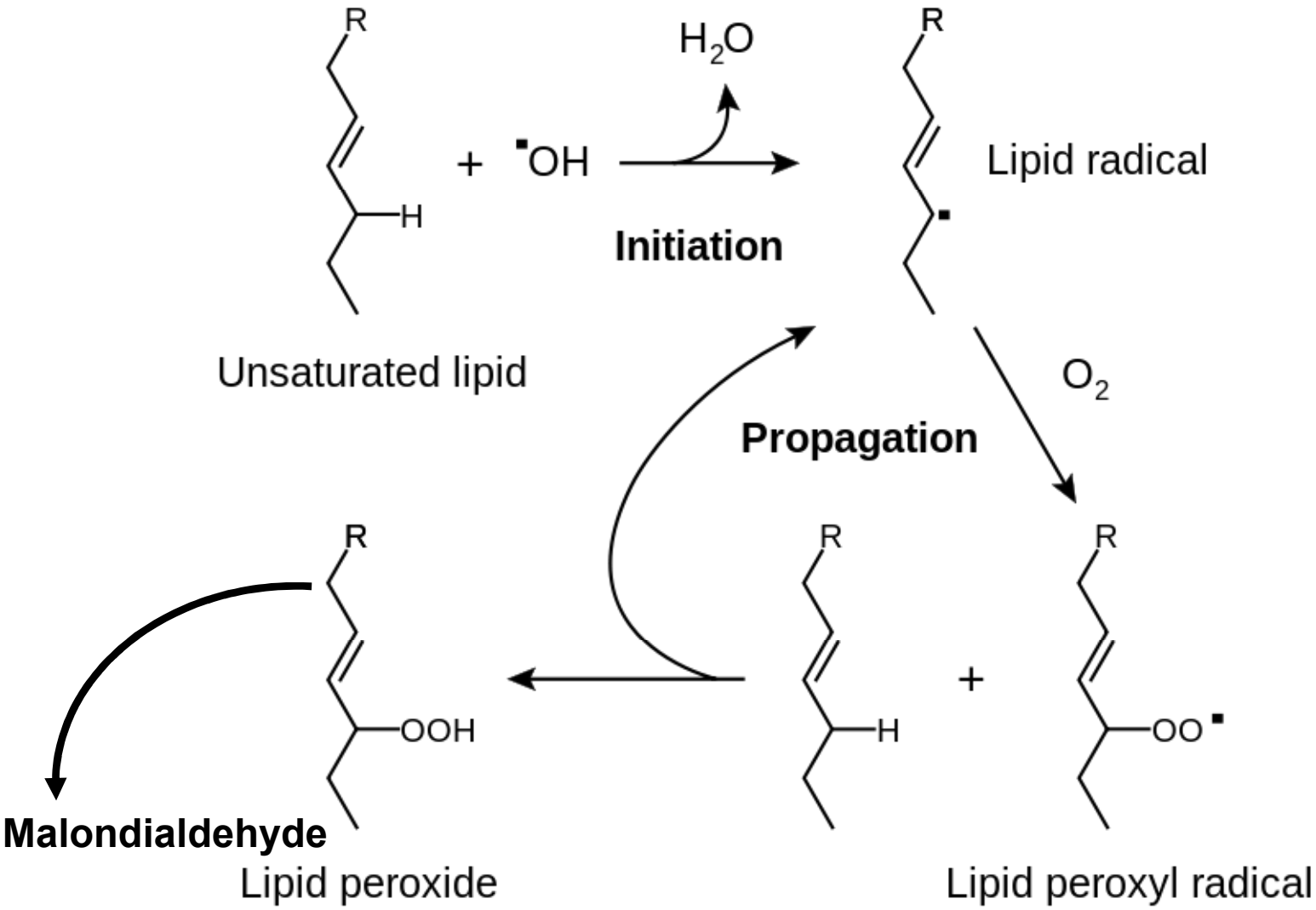
Plant source[38]	Amount (mg / 100g)
Popcorn	5.0
Pistachio nuts	2.8
Mayonnaise	3.3
Avocados	2.6
Spinach, raw	2.0
Asparagus	1.5
Broccoli	1.4
Cashew nuts	0.9
Bread	0.2-0.3
Rice, brown	0.2
Potato, Pasta	<0.1

Animal source[38]	Amount (mg / 100g)
Fish	1.0-2.8
Oysters	1.7
Butter	1.6
Cheese	0.6-0.7
Eggs	1.1
Chicken	0.3
Beef	0.1
Pork	0.1
Milk, whole	0.1
Milk, skim	0.01

As a **fat-soluble antioxidant**, it interrupts the propagation of reactive oxygen species (ROS) that spread through biological membranes or through a fat when its lipid content undergoes oxidation by reacting with more-reactive lipid radicals to form more stable products.*

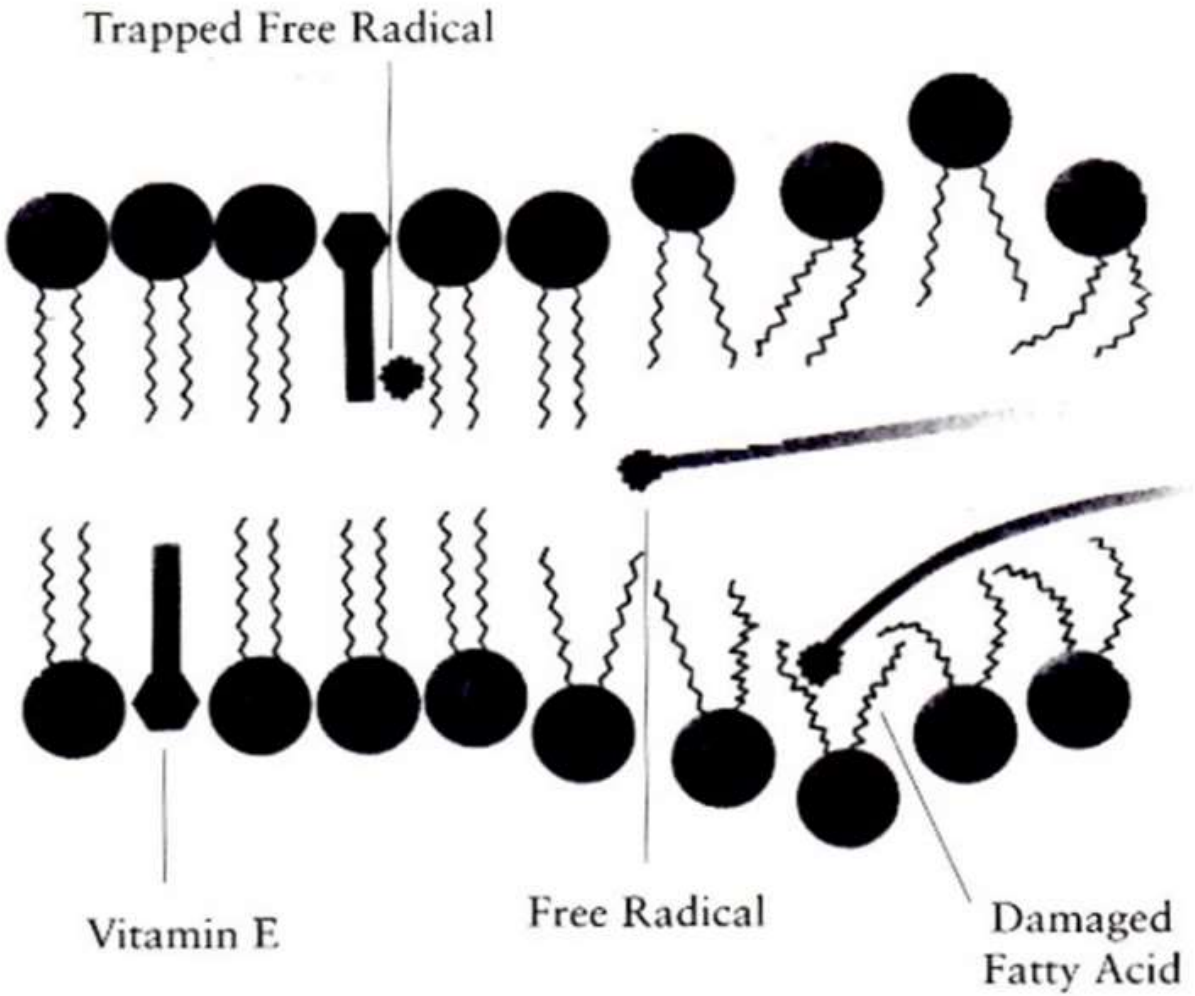
*Galli, F. Azzi, A. Birringer, M. Cook-Mills, J. M. Eggersdorfer, M. Frank, J. Cruciani, G. Lorkowski, S. Ozer, N. K. (2017). "Vitamin E: Emerging aspects and new directions". *Free Radic Biol Med*. 102: 16–36.

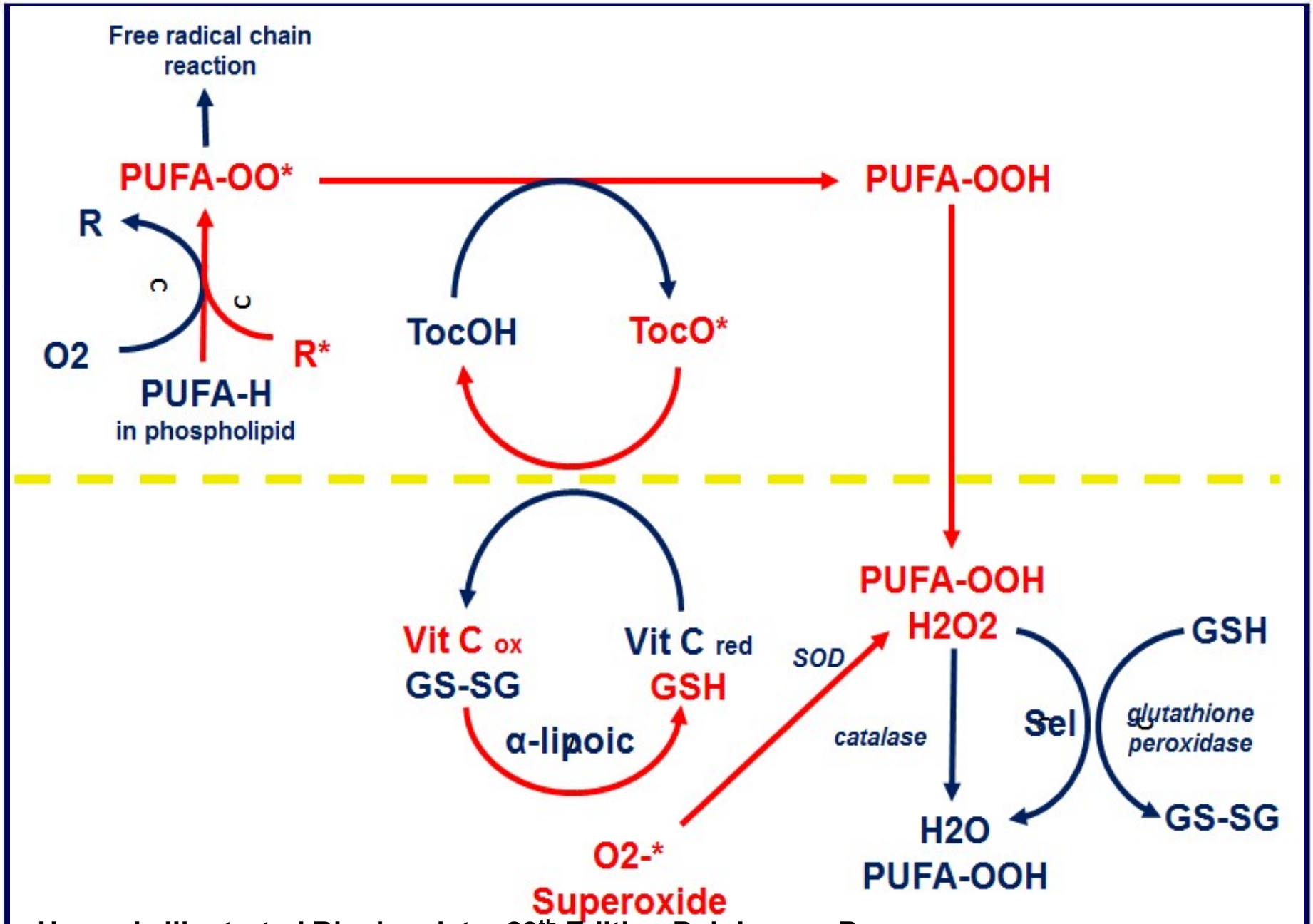
RANCID FATS



Harper's Illustrated Biochemistry 29th Edition Pub Lange. Page

Vitamin E Activity in Cell membrane





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Vitamin E

the phospholipids of the mitochondria, endoplasmic reticulum and the plasma membranes possess affinities for tocopherols and the vitamin appears to concentrate predominantly at these sites.

The crucial function played by Vitamin E may involve antioxidant functions in cell membranes. Other theories hold that vitamin E – specifically the RRR stereoisomer of alpha-tocopherol – act by controlling gene expression and cell signal transduction.*

**Rimbach G, Moehring J, Huebbe P, Lodge JK (2010). "Gene-regulatory activity of alpha-tocopherol". Molecules. 15 (3): 1746–1761.*

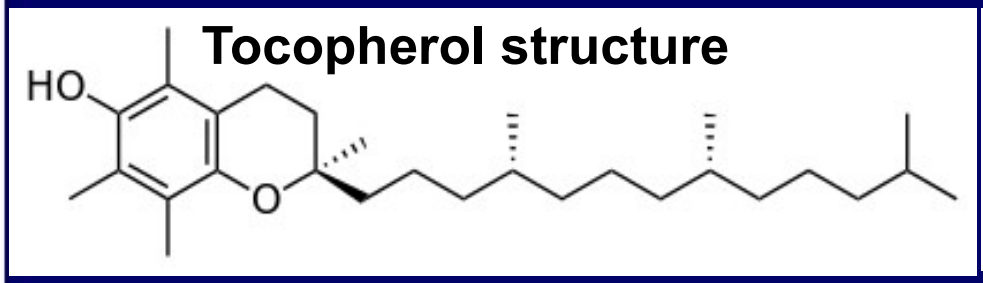
Consumption of vitamin E has been in decline in recent years and it is now estimated that more than 90 per cent of the population in the US do not meet the dietary intake recommendations. The impact of low vitamin E intake globally is a serious public health concern and there is an urgent requirement for additional research.*

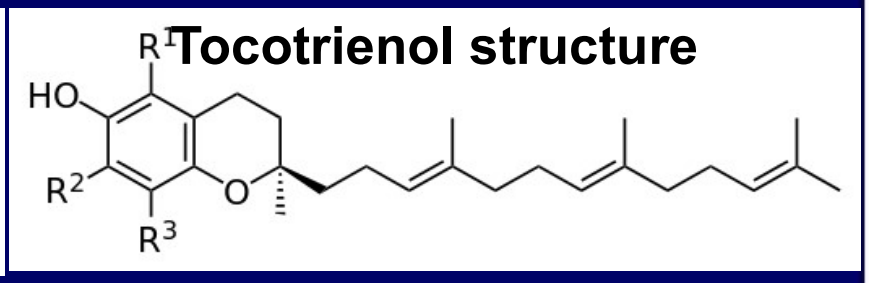
*Nutrient Intakes from Food and Beverages"(PDF). *What We Eat In America, NHANES 2012-2014 (2016)*. Retrieved 18 August 2018

Tocotrienols are members of the vitamin E family. The body contains four tocotrienols (alpha, beta, gamma, delta) and four tocopherols (alpha, beta, gamma, delta).* However these have different antioxidant activities when measured in human plasma.

** Kamal-Eldin A, Appelqvist LA (July 1996). "The chemistry and antioxidant properties of tocopherols and tocotrienols". Lipids. 31(7): 671–701*

The critical difference between tocotrienols and tocopherols is in that tocopherols have saturated side chains, whereas tocotreinols have unsaturated isoprenoid side chains (farnesyl isoprenoid tails) with three double bonds.*





** Kamal-Eldin A, Appelqvist LA (July 1996). "The chemistry and antioxidant properties of tocopherols and tocotrienols". Lipids. 31(7): 671–701*

Tocotrienols are compounds naturally occurring at higher levels in select vegetable oils, including palm oil, rice bran oil, wheat germ, barley, saw palmetto, evening primrose, and certain other types of seeds, nuts, grains, and the oils derived from them.*

*Tocopherol and tocotrienol contents of raw and processed fruits and vegetables in the United States diet p.199

High levels of up to 70% occur in palm oil, rice bran oil, wheat germ, barley, saw palmetto and certain other types of seeds, nuts and grains, and the oils derived from them. This vitamin E analogue typically only occurs at very low levels in the human body but different isomers function well as a physical antioxidant.*

*Tocopherol and tocotrienol contents of raw and processed fruits and vegetables in the United States diet p.199

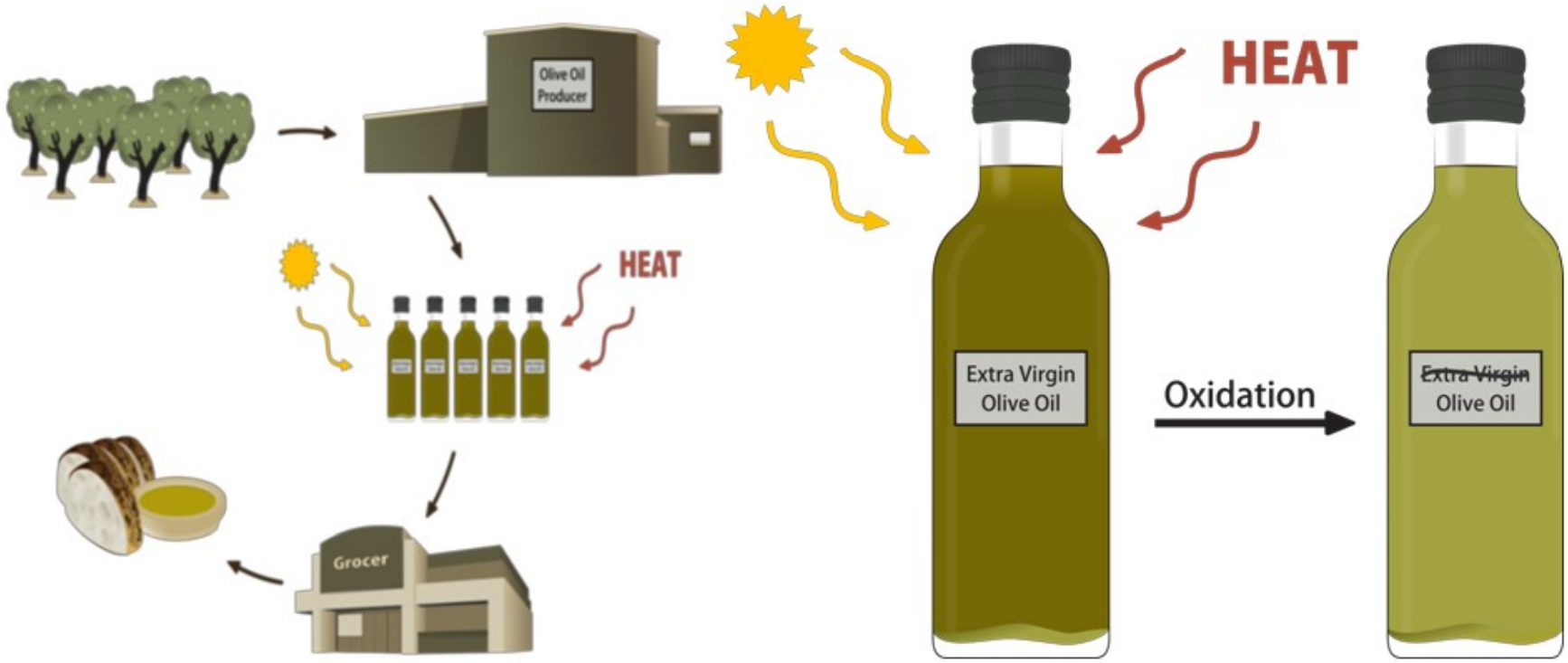
FDA Daily Value (RDA)

30IU

US vitamin E recommendations (mg per day)[1]	
AI (children ages 0–6 months)	4
AI (children ages 7–12 months)	5
RDA (children ages 1–3 years)	6
RDA (children ages 4–8 years)	7
RDA (children ages 9–13 years)	11
RDA (children ages 14–18 years)	15
RDA (adults ages 19+)	15
RDA (pregnancy)	15
RDA (lactation)	19
UL (adults)	1,000

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

Vitamin E is present in all seed oils. When the Vitamin E is used up the oil goes rancid just like our unsaturated phospholipids and brain.


Olive Oil Producer
HEAT
Grocer
HEAT
Extra Virgin Olive Oil
Oxidation
~~Extra Virgin~~ Olive Oil

Malondialdehyde

Malondialdehyde from rancid fats. 50%

Flax, Olive, Rapeseed, Sunflower Corn, Groundnut, Safflower oils. Most packaged, bottles and processed foods e.g. Mayonnaise, Humus, Sardines, Anchovies etc

Use only Genuine Organic Cold pressed olive oil and or Organic cold pressed rapeseed oil or Oreganic Avodaro oil for cooking.

Use organic butter but only put small amount out at a time. Keep remainder in refrigerator.

Malondialdehyde from rancid fats. 50%

Common diseases – Neurological disorders, Skin, High PgE2.

Detoxified by Sulfotransferase
Aldehyde dehydrogenase
Aldehyde oxidase
Glutathione

Antidote – Vitamin E, Adenosylcobalamin, Glutathione, P-5-P, Folinic acid, Non rancid oils, Selenium,

Acetaldehyde

2q 373nm

aldehyde oxidase

O2

(adenosylcobalamin)

NAD, FAD

Mol, Fe++

K, Thiols

aldehyde dehydrogenase

O2

(adenosylcobalamin)

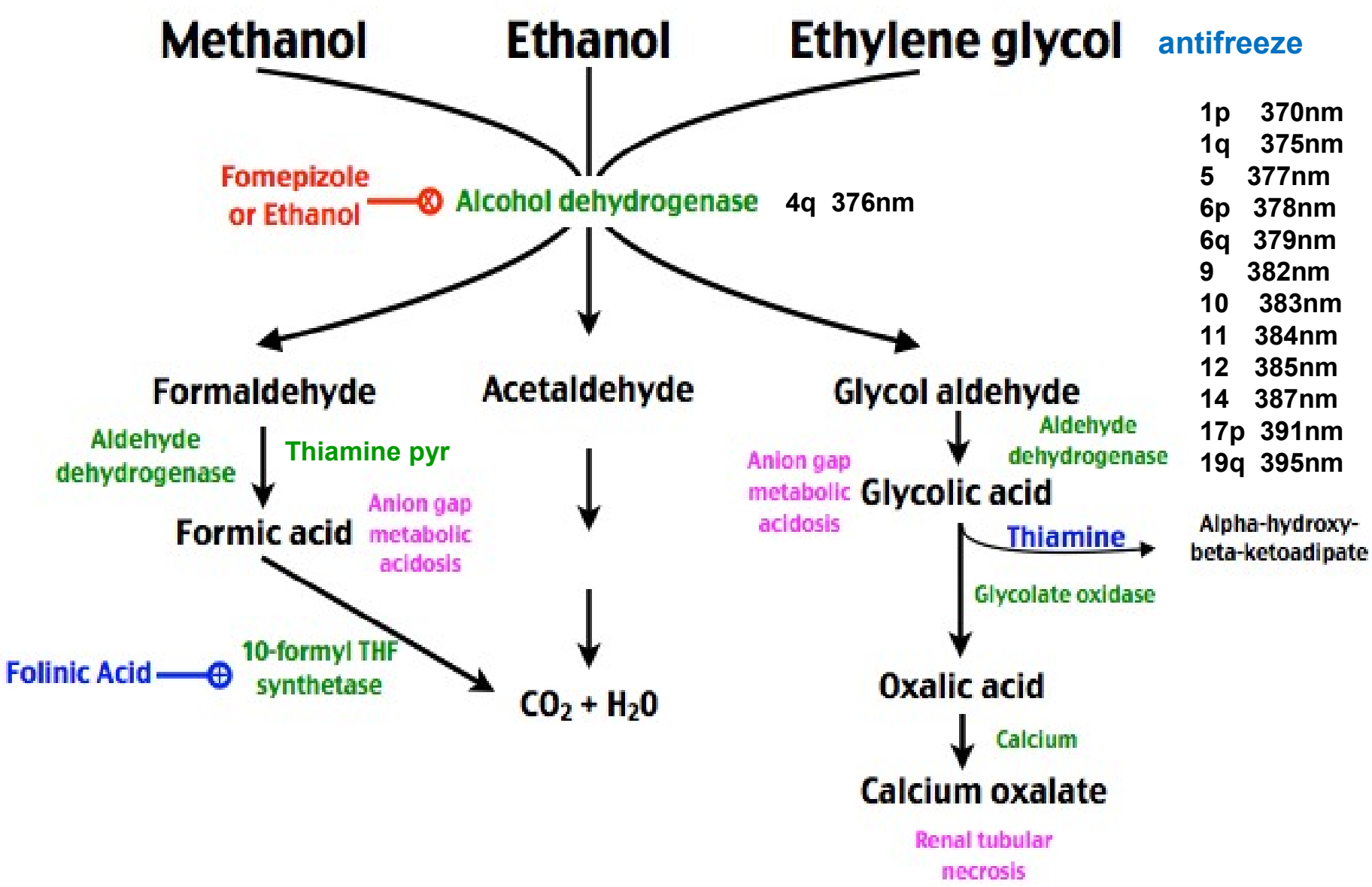
NAD,

Mg

1p 370nm
1q 375nm
5 377nm
6p 378nm
6q 379nm
9 382nm
10 383nm
11 384nm
12 385nm
14 387nm
17p 391nm
19q 395nm

Acetic acid

Toxic Alcohol Metabolism



Free radical decomposition of lipid hydro-peroxides leads to the formation of excited chemo-luminescent species by the self reaction of secondary lipids peroxy-radicals, producing either singlet oxygen or excited carbonyl groups.

Cadneas and Sies: Low level chemoluminescence in liver microsomeal fractions initiated by tetrabutyl hydroperoxide: Eur J. Biochemistry 124, 349-356

Lipid radical L°
Lipid peroxyl radical LOO °
Lipid hydro-peroxide LOOH

All form Malondialdehyde and 4 Hydroxynonenal.

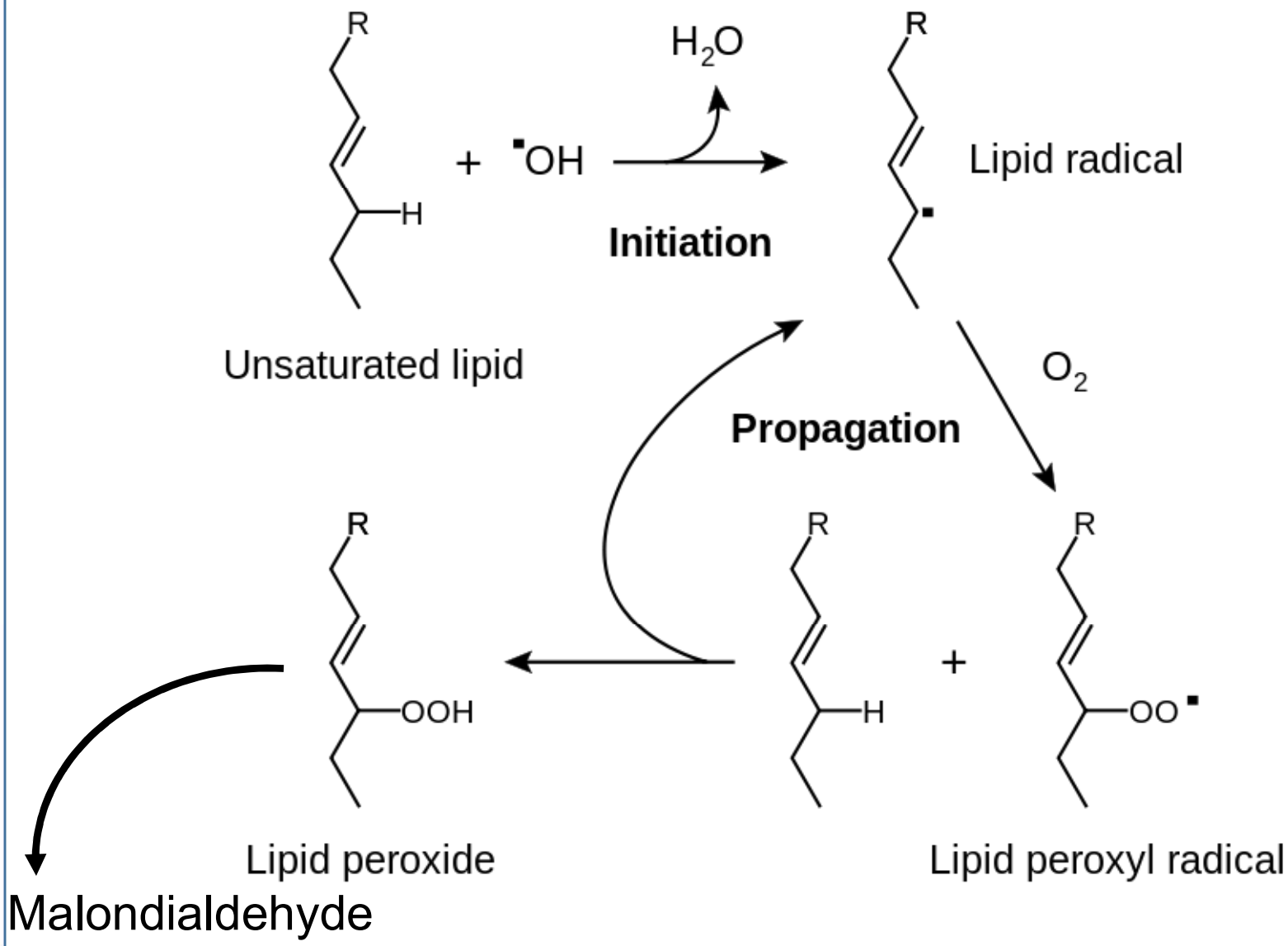
Certain diagnostic tests are available for the quantification of the end-products of lipid peroxidation, to be specific, malondialdehyde (MDA). The most commonly used test is called a TBARS Assay (thiobarbituric acid reactive substances assay). Thiobarbituric acid reacts with malondialdehyde to yield a fluorescent product.

Lipid peroxidation-DNA damage by malondialdehyde. Marnett LJ. *Mutation research* 1999 Mar 8;424(1-2):83–95.

Rancid Fats

- Primarily occurs with unsaturated fats
- More susceptible to rancidity because of structure with many double bonds
- Fats turn rancid in the presence of free radicals or reactive oxygen species

RANCID FATS


R
H
+ ▪OH
H_2O
Initiation
R
Lipid radical
Unsaturated lipid
O_2
Propagation
R
OOH
R
H
+
R
OO▪
Lipid peroxide
Lipid peroxyl radical
Malondialdehyde

Rancid Fats

- Reactive oxygen species degrade polyunsaturated lipids forming malondialdehyde
- Reactive aldehyde causes toxic stress in cells and forms advanced lipoxidation end products
- Lead to loss of membrane integrity

Rancid Fats

- **Malondialdehyde** is used as a biomarker to assess the oxidative stress of a person
- It reacts with deoxyadenosine and deoxyguanosine in DNA to form DNA combinations which can be mutagenic

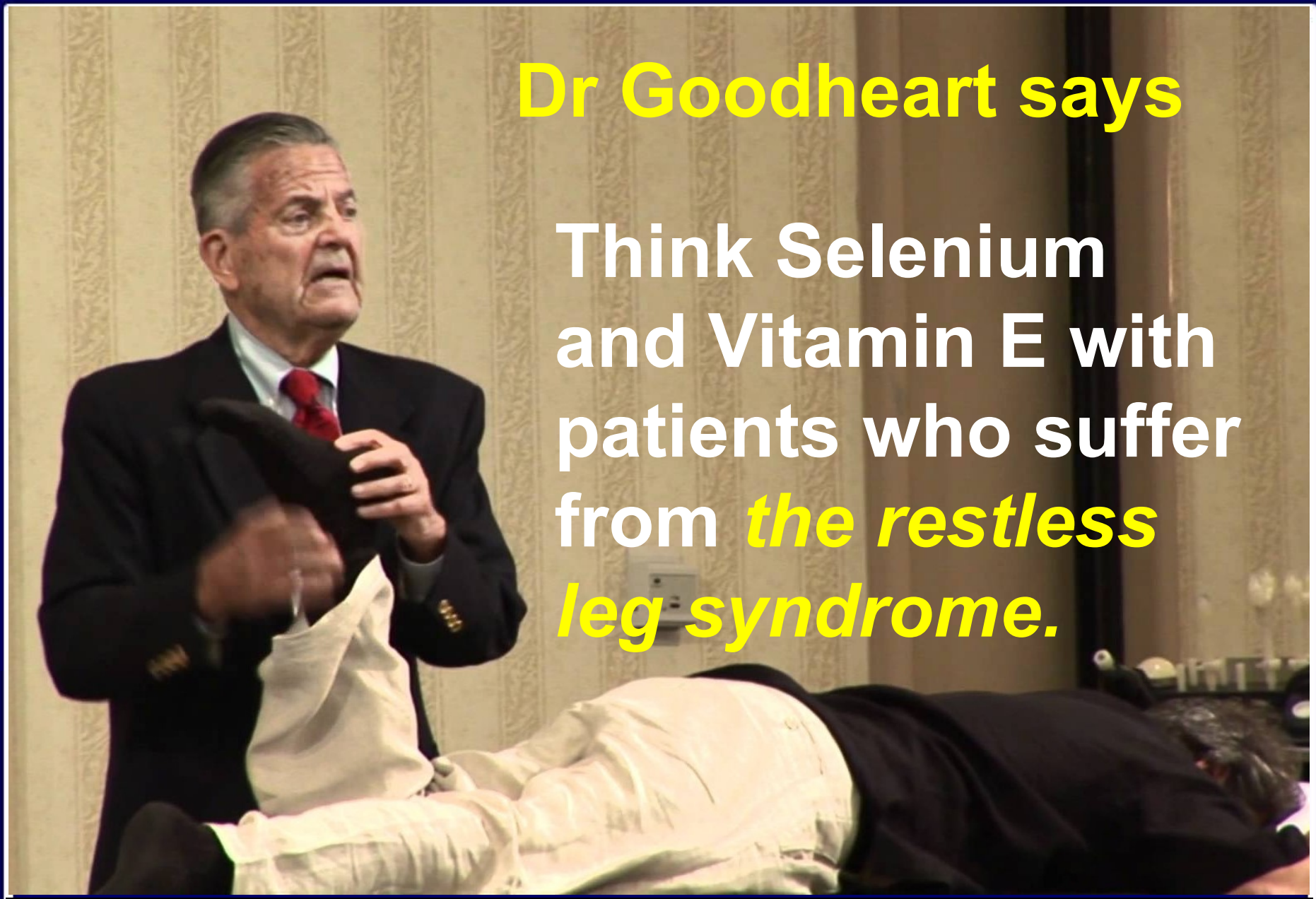
Rancid Fats

- Measure the oxidative stability of an oil
- Rancimat method measures the progress of the oxidation reaction
- Measures the volatile oxidation products, largely formic acid
- Biomarker Formic acid to test rancid oils

To test if an oil or food is rancid

- Test patient with Formic acid to check not weakening in the clear
- Test oil or food vial
- Test oil or food with formic acid test vial on the body

- If SIM weakens, oil or food is rancid and contributing to lipid peroxidation



Collected Published Articles and Reprints by Dr G. Goodheart

Dr Goodheart says

Think Vitamin E along with iodine and thiamine for Metrorrhagia (bleeding between menstrual cycles)

Being a Family Doctor by George Goodheart and Walther H. Schmitt published by Lance West DC

Dr Goodheart says give Vitamin E in athletes who get shin splints

Being a Family Doctor by George Goodheart and Walther H. Schmitt published by Lance West DC

Dr Goodheart says

Think Vitamin E in cases of threatened miscarriage.

Being a Family Doctor by George Goodheart and Walther H. Schmitt published by Lance West DC

Dr Goodheart says

Use Vitamin E and Selenium in muscle cramping and Intermitant claudication

Being a Family Doctor by George Goodhear
West DC

Muscles associated with Vitamin E*

Abdominals
Adductors
Gluteus maximus
Gluteus medius
Hamstrings
Quadratus lumborum
Sacrospinalis
Subscapularis

*Applied Kinesiology Synopsis 2nd Edition by David Walther DC

Vitamin K 1 and K2
Menaquinone

Menadione (K3)

(water soluble, most potent form but not found naturally)

Menaquinone- 4, 7 (K2)

(fat soluble, from animal tissue and synthesised by intestinal bacteria)

MK4- Synthesized in artery walls, pancreas and testes.

MK7 -By bacterial fermentation in the colon by B. Subtilis.

Phyloquinone (K1)

(fat soluble from plant tissue)

Vitamin K is a fat-soluble vitamin that occurs naturally in two forms: Vitamin K1 (phylloquinone), found in plants; and ‘vitamin K2’, the group of compounds called ‘menaquinones,’ mainly found in dairy products.

Vitamin K is best known for its role in helping blood to clot (coagulate) properly; the ‘K’ comes from its German name, ‘Koagulationsvitamin’.*

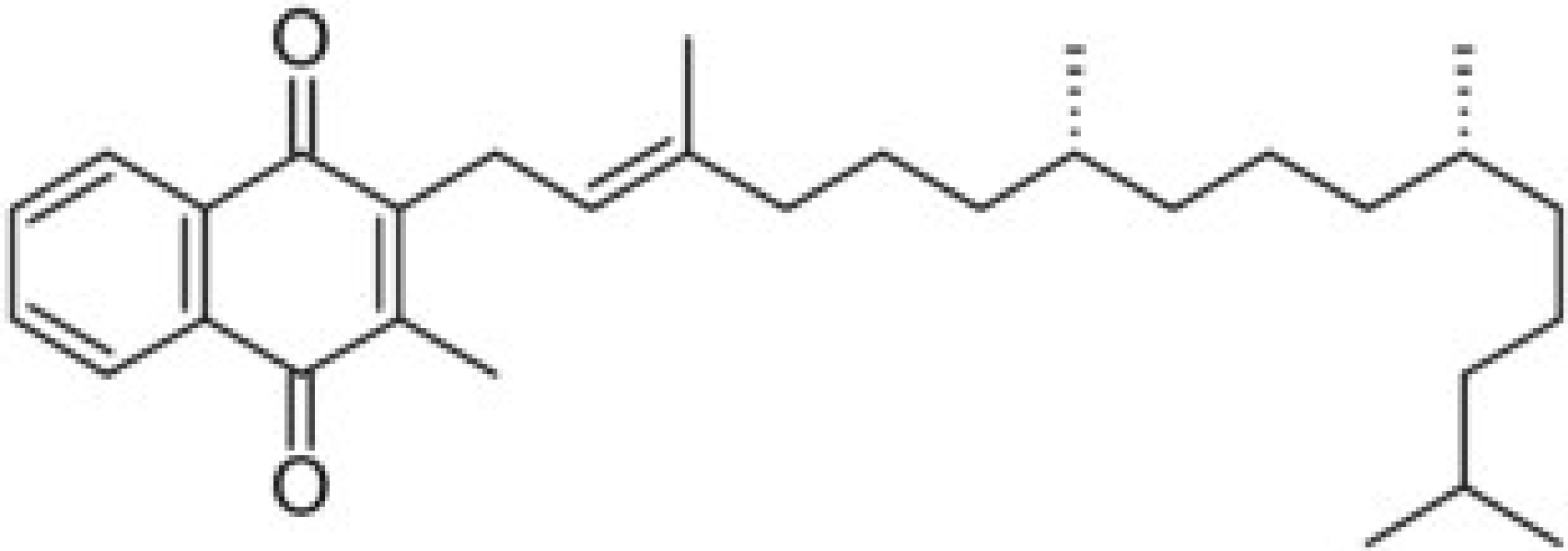
*"Vitamin K". Micronutrient Information Center, Linus Pauling Institute, Oregon State University, Corvallis, OR. July 2014. Retrieved 20 March 2017.

A sufficient intake of vitamin K is important as it helps the body to:
Clot (i.e. coagulate) blood
Maintain bone health
Keep blood vessels functioning properly.

*"Vitamin K". Micronutrient Information Center, Linus Pauling Institute, Oregon State University, Corvallis, OR. July 2014. Retrieved 20 March 2017.

Phyloquinone (K1)

(fat soluble from plant tissue)



The best-known function of vitamin K in animals is as a cofactor in the formation of coagulation factors II (prothrombin), VII, IX, and X by the liver. It is also required for the formation of anticoagulant factors protein C and S. It is commonly used to treat warfarin toxicity.*

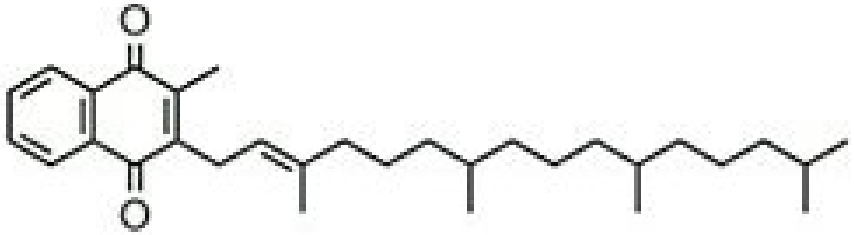
*Ageno, W; Gallus, AS; Wittkowsky, A; Crowther, M; Hylek, EM; Palareti, G; American College of Chest, Physicians. (February 2012). "Oral anticoagulant therapy: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines". *Chest*. 141 (2 Suppl): e44S–88S

Vitamin K2

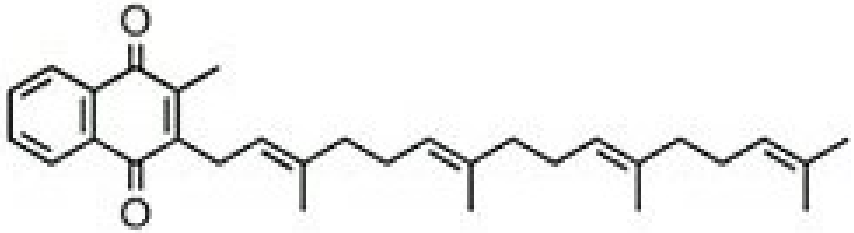
Menaquinone- 4, 7

(fat soluble, from animal tissue and synthesised by intestinal bacteria)

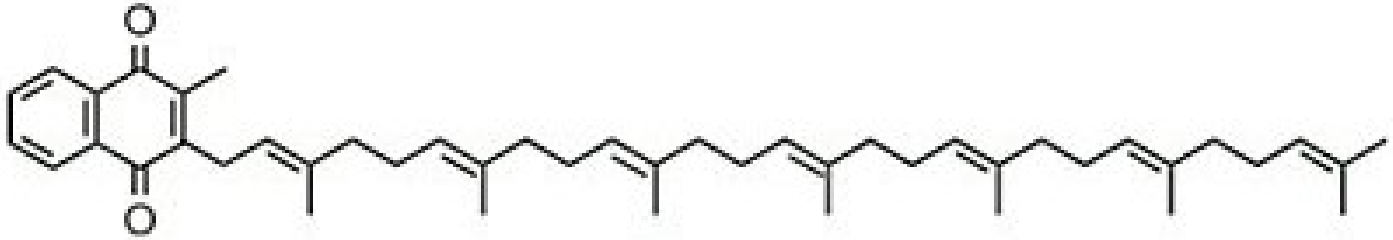
K1



MK-4

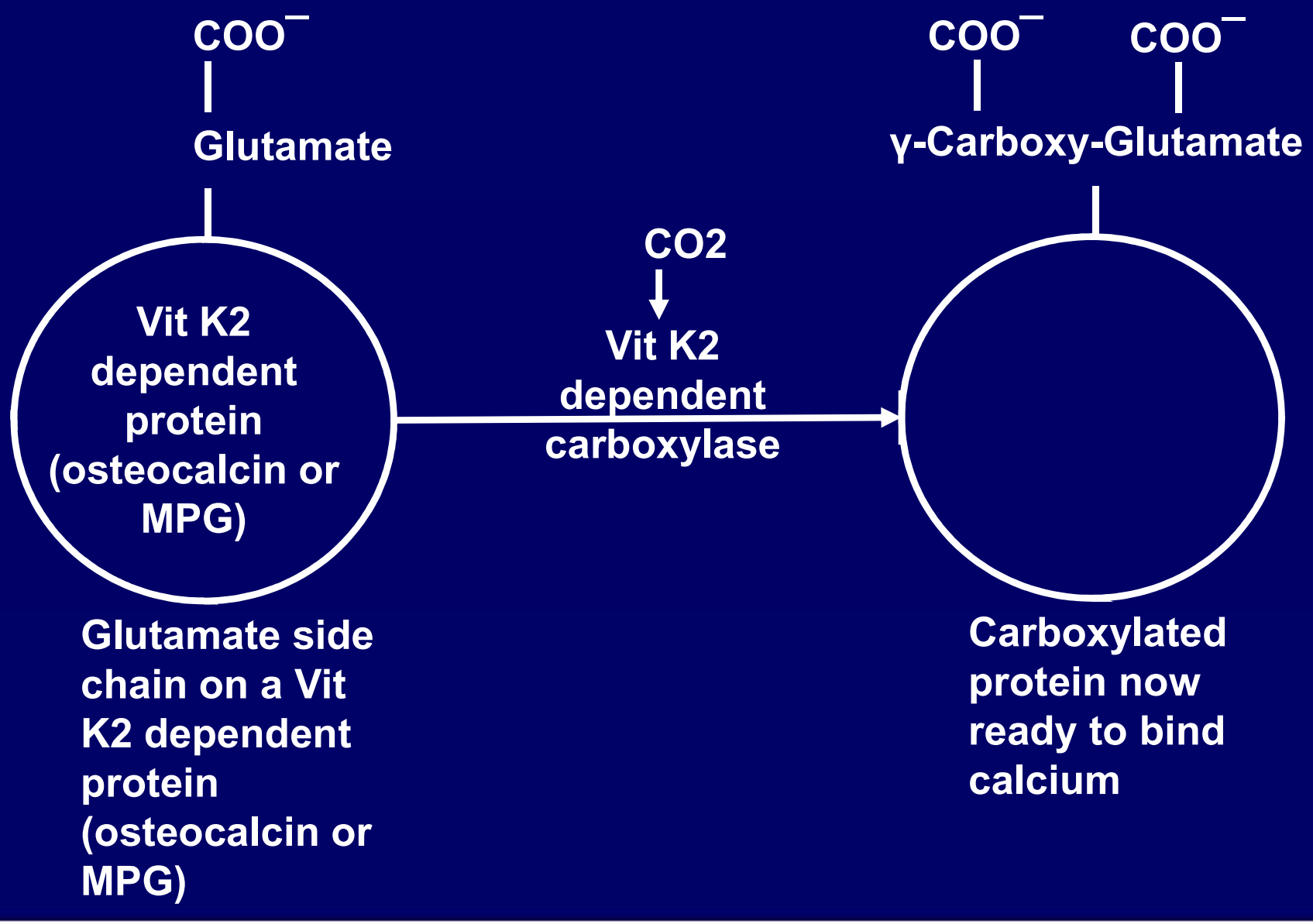


MK-7



Vitamin K_2 or menaquinone has nine related compounds, generally subdivided into the short-chain menaquinones (with MK-4 as the most important member) and the long-chain menaquinones, of which MK-7, MK-8 and MK-9 are nutritionally the most recognized.

Gamma - carboxylation



Vitamin K2 MK-7: A stability challenge, a market study

30-Mar-20172017-03-30

Demand for vitamin K2 has increased rapidly over the past decade as awareness of its role in bone and cardiovascular health has spread. However, studies run by Kappa Bioscience show many K2 products contain lower-than-claimed levels of the vitamin, a finding that threatens to undermine the market and its products' ability to provide health benefits and slow the natural effects of aging.

Interest in K2 stems from its role in regulating calcium. K2 activates osteocalcin proteins which incorporate calcium into bone. Bone mass acquired through childhood and adolescence leads to healthy bones later in life, which are needed to sustain physical stress and avoid diseases including osteoporosis and osteopenia. Bone mass declines throughout adult life, with peak bone mass (PBM) achieved in childhood at the age of 13 to 19 years. A 10% increase in PBM is estimated to reduce the risk of osteoporotic fracture as we age by 50%.

Vitamin K2 also activates matrix GLA (MGP) protein which binds excess calcium to prevent deposit in soft tissues such as arteries, a significant risk factor in cardiovascular disease and a common condition as we age. Vitamin K2 is deficient in the western diet, and, as such, supplementation is critical to good health. The MK-7 form of K2 is optimal for dietary supplementation because it has a half-life of two to three days, compared to the one to two hours of MK-4 .

Vitamin K is a quinone used in plants in photosynthesis (a phylloquinone). Animals use it for a different purpose. Basically there is an enzyme that takes vitamin K and takes a protein that's been already made, and converts the glutamic to a γ-carboxy glutamic acid (Gla.)*

* McCann JC, Ames BN. Vitamin K, an example of triage theory: is micronutrient inadequacy linked to diseases of aging? Am J Clin Nutr. 2009;90(4):889-907.

Glutamic has one carboxyl group at the end, and what this does is add another carboxyl group right next door. So you have two carboxyl groups and they combine to calcium. All the proteins that have a Gla in it are calcium-binding proteins, and that's important in their function. To do that step, Vitamin K is required.*

*American Journal of Clinical Nutrition page 889 or 2009 issue.

Function of K2

- Regulation of calcium
- Moves calcium into bones
- Removes calcium from arteries
- Fights osteoporosis
- Fights Coronary Heart Disease

Dr. Bruce Ames and Dr. McCann* evaluated the relative lethality of 11 known mouse knockout mutants that are associated with these vitamin K-related proteins. Vitamin K is required for coagulation, so there is something about the blood coagulation matrix that has been very clearly understood.

*Jeff Bland Functional Medicine Update April 2010

Vitamin K-related proteins interact with bone matrix proteins like osteocalcin and matrix Gla protein, and they also have to do with growth arrest (specific proteins transforming growth factor beta inducible protein) and other gene expression-related proteins that–like vitamin K–have pleiotropic effects on modulating cellular physiology.

*Jeff Bland Functional Medicine Update April 2010

The authors list in excess of 15 different vitamin K protein sensitivities that can be associated with various extraordinary symptomatologies beyond coagulation defects.

*Jeff Bland Functional Medicine Update April 2010

There are 5 proteins that turn out to be the interesting ones. When you knock them out you get heart disease or cancer (in the long-term). *

*Jeff Bland Functional Medicine Update April 2010 interviewing Bruce Ames

But the priority is to get the essential one for survival, which are the coagulation proteins, and you do that first in the liver, and then only if you have enough do you ship it out to the peripheral regions. Take the matrix Gla protein (Gla stands for γ-carboxy glutamic acid).*

*Jeff Bland Functional Medicine Update April 2010 interviewing Bruce Ames

When you knock that protein out in mice, they all die at 2 or 3 months of age of calcification of the arteries. We all know calcification of the arteries is an important factor in heart disease. And another one has to do with acute coronary syndrome.*

*Jeff Bland Functional Medicine Update April 2010 interviewing Bruce Ames

Another one of the genes has to do with cancer; you knock it out, they all die of cancer. The mechanism is the matrix protein interacting with integrin on the surface, which interacts with the microtubules, and so the animals get aneuploidy and all sorts of chromosome abnormalities.*

*Jeff Bland Functional Medicine Update April 2010 interviewing Bruce Ames

Dr. Ames and Dr. McCann conclude: “In the United States, the average intake of vitamin K1 is about 70-80 micrograms per day, which is below the currently recommended adequate intake of 90-120 micrograms per day.

They also point out that recommended intakes of vitamin K are based on amounts required to maintain coagulation function, not to promote proper enzyme function or gene expression patterns that associated with vitamin K sufficiency.

K2 dependant enzymes

Several human Gla-containing proteins have been discovered:

1. **Coagulation factors** (II, VII, IX, X), as well as anticoagulation proteins (C, S, Z). These Gla-proteins are synthesized in the liver and play an important role in blood homeo-stasis.

2. Osteocalcin. This non-collagenous protein is secreted by osteoblasts and plays an essential role in the formation of mineral in bone.

3. Matrix gla protein (MGP). This calcification inhibitory protein is found in numerous body tissues, most pronounced in cartilage and in arterial vessel walls.

- Vitamin K2 is the cofactor for an enzyme called vitamin K dependent carboxylase
- This enzyme when activated by K2 alters the structure of osteocalcin and MGP to allow those proteins to bind calcium

4. Growth arrest-specific protein 6 (GAS6). GAS6 is secreted by leucocytes and endothelial cells in response to injury and helps in cell survival, proliferation, migration, and adhesion.

5. Proline-rich Gla-proteins (PRGP), transmembrane Gla-proteins (TMG), Gla-rich protein (GRP) and periostin; whose precise functions are still unexplored.

Sources K1 Green vegetables (e.g., broccoli, kale, spinach, turnip greens, collards, Swiss chard, mustard greens)

Sources K2

Animal livers especially goose, Natto, Soft cheese eg Camerbert, Brie, Gouda, Edam, Sauerkraut. Emu oil, Butter.

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

Food	Vitamin K_2 (µg per 100 g)	Proportion of compounds
Nattō, cooked	1,034.0[13]	0% MK-4, 1% MK-5, 1% MK-6, 90% MK-7, 8% MK-8
Goose liver pâté Foie gras	369.0[13]	100% MK-4
Australian emu oil	360[17][18]	100% MK-4[18]
Hard cheeses	76.3[13]	6% MK-4, 2% MK-5, 1% MK-6, 2% MK-7, 22% MK-8, 67% MK-9
Soft cheeses	56.5[13]	6.5% MK-4, 0.5% MK-5, 1% MK-6, 2% MK-7, 20% MK-8, 70% MK-9
Egg yolk (Netherlands)	32.1[13]	98% MK-4, 2% MK-6
Goose leg	31.0[13]	100% MK-4
Grass-fed ghee and butter oil	19.6–43.1 average 29.9[19]	
Curd cheeses	24.8[13]	2.6% MK-4, 0.4% MK-5, 1% MK-6, 1% MK-7, 20% MK-8, 75% MK-9
Egg yolk (U.S.)	15.5[20]	100% MK-4
Butter	15.0[13]	100% MK-4
Chicken liver (raw)	14.1[20]	100% MK-4
Chicken liver (pan-fried)	12.6[20]	100% MK-4
Cheddar cheese (U.S.)	10.2[20]	6% MK-4, 94% other MK
Meat franks	9.8[20]	100% MK-4
Salami	9.0[13]	100% MK-4
Chicken breast	8.9[13]	100% MK-4
Chicken leg	8.5[13]	100% MK-4

FDA Daily Value (RDA)

80mcg

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

Muscles associated with Vitamin K*

None specific

*Applied Kinesiology Synopsis 2nd Edition by David Walther DC

Think Vitamin K2 with

Osteoporosis

The French paradox

Atherosclerosis

Angina

Elastin loss

Cysts

Vitamin K2 may reverse calcification of blood vessels in people with kidney disease

By Tim Cutcliffe, 23-Jun-2017

Last updated on 23-Jun-2017 at 15:42 GMT

Source: *BMC Nephrology*

Published online ahead of print, doi: 10.1186/s12882-017-0609-3

"High Dephosphorylated-Uncarboxylated MGP in Hemodialysis patients: risk factors and response to vitamin K2, a pre-post intervention clinical trial."

Authors: Mabel Aoun, *et al*

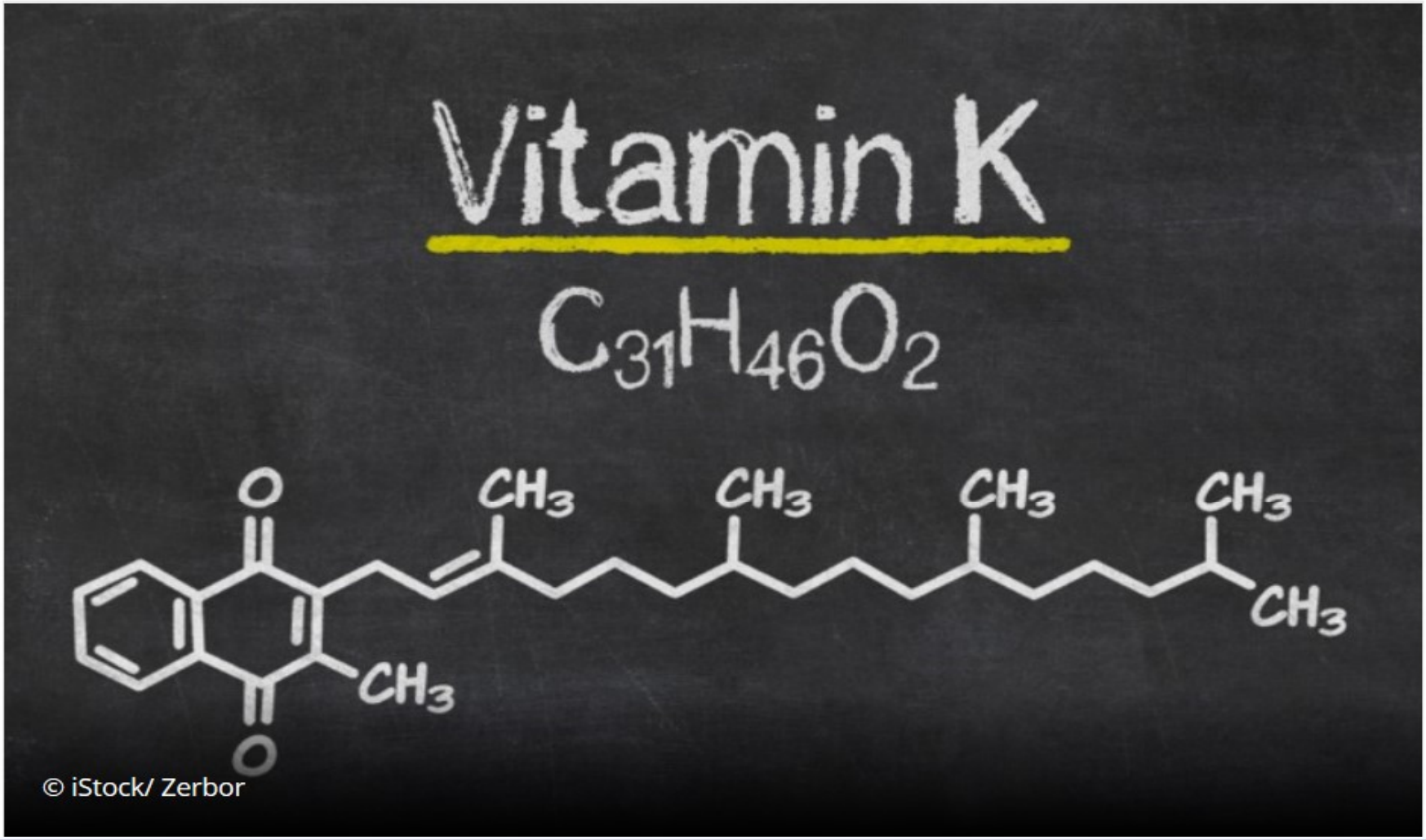
Four-week supplementation with vitamin K2 MK-7 (menaquinone-7) significantly improves vascular calcification (VC), according to a new study published in *BMC Nephrology*.

Low vitamin K linked to heart disease deaths: Dutch data

By Tim Cutcliffe

15-Dec-2017 - Last updated on 15-Dec-2017 at 12:34 GMT

29



© iStock/ Zerbor

There is a strong link between poor vitamin K status and cardiovascular (CV) mortality, say researchers who warn that around a third of people may be deficient.

Data from the prospective general population-based Prevention of Renal and Vascular End-Stage Disease (PREVEND) study identified that functional vitamin K insufficiency was present in almost one in three of subjects.

Insufficiency rates were even higher (around 50%) in the elderly and subjects with other conditions like high blood pressure, type-2 diabetes, chronic kidney disease (CKD), and CV disease, found the research team from Groningen University.

Writing in *Nutrients,* the researchers established J-shaped risk curves linking the vitamin K biomarker (blood levels of desphospho-uncarboxylated Matrix Gla Protein (dp-ucMGP)) to all-cause and CV mortality. Risks for the respective outcomes started to rise substantially at 414 picomoles/ litre (pmol/l) and 557 pmol/l.

"We demonstrated that the prevalence of functional vitamin K insufficiency, as derived from plasma dp-ucMGP, was ~30% in the total study population," wrote first author Dr. Ineke Riphagen

"Among the elderly and subjects with hypertension, type 2 diabetes, CKD, and CVD, prevalence was significantly higher (i.e. ~50%), and this prevalence increased even further as the number of comorbidities increased.

"Furthermore, we found J-shaped associations of plasma dp-ucMGP concentrations with all-cause and cardiovascular mortality," Riphagen added.

Functional insufficiency was defined as a blood level of dp-ucMGP of >500 pmol/l. The figure was based on the shape of these risk curves.

Source: *Nutrients*
Volume 9, issue 12, 1334, doi: **10.3390/nu9121334**
"Prevalence and Effects of Functional Vitamin K Insufficiency: The PREVEND Study"
Authors: Ineke J. Riphagen, Stephan J.L. Bakker

Vitamin K2 a 'novel therapeutic target' for common cardiovascular condition: Review

Source: *European Heart Journal*

https://doi.org/10.1093/eurheartj/ehx653

12 7

"Calcific aortic valve stenosis: hard disease in the heart: A biomolecular approach towards diagnosis and treatment"

Authors: Frederique E C M Peeters, *et al.*

"We have identified novel therapeutic targets like vitamin K," wrote researchers. ©iStock

Vitamin K2 could help tackle calcific aortic valve stenosis (CAVS), a common cardiovascular condition among older people.

Review: Co-supplementation of vitamins D, K may lead to stronger bones in children

By Adi Menayang

07-Sep-2017 - Last updated on 11-Sep-2017 at 09:29 GMT

Image © iStock

Source: *Journal of the American College of Nutrition*
Pulbished online and print, DOI: 10.1080/07315724.2017.1307791

"Roles of Vitamins D and K, Nutrition, and Lifestyle in Low-Energy Bone Fractures in Children and Young Adults"

Authors: Michal Karpinski, et al.

The
Vitamin Bs

Certain B vitamins could protect against air pollution risk

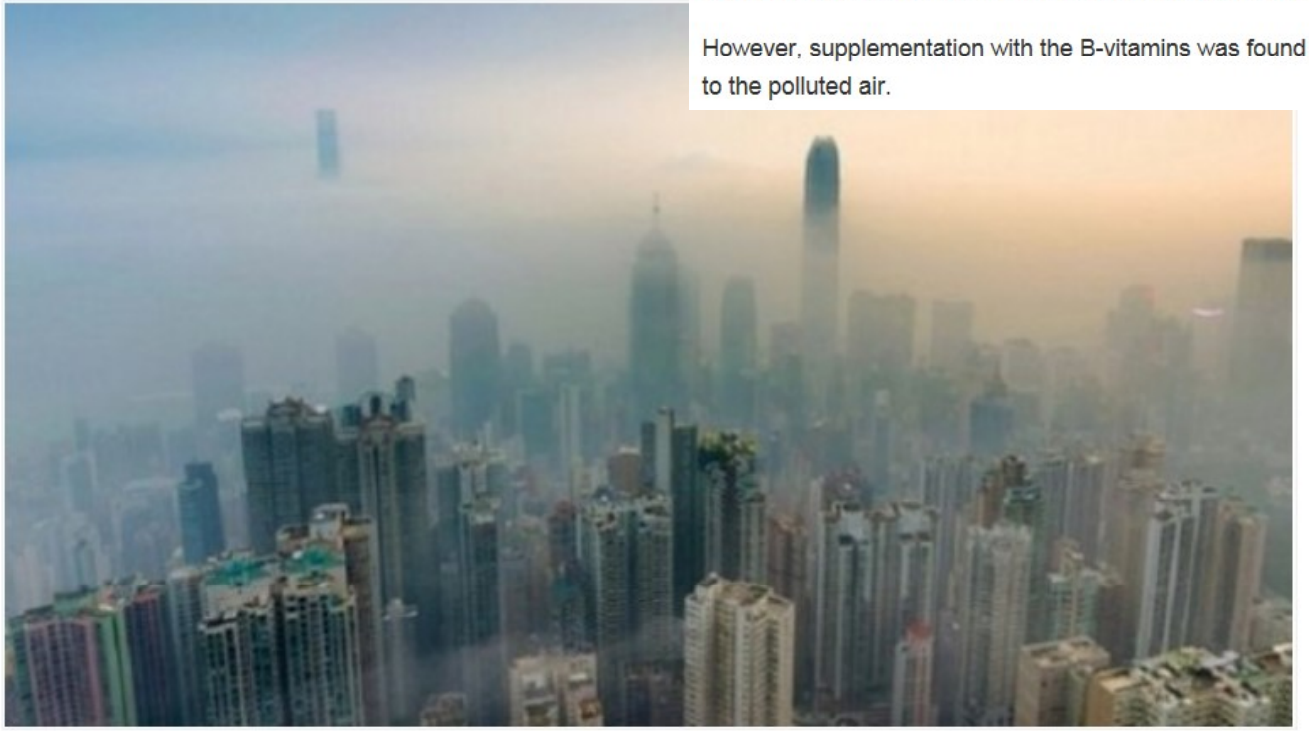
By Nathan Gray+

15-Mar-2017

The trial randomly gave a small group of participants a B-vitamin supplement (2.5 mg of folic acid, 50 mg of vitamin B6, and 1 mg of vitamin B12) or a placebo. After initial blood measures were taken the group were then exposed to ambient pollution with a particulate matter smaller than 2.5 µm (known as PM2.5).

They found that exposure to the particulate matter caused epigenetic changes, including alteration to methylation of genes involved in mitochondrial oxidative energy metabolism.

However, supplementation with the B-vitamins was found to prevent these changes when exposed to the polluted air.



Related tags: Air pollution, Air quality, Pollution, Vitamins, Vitamin B, Folic acid, B vitamins, Epigenetics

Dietary intake of B vitamins might play a role in reducing the impact of air pollution on the epigenome, say researchers.

Co-enzymes

Thiamine pyrophosphate
Thiamine triphosphate
Flavin mononucleotide FMN
Flavin adenine nucleotide FAD(H2)
Nicotinamide adenine dinucleotide NAD(H)
Nicotinamide adenine dinucleotide Phosphate NADP(H)
Co-enzyme A CoA
Pyridoxal-5-phosphate P-5-P
Tetrahydrofolate
Methenyl tetrahydrofoalte
Methylene tetrahydrofolate
5-Methyl tetrsahydrofolate 5MTHF
H4Biopterin
Adenosylcobalamin
Methylcobalamin
Biotin

Co-enzymes

Alpha Lipoic acid
Co-enzyme Q10
S.Adenosyl Methionine SAM
Vitamin C

B Complex

Why Vitamin B and G Separately

George Goodheart taken from Royal Lee – Standard Process.

Vitamin B Complex (Thiamine, Adenine (Vit B4), Pantothenic acid, B12) Soluble in alcohol. Heat stable. Associated with the nervous system. Acts as a vasoconstrictor. Increases blood pressure and enhances blood vessel tone. Destroyed by *thiaminase* in clams and salted herring.

Deficiency - Most symptoms due to high lactic acid levels. Burning in soles of feet. Tenderness of the calf muscles, Back pain at night. Poor breath holding less than 20 seconds, low body temperature, frequent yawning, fatigue, lack of appetite, bloating. Symptoms worse with exercise.

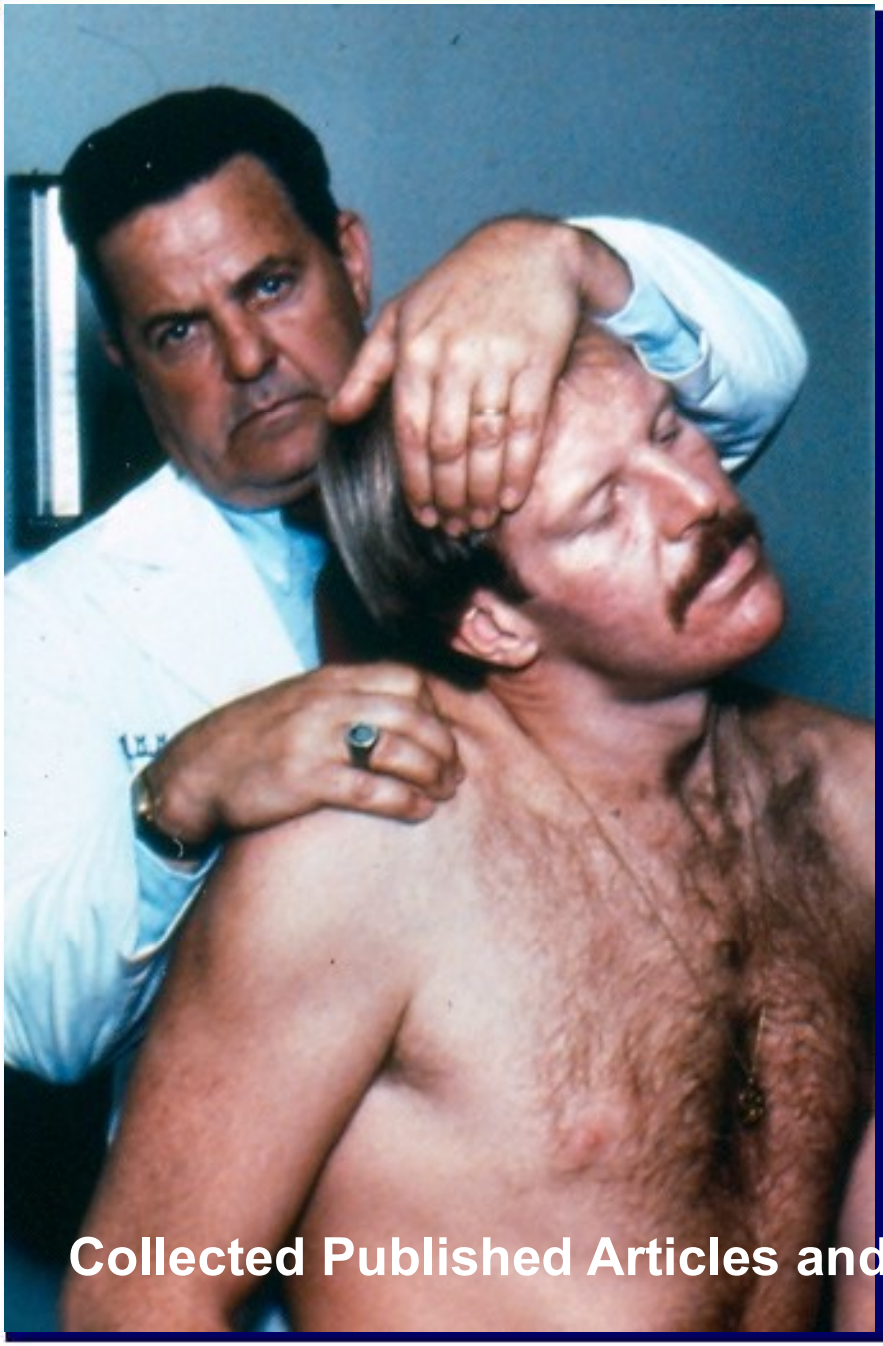
Increased psychotic tendency, intolerance to noise, apprehension. Bradycardia, irregular heart beat, atrial fibrillation, heart block. Split S1 and / or S2. Increased body weight.

Lack of vibration sense. Hat on or tight band sensation around the head.

Lack of appetite. Drowsiness after meals. Enhances salivary glands and pancreas to produce their alkaline enzymes thus aiding carbohydrate metabolism. Helps overly acidic patient.

Goes to sleep but wakes up and cannot get back to sleep. Nocturnal frequency.

Vitamin G Complex (Riboflavin, Niacin, Pyridoxine, Folic acid, Choline, Inositol, Biotin, Betaine)
Insoluble in alcohol, heat labile.
Nerve relaxing, acts as a vasodilator, aids hypertension.
Deficiency
Excessively worried, moody, apprehensive, suspicious, depression.
Tachycardia, Ventricular ectopic beats, pre angina pectoris, Pre-myocardial infarction. S1 and S2 equally spaced.
Aids in stomach HCl production. Helps overly alkaline patient. Spastic gall bladder. Bright red tip of the tongue. Purple or strawberry tongue with Vit B2 deficiency.
Rectal and vaginal irritation.
Frequent crying for no cause.
Cracking of the lips especially in the corners. Loss of substance in the upper lip.
Loss of capillary tone. Bloodshot eyes. Spider nervi.
Regulates oxygen / hydrogen. Role in sugar and aids fat metabolism. Deficiency leading to photophobia, burning, itching and blepharospasm. Things go in and out of vision.
Stimulates both acetylcholine synthesis and metabolism. Stimulates acetylcholinesterase so deficiency leads to spasms, atherosclerosis including coronary vessels, restless legs- jumpy or shaky legs.
Low levels of tissue choline as lecithinase is R/N dependant. Leads to fat deposition.



Dr Goodheart says

Think calcium when patients cannot get to sleep. *(Magnesium)*

Think B Complex when they cannot stay asleep.

Collected Published Articles and Reprints by Dr G. Goodheart

Dr Goodheart says

Irregular heart beat – B Complex (B1, B4)

Fibrillation and Bundle branch block G vitamins (B2 and B3)

Collected Published Articles and Reprints by Dr G. Goodheart

Dr Goodheart says

B Complex and Calcium for Enuresis

(aspartame / citric acid)

Collected Published Articles and Reprints by Dr G. Goodheart

Dr Goodheart says

B Complex for Menorrhagia along with Vitamin E and Calcium

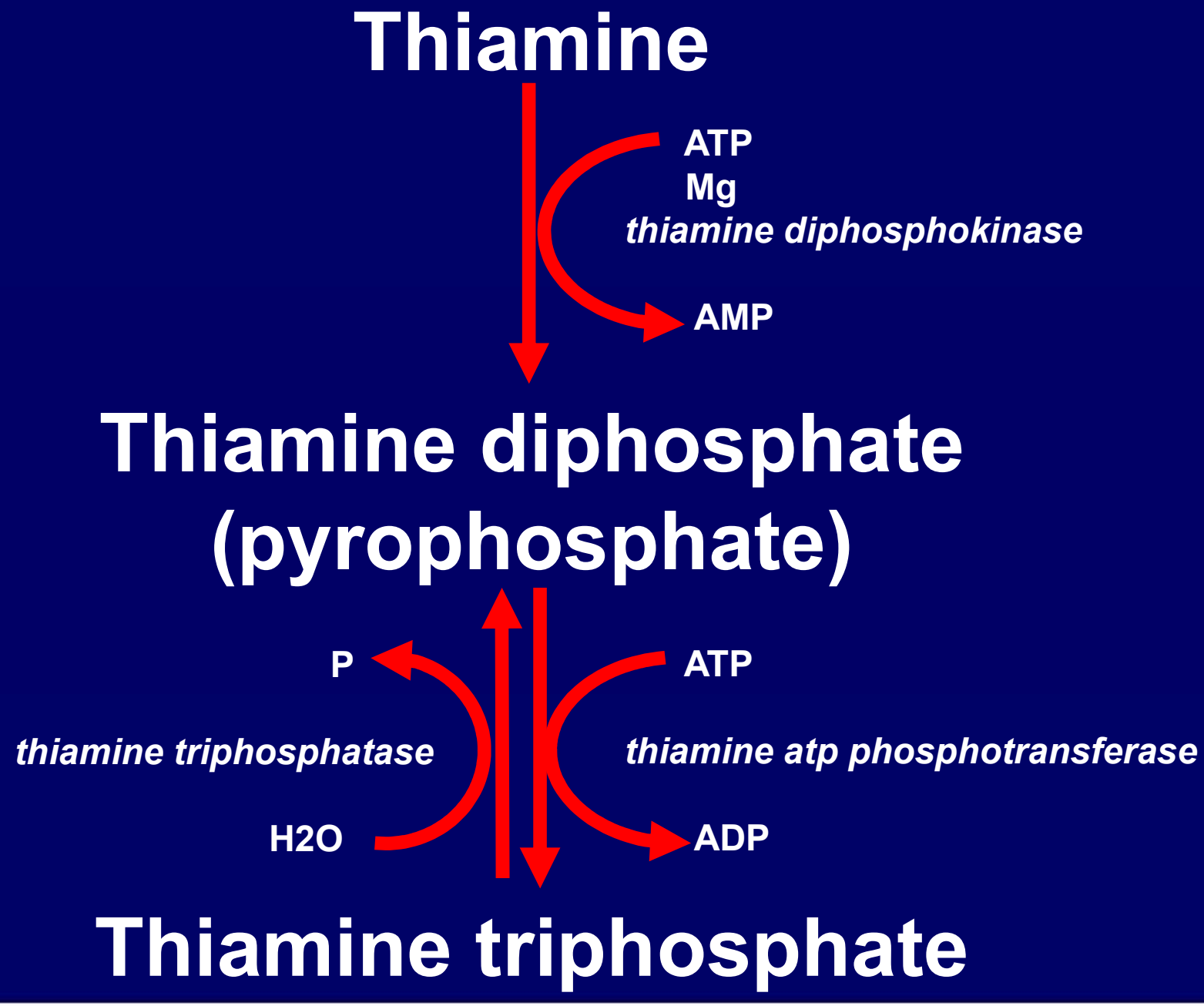
Collected Published Articles and Reprints by Dr G. Goodheart

Muscles associated with B. Complex*

Pectoralis major clavicular
Pectoralis minor
Peroneals
Quadriceps
Subscapularis
Supinator
Upper trapezius

*Applied Kinesiology Synopsis 2nd Edition by David Walther DC

Vitamin B1
Thiamine


Thiamine
ATP
Mg
thiamine diphosphokinase
AMP
Thiamine diphosphate
(pyrophosphate)
P
thiamine triphosphatase
H2O
ATP
thiamine atp phosphotransferase
ADP
Thiamine triphosphate

Vitamin B1 is found in most foods*, though mostly in small amounts. The best source of thiamine is dried brewer's yeast but other good sources include meat (especially pork and ham products), some species of fish (eel, tuna), whole grain cereals and bread, nuts, pulses, dried legumes and potatoes.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 265

A sufficient intake of Vitamin B1 is vital, as it plays an essential role in* -

The production of energy from food.

The synthesis of nucleic acids.

The conduction of nerve impulses.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 265

The European Food Safety Authority (EFSA), which provides scientific advice to policy makers, has confirmed that clear health benefits have been established for the dietary intake of vitamin B1 in contributing to:

The normal function of the heart
Normal carbohydrate and energy-yielding metabolism
The normal function of the nervous system
Normal neurological development and function
Normal psychological functions.

Vitamin B1 (thiamine) deficiency is rare, but can occur in people who get most of their calories from sugar or alcohol. People with thiamine deficiency have difficulty digesting carbohydrates, causing a loss of mental alertness, difficulty in breathing and heart damage.

Function*
Thiamine pyrophosphate TPP

1. Pyruvate dehydrogenase

converts pyruvate to acetyl CoA

2. α-Ketoglutarate dehydrogenase

converts a-Ketoglutarate to Succinyl CoA

3. Oxidative decarboxylation

can be an alternative to pyridoxal-5-phosphate

4. 2-Oxo acid dehydrogenase

oxidative decarboxylation of branched, short-chain alpha-ketoacids

Maple syrup urine disease. Defect in leucine, valine and isoleucine metabolism

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 261

5. Xylulose-5-phosphate transketolase

Pentose phosphate shunt

6. Transketolase

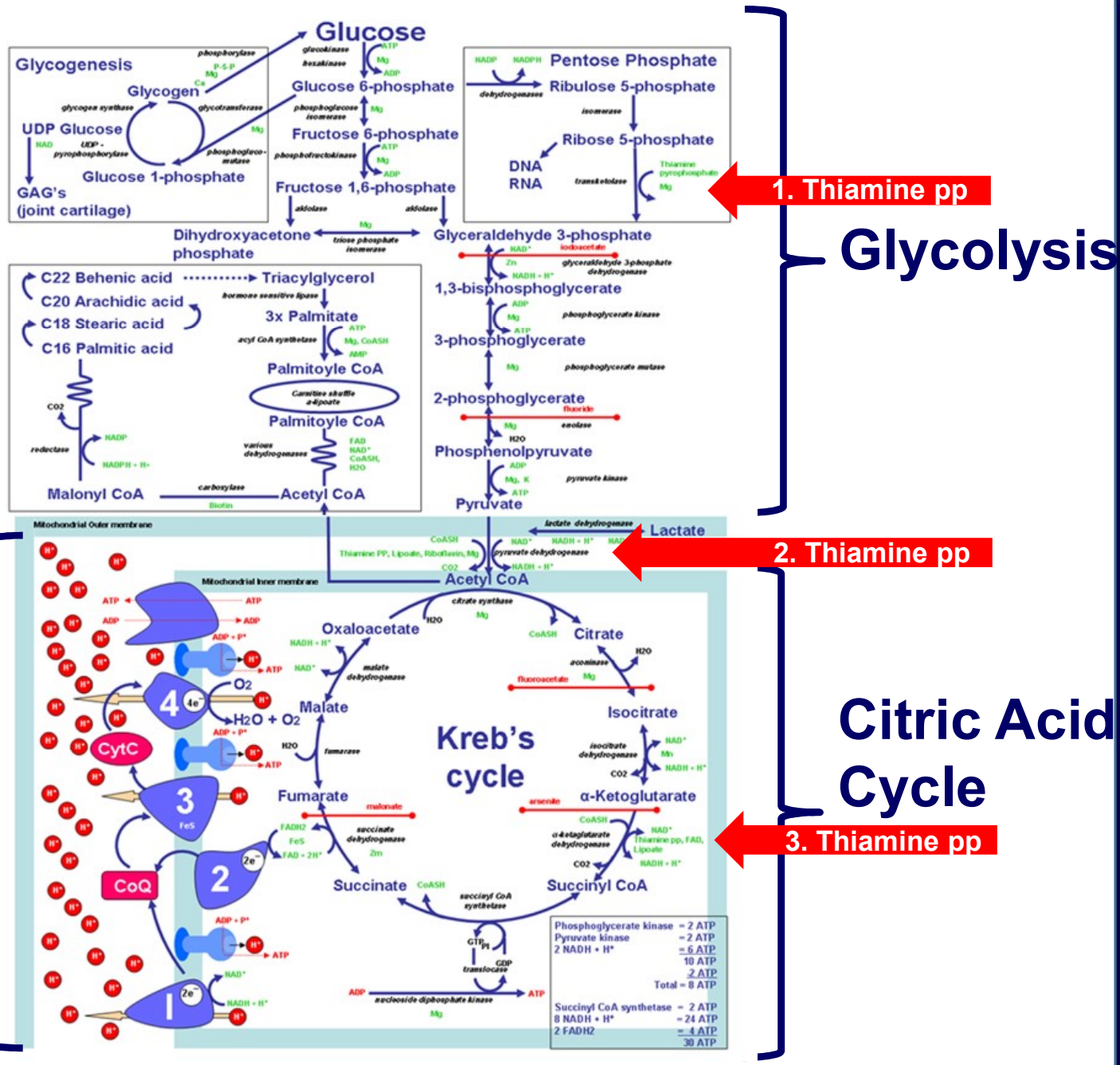
Pentose phosphate shunt

7. Thiamine pyrophosphate-ATP phosphoryltransferase

synthesises thiamine triphosphate

Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 261

Energy pathway



Chris Astill-Smith© 2008

Active co-enzymes

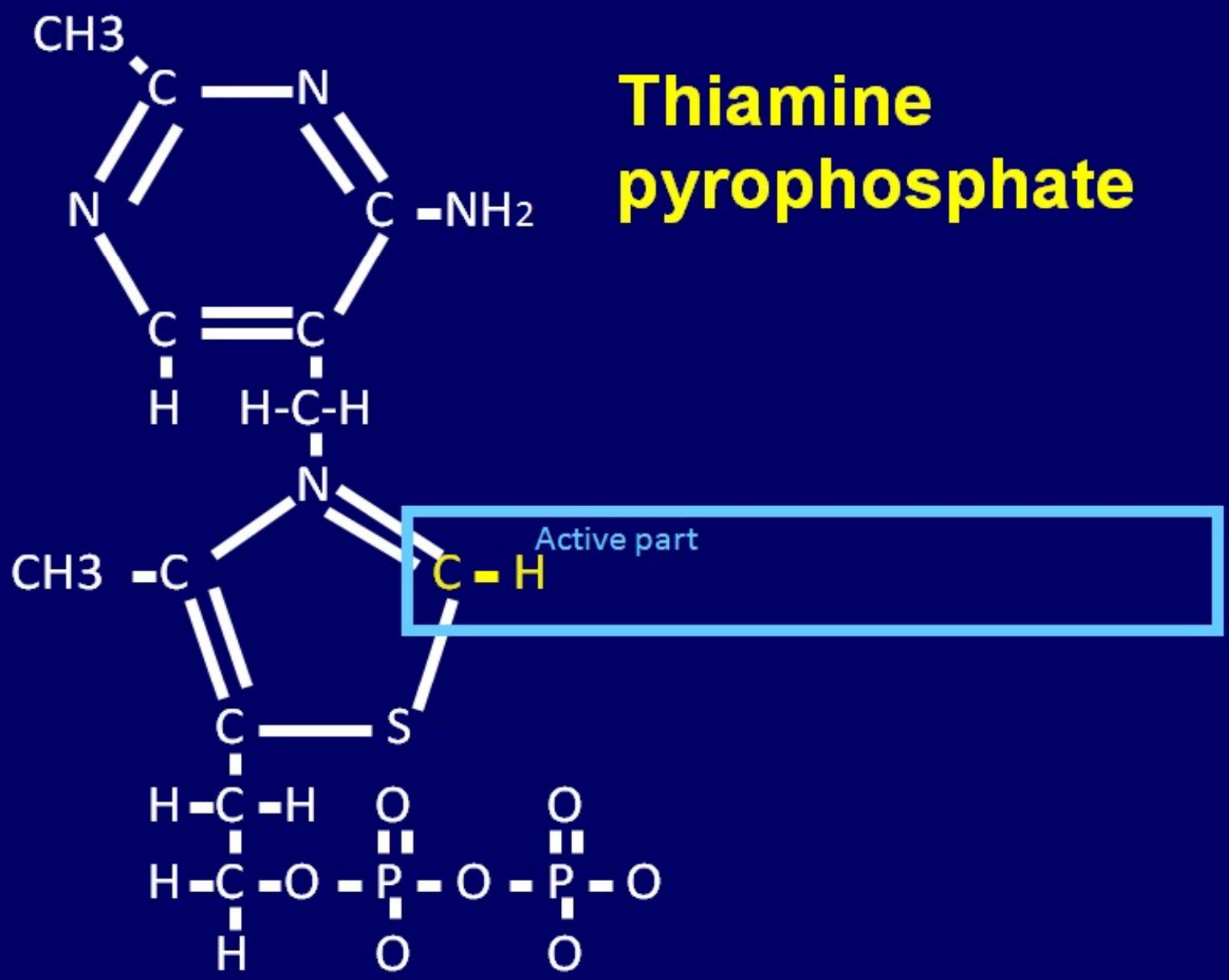
Thiamine pyrophosphate (energy production and DNA synthesis)*

Thiamine triphosphate** (synthesises Acetylcholine)

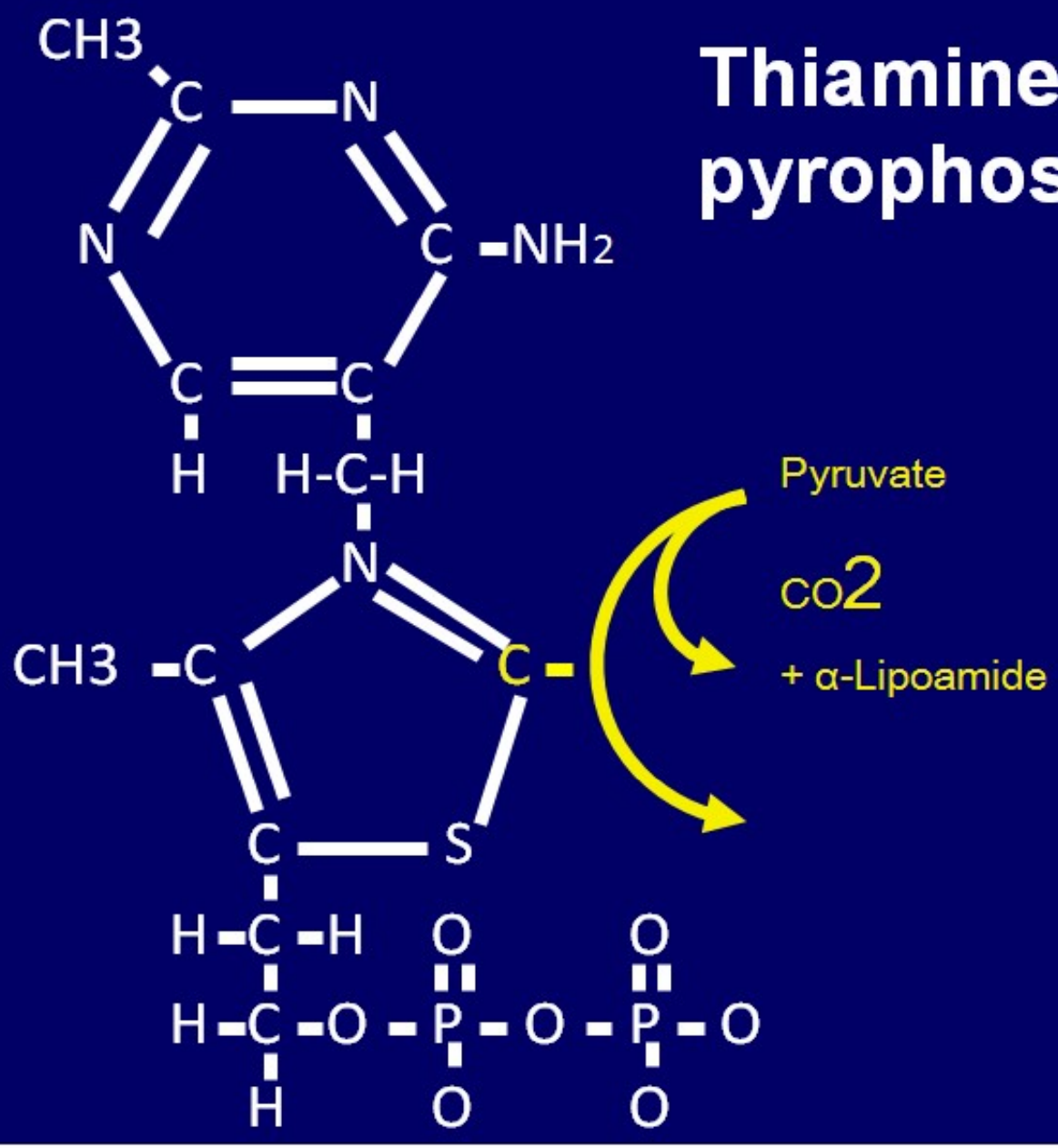
*Butterworth RF. Thiamin. In: Shils ME, Shike M, Ross AC, Caballero B, Cousins RJ, editors. Modern Nutrition in Health and Disease, 10th ed. Baltimore: Lippincott Williams & Wilkins; 2006

**Makarchikov AF, Lakaye B, Gulyai IE, Czerniecki J, Coumans B, Wins P, Grisar T, Bettendorff L (2003). "Thiamine triphosphate and thiamine triphosphatase activities: from bacteria to mammals". *Cell. Mol. Life Sci.* 60 (7): 1477–1488.

Thiamine pyrophosphate



Thiamine pyrophosphate

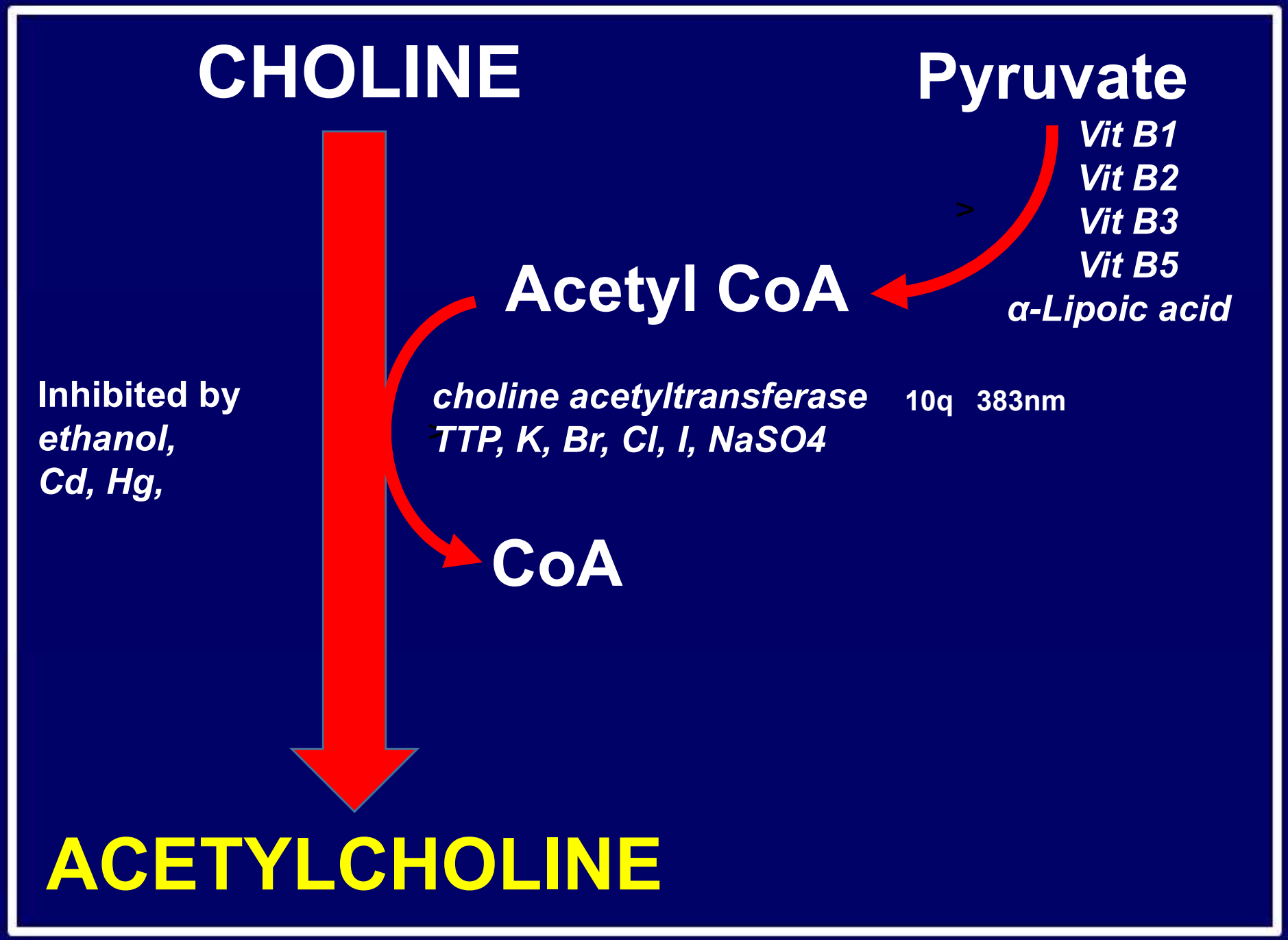


Function

Thiamine triphosphate TTP

Acetyltransferase in the synthesis of acetylcholine

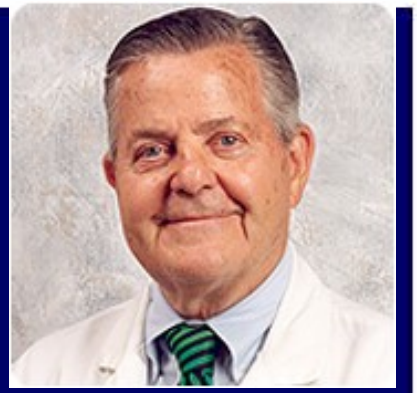
Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 261


CHOLINE
Pyruvate
Vit B1
Vit B2
Vit B3
Vit B5
α-Lipoic acid
Acetyl CoA
Inhibited by
ethanol,
Cd, Hg,
choline acetyltransferase
TTP, K, Br, Cl, I, NaSO4
10q
383nm
CoA
ACETYLCHOLINE

Deficiency symptoms

Beriberi, Wernick's disease, Yawning, Fatigue, muscle pains, parasthesia, atrophy, foot drop, weight loss, anorexia, megaloblastic anaemia, hyperkinetic myopathy. Behaviour changes, enuresis, memory loss. Skin rashes, respiratory symptoms

Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 264



Patient has a variety of complaints. “I have this skin trouble. It breaks out all over. It starts out with this one little patch. I haven’t changed my diet any. It itches. I was in the car and I get sleepy.

Collected Published Articles and Reprints by Dr G. Goodheart

Then when I go to bed I have this trouble falling asleep."
The tension usually goes to the skin and they don't tell you about the sleepiness because they have got used to it.

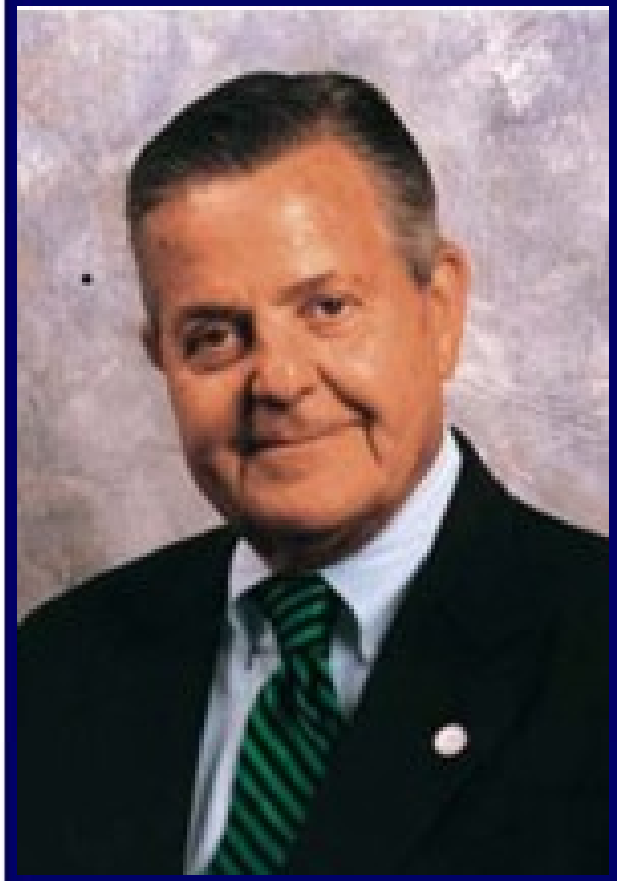
Dr Goodheart says patients who yawn a lot while talking need Vitamin B1

Collected Published Articles and Reprints by Dr G. Goodheart

Dr Wally Schmitt says check for Vitamin B1, Iodine, EFAs and L. Acidophilus in cases of dry vagina.

(L. Crispatus and Sea Buckthorn Oil)

Dr Goodheart says



If patient hops on one leg 10 times, then the other, the pulse should go up 40 beats.

If it doesn't, give Vitamin B1.

Collected Published Articles and Reprints by Dr G. Goodheart

David Leaf says

Take breath in and half way out and hold.
Should be able to hold for 20 seconds.

If it doesn't, give Vitamin B1.

Collected Published Articles and Reprints by Dr G. Goodheart

Dr Goodheart says

Give B1 for nocturnal polyuria

Sources

Liver, Beans and peas • Enriched grain products (e.g., bread, cereal, pasta, rice) • Nuts • Pork • Sunflower seeds • Whole grains

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

Foods that have anti-thiamine activity*

Blueberries Blackcurrant
Red chicory Sprouts
Red cabbage Coffee
Tea (green and black) Betal nut
Cotton seed Baking soda
Raw carp, herring, shellfish, freshwater fish contain thiaminase

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 265

FDA Daily Value (RDA)

1.5mg

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

Muscles associated with Vitamin B1*

None specific

*Applied Kinesiology Synopsis 2nd Edition by David Walther DC

Vitamin B1 deficiency linked to infertility and miscarriage: Japanese study

By Cheryl Marie Tay+

12-Jul-2017

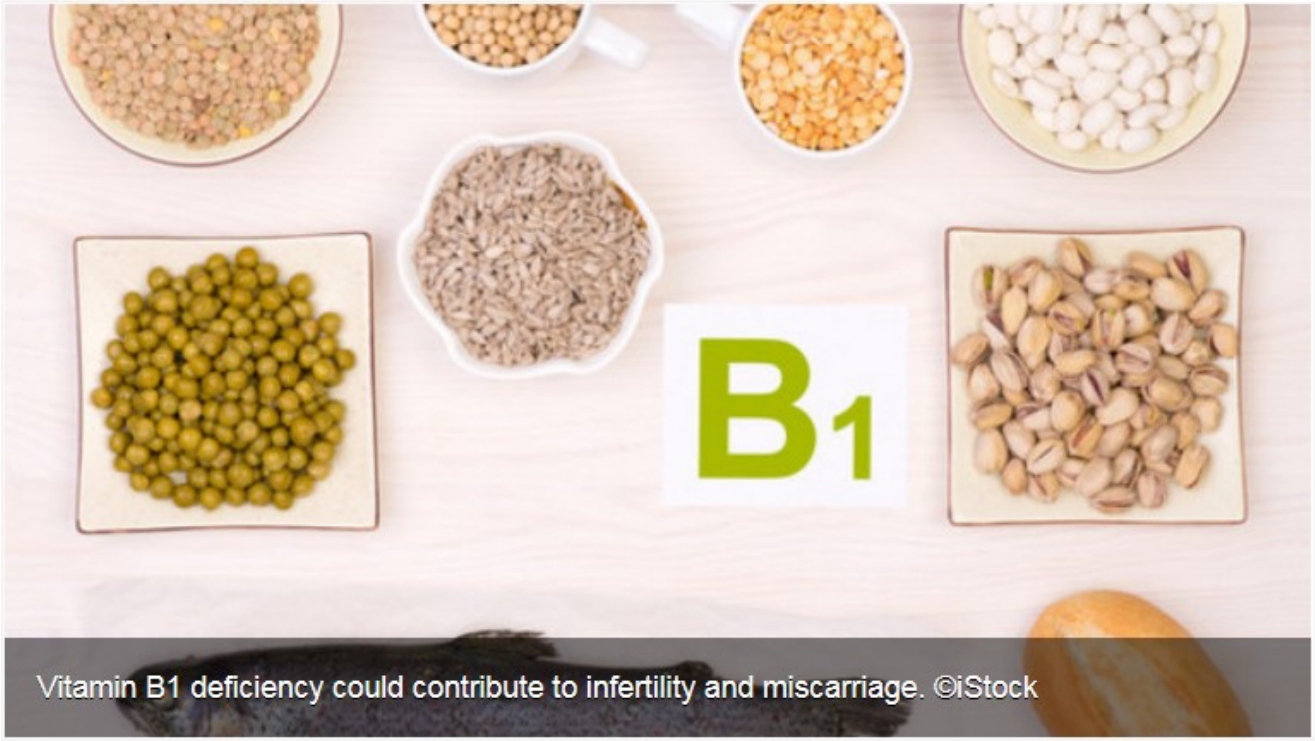
Last updated on 13-Jul-2017 at 17:31 GMT

Source: *Nutrition and Metabolic Insights*

http://doi.org/10.1177/1178638817693824

"Effects of Mild and Severe Vitamin B Deficiencies on the Meiotic Maturation of Mice Oocytes"

Authors: Ai Tsugi, *et al.*



Vitamin B1 deficiency could contribute to infertility and miscarriage. ©iStock

Related tags: Vitamin B1, Deficiency, Infertility, Miscarriage, Japan

Vitamin B1 deficiency could be a factor in infertility and miscarriage by contributing to low-quality oocytes, a study from Japan has found.

Vitamin B2
Riboflavin

Riboflavin

ATP

flavokinase Mg, T3, T4

AMP

Flavin mononucleotide (FMN) (Riboflavin-5-phosphate)

ATP

FAD synthetase Mg, Ca, Mn
T3, T4

PP

Flavin Adenine Dinucleotide (FAD)

Vitamin B2*, also called riboflavin, first isolated from milk, is one of the most widely distributed water-soluble vitamins. The term 'flavin' originates from the Latin word 'flavus', referring to the yellow colour of this vitamin. In the body, riboflavin is primarily a component of the coenzymes.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 265

The most important **dietary sources** are milk and milk products, lean meat, eggs and green leafy vegetables. Cereal grains, although poor sources of riboflavin, are important for those who rely on cereals as their main dietary component. Fortified cereals and bakery products supply large amounts.

A sufficient intake of Vitamin B2 (riboflavin) is important as it helps the body to:

Convert food (carbohydrates) into glucose to produce energy

Neutralize ‘free radicals’ that can damage cells and DNA.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas.

This neutralizing ‘antioxidant’ effect may reduce or help prevent some of the damage contributing to the aging process, as well as the development of a number of health conditions like heart disease and cancer.

Convert vitamin B6 and vitamin B9 into active forms.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas.

The European Food Safety Authority (EFSA), which provides scientific advice to assist policy makers, has confirmed that clear health benefits have been established for the dietary intake of vitamin B2 in contributing to:

Normal energy-yielding metabolism
Normal metabolism of iron in the body
The maintenance of normal skin and mucous membranes
The maintenance of normal red blood cells

The maintenance of normal vision.
The protection of cell constituents from oxidative damage.
The maintenance of the normal function of the nervous system
The reduction of tiredness and fatigue.

Individuals who have inadequate food intake are at risk of Vitamin B2 deficiency, particularly children from low socio-economic backgrounds, elderly people with poor diets, chronic ‘dieters’ and people who choose to exclude milk products from their diet (vegans).

Symptoms of riboflavin deficiency include fatigue, slowed growth, digestive problems, cracks and sores around the corners of the mouth, swollen magenta tongue, eye fatigue, and swelling and soreness of the throat..

Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 275

In order to become their component,vitamin B2 has to be converted into active forms* – flavin mononucleotide (FMN otherwise known as Riboflavin-5 phosphate) or
flavin adenine dinucleotide (FAD and its reduced form – FADH2).

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 268

Enzymes*

L. Amino acid dehydrogenase.
Alpha hydroxy acid oxidase.
Acyl CoA dehydrogenase.
Electron transferring protein dehydrogenase.
Succinate dehydrogenase.
Alpha glycerophosphate dehydrogenase in mitochondria.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 269

Pyruvate dehydrogenase.
NADH dehydrogenase complex.
Sarcosine dehydrogenase.
Aldehyde oxidase (dehydrogenase).
Xanthine oxidoreductase.
Cytochrome p450.
Kynurenine-3-oxidase.
Thioreductin dehydrogenase.

Choline oxidase.
Glutathione reductase.
Alpha ketoglutarate dehydrogenase.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 269

It is an orange / yellow-coloured fluorescent substance that is relatively heat-stable but decomposes under visible or ultraviolet light.

Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 266

The riboflavin-dependent enzymes are known as flavo enzymes or flavo-proteins.

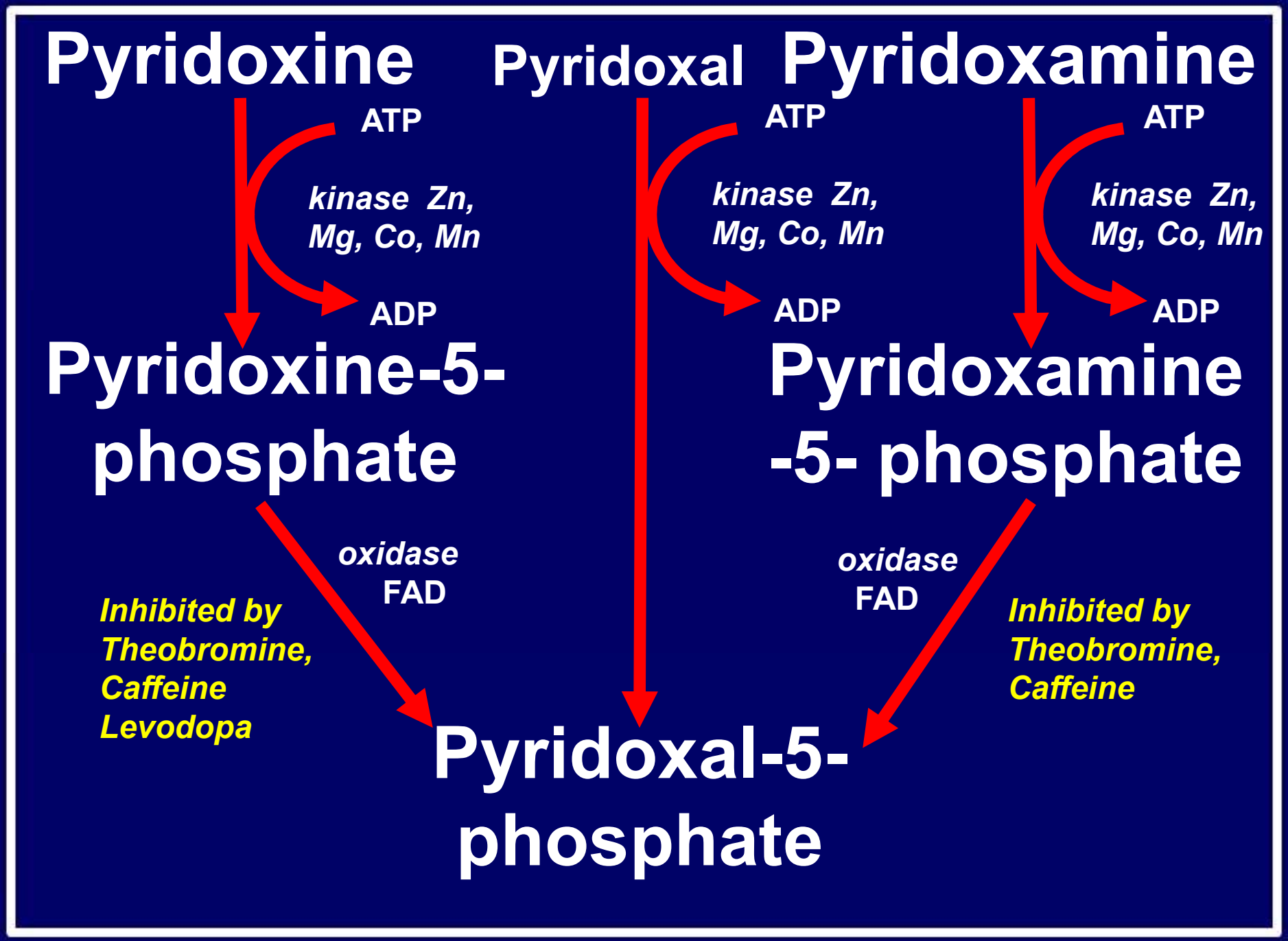
Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 266

Many flavo-enzymes also contain one or more metals, for example, molybdenum, iron and / or copper, and are therefore named metallo-flavoproteins.

Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 266

They are widespread and important for amino acid deamination, detoxifying aldehydes, sulfites, breaking down purines, fatty acids, for the functioning of the Krebs cycle and electron transport in the mitochondria.

They also function as components of glutathione reductase (providing reduced glutathione, a potent antioxidant and detoxifier) and of the enzyme producing an activated form of vitamin B6 in the liver.


Pyridoxine
Pyridoxal
Pyridoxamine
ATP
ATP
ATP
kinase Zn, Mg, Co, Mn
kinase Zn, Mg, Co, Mn
kinase Zn, Mg, Co, Mn
ADP
ADP
ADP
Pyridoxine-5-phosphate
Pyridoxamine -5- phosphate
oxidase FAD
oxidase FAD
Inhibited by Theobromine, Caffeine Levodopa
Inhibited by Theobromine, Caffeine
Pyridoxal-5-phosphate

Some medicines like adrenocorticotropic hormone – ACTH, chlorpromazine (a sedative) inhibit the conversion of riboflavin to its activated forms.*

*BRENDA enzyme database - http://www.brenda-enzymes.org/enzyme

Early symptoms of riboflavin deficiency are: angular stomatitis (inflammation at sides of the mouth), cheilosis (fissures at corners of the mouth) and glossitis (inflamed tongue).

Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 275

Deficiency of vitamin B2 may also occur in phototherapy and in intensive sun tanning.

Patients complain of “I have this pain in my legs, so I stop walking and it goes away”.

Collected Published Articles and Reprints by Dr G. Goodheart

Sources

• Eggs • Enriched grain products (e.g., bread, cereal, pasta, rice) • Meats • Milk • Mushrooms • Poultry • Seafood (e.g., oysters) • Spinach

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

FDA Daily Value (RDA)

1.7mg

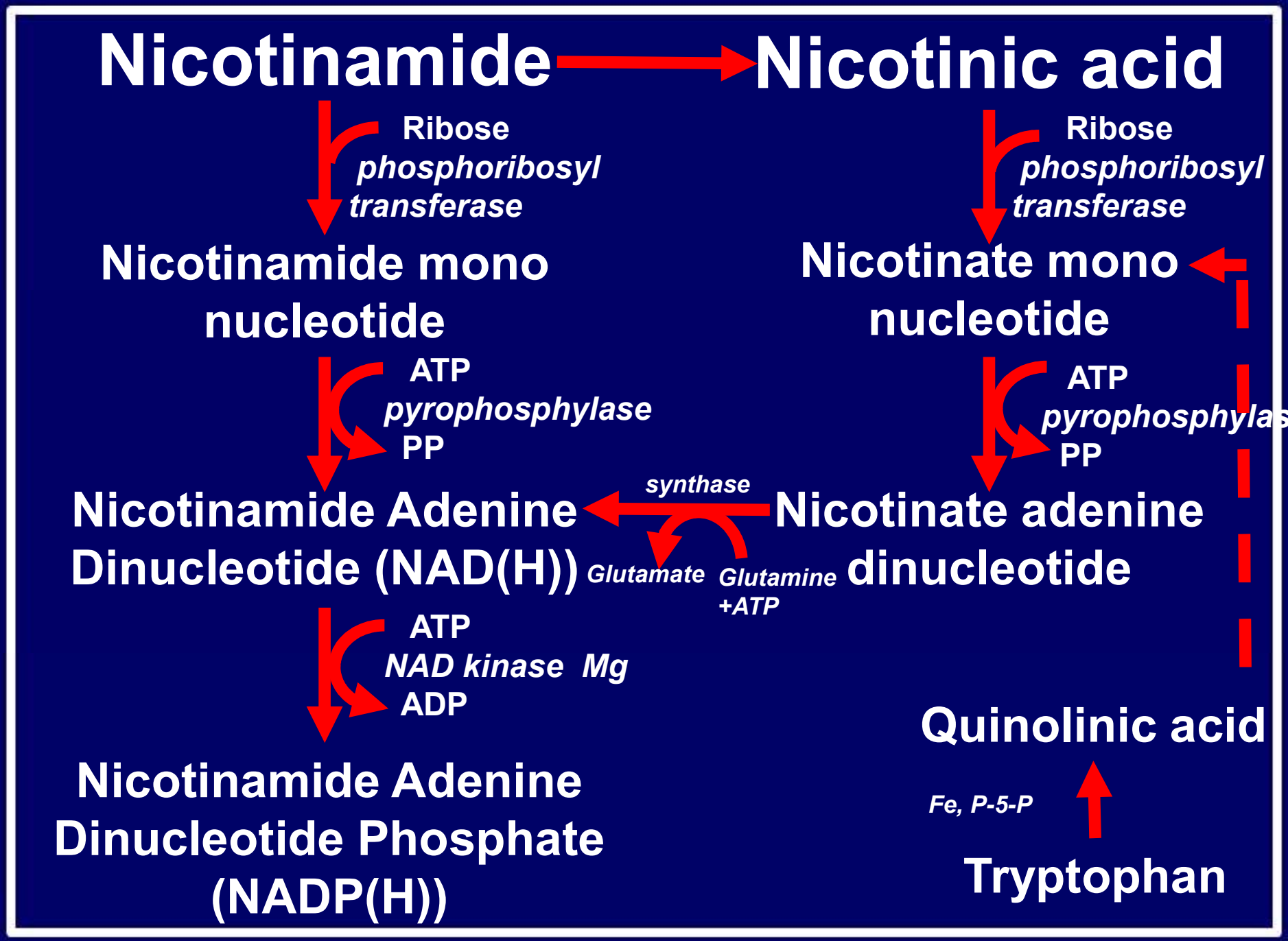
https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

Muscles associated with Vitamin B2*

Neck extensors

*Applied Kinesiology Synopsis 2nd Edition by David Walther DC

Vitamin B3
Niacin


Nicotinamide
Nicotinic acid
Ribose
phosphoribosyl
transferase
Ribose
phosphoribosyl
transferase
Nicotinamide mono
nucleotide
Nicotinate mono
nucleotide
ATP
pyrophosphylase
PP
ATP
pyrophosphylase
PP
synthase
Nicotinamide Adenine
Dinucleotide (NAD(H))
Glutamate
Glutamine
+ATP
Nicotinate adenine
dinucleotide
ATP
NAD kinase Mg
ADP
Quinolinic acid
Fe, P-5-P
Nicotinamide Adenine
Dinucleotide Phosphate
(NADP(H))
Tryptophan

The term niacin* refers to ‘nicotinic acid’ and ‘nicotinamide’ (also called niacinamide). Both are used to form the coenzymes.

Yeast, liver, poultry, lean meats, nuts and legumes contribute most of the niacin obtained from food. In cereal products (corn, wheat), niacin is bound to certain components of the cereal and is thus not bioavailable.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 307

The amino acid tryptophan* contributes as much as two thirds of the niacin activity needed by adults in typical diets. Important food sources of tryptophan are meat, milk and eggs.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 307

Vitamin B3 (niacin)* is important for the body because it helps to:

Convert food into glucose, used to produce energy.

Produce macromolecules, including fatty acids and cholesterol.

Facilitate DNA repair and stress responses.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 309

The European Food Safety Authority (EFSA), which provides scientific advice to policy makers, has confirmed that clear health benefits have been established for the dietary intake of niacin (vitamin B3) in contributing to:

Normal energy-yielding metabolism

The normal function of the nervous system

The maintenance of normal skin and mucous membranes

Normal psychological functions

The reduction of tiredness and fatigue.

In developed countries, where Vitamin B3 deficiency* is rare, alcoholism is the prime cause of deficiency. Symptoms of mild deficiency include indigestion, fatigue, canker sores, vomiting, and depression.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 307

Niacin* is the generic name for **nicotinic acid and nicotinamide,** either of which may act as a source of the vitamin in the diet. It is a for the functioning of a wide range of enzymes catalysing redoxreaction, the oxidoreductases.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 307

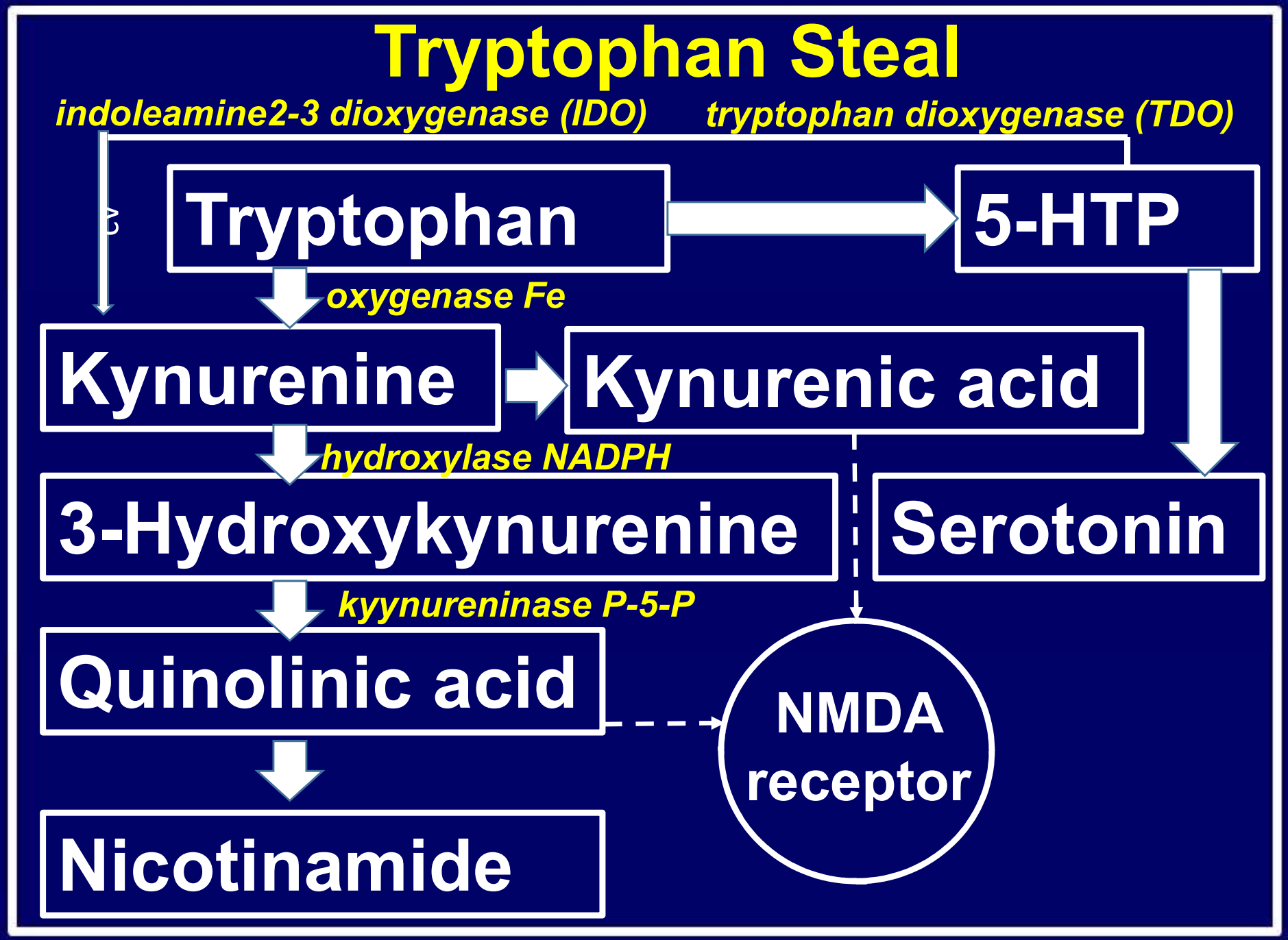
In order to become their coenzyme component, vitamin B3 has to be converted into active forms –nicotinamide adenine Dinucleotide (NAD^+) or nicotinamide adenine dinucleotide phosphate ($NADP^+$)*.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 307

Besides the dietary entry, nicotinic acid has been well known to be obtained from the amino acid tryptophan.

However, this pathway is inefficient: as much as 60 mg tryptophan is needed to make 1 mg of niacin. The process requires vitamins B1, B2 and B6, and occurs only after the needs of protein synthesis are met.

Tryptophan Steal



NAD-and NADP-linked oxidoreductases* act in many metabolic pathways regulating the turnover of carbohydrates, lipids and amino acids. NAD-dependent enzymes catalyse oxidation pathways while those depending on NADP are often active in the reductive syntheses (like synthesis of fatty acids or steroids).

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 307

Common enzymes*

Glycerol-50phosphate dehydrogenase.

Lactic acid dehydrogenase.

Alcohol dehydrogenase.

Retinol dehydrogenase.

Malate dehydrogenase.

Isocitrate dehydrgenase.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 311

Alpha ketoglutarate dehydrogenase.
Pregnenalone dehydrogenase.
Methylenetetrahydrofolate reductase.
Betaine aldehyde dehydrogenase.
Pyruvate dehydrogenase.

Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 313

Isocitrate dehydrogenase.
Testosterone hydrozylase.
Testosterone reductase.
Testosterone a-reductase.
3beta hydroxysteroid dehydrogenase.
Cholesterol desmolase.
Glutathione reductase.

Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 316

25-Cholecalciferol hydroxylase.
1a-Hydroxycholecalciferol hydroxylase.
24-Hydroxycholecalciferol hydroxylase.
Delta-6-desaturase.

Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 325

Besides redox reactions, NAD is also required for the repair of ultraviolet light-damaged DNA.

Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 328

Vitamin B3 Deficiency

Pellagra

1. Diarrhoea
2. Dermatitis
3. Dementia

Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 326

Sources

Beans • Beef • Enriched grain products (e.g., bread, cereal, pasta, rice) • Nuts • Pork • Poultry • Seafood • Whole grains

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

FDA Daily Value (RDA)

20mg

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

Muscles associated with Vitamin B3*

Gracilis

Neck extensors

Pectoralis minor

Sternocleidomastoid

*Applied Kinesiology Synopsis 2nd Edition by David Walther DC

Niacin may have a role in melanoma prevention, suggests review

By Tim Cutcliffe, 09-Aug-2017
Last updated on 09-Aug-2017 at 14:47 GMT

Source: *Photodermatology, Photoimmunology & Photomedicine*

Published online ahead of print. doi: 10.1111/phpp.12328

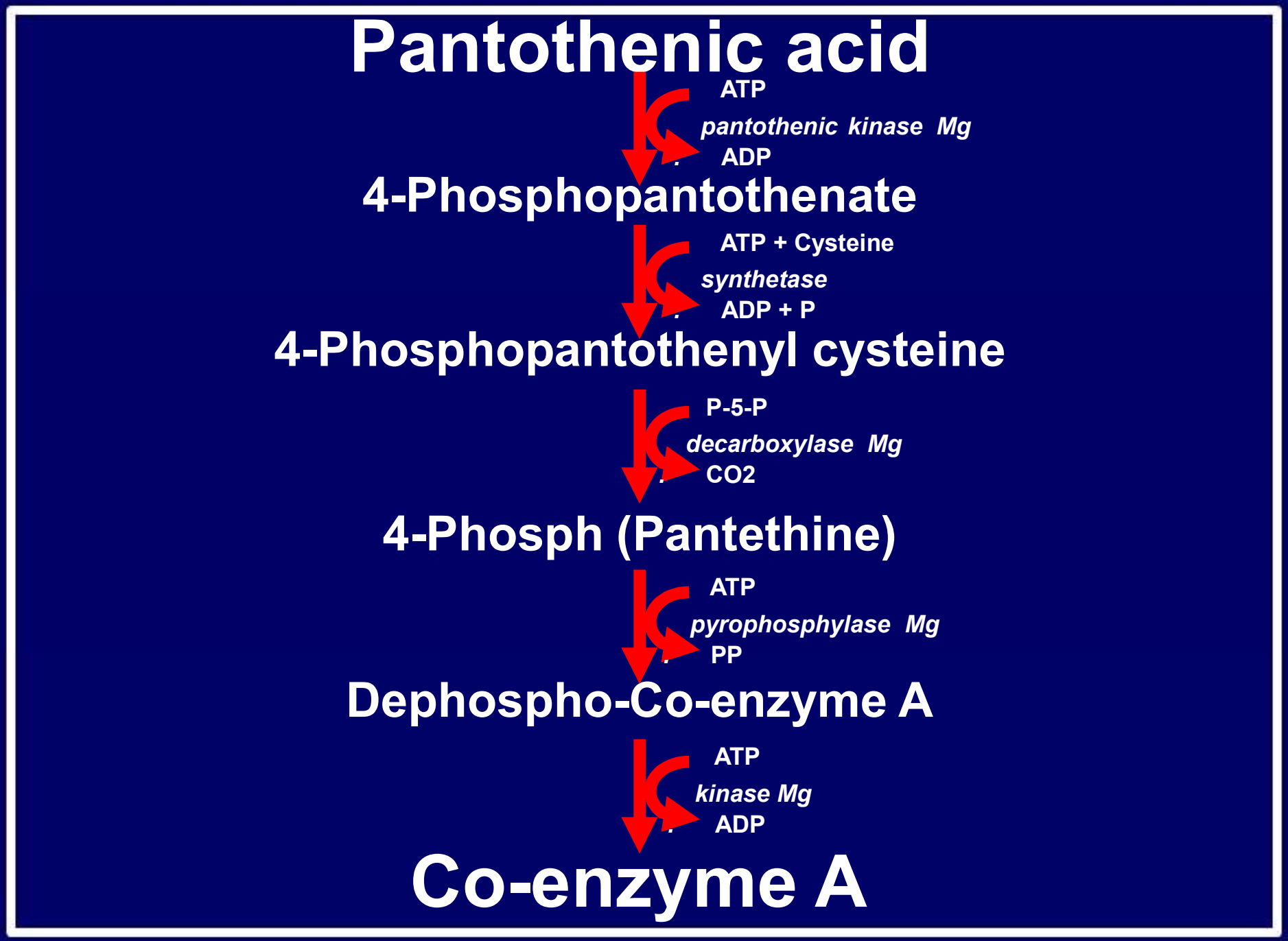
"Melanoma and non-melanoma skin cancer chemoprevention: a role for nicotinamide?"

Authors: Rashi Minocha, Diona L. Damian and Gary M. Halliday

Nicotinamide, a form of niacin, may have the potential to prevent melanoma in high-risk individuals, propose authors of a review.

Nicotinamide (vitamin B3) has previously demonstrated a reduction in non-melanoma skin cancer (NMSC) incidence in a human trial. The vitamin has also shown photoprotective effects against some of the mechanisms involved in melanoma development, found researchers from the University of Sydney - writing in *Photodermatology, Photoimmunology & Photomedicine.*

Vitamin B5
Pantothenic acid


Pantothenic acid
ATP
pantothenic kinase Mg
ADP
4-Phosphopantothenate
ATP + Cysteine
synthetase
ADP + P
4-Phosphopantothenyl cysteine
P-5-P
decarboxylase Mg
CO2
4-Phosph (Pantethine)
ATP
pyrophosphylase Mg
PP
Dephospho-Co-enzyme A
ATP
kinase Mg
ADP
Co-enzyme A

Vitamin B5, also called Pantothenic acid*, belongs to the group of water-soluble B vitamins. Its name originates from the Greek word *pantos*, meaning 'everywhere'. The richest vitamin B5 sources are yeast and organ meats (liver, kidney, heart, brain); although eggs, milk, vegetables, legumes and wholegrain cereals are more common sources.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 329

An adequate supply of Vitamin B5* is important as it helps the body to:

- Convert food into glucose, used to produce energy
- Break down fats, carbohydrates, and proteins for energy generation
- Synthesize cholesterol cholesterol
- Form red blood cells, as well as sex and stress-related hormones.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 331

The European Food Safety Authority (EFSA), which provides scientific advice to assist policy makers, has confirmed that clear health benefits have been established for the dietary intake of pantothenic acid (vitamin B5) in contributing to:

Normal energy-yielding metabolism

Normal mental performance

Normal synthesis and metabolism of steroid hormones, vitamin D and some neurotransmitters

The reduction of tiredness and fatigue.

Since Vitamin B5 occurs to some extent in all foods, it's generally assumed that deficiency is extremely rare. The truth is it probably happens in conjunction with deficiencies in other B vitamins.

Groups at risk of deficiency are alcoholics, women on oral contraceptives, people with insufficient food intake (the elderly, post-operative), and people with impaired absorption (due to certain intestinal diseases).*

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 338

Enzymes requiring Coenzyme A*

1. Pyruvate dehydrogenase
2. α-ketoglutarate dehydrogenase
3. Carnitine acyltransferase
4. Acyl-CoA dehydrogenase in the mitochondria
5. Choline acetyltransferase

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 331

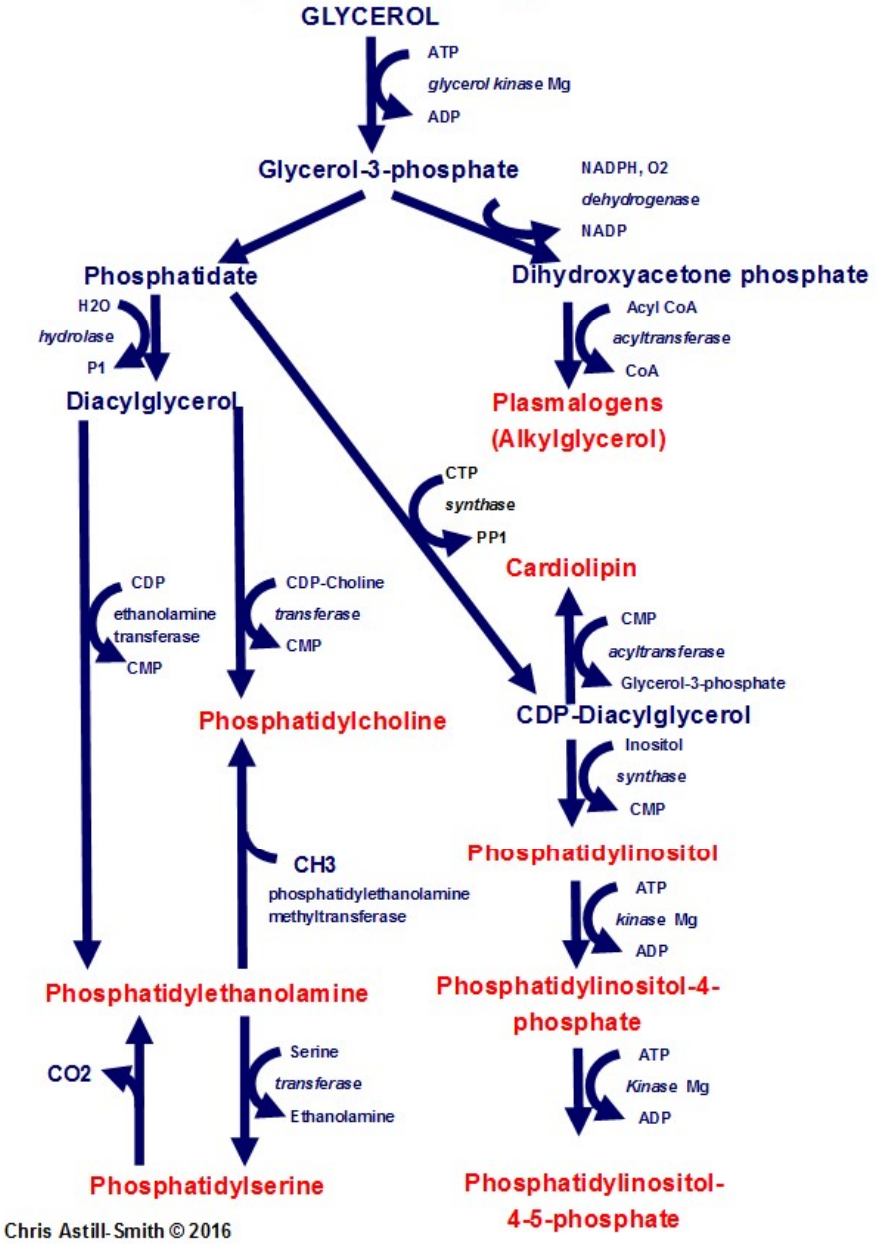
6. Acetyl-CoA Glucosamine-6-phosphate transferase

7. Acetyl-CoA-Sphingosine phosphorylcholine transferase (making sphingosine)

8. Acetyl-CoA-Sphingosine transferase (ceramides to cerebrosides and gangliosides

Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 331

Phospholipid synthesis



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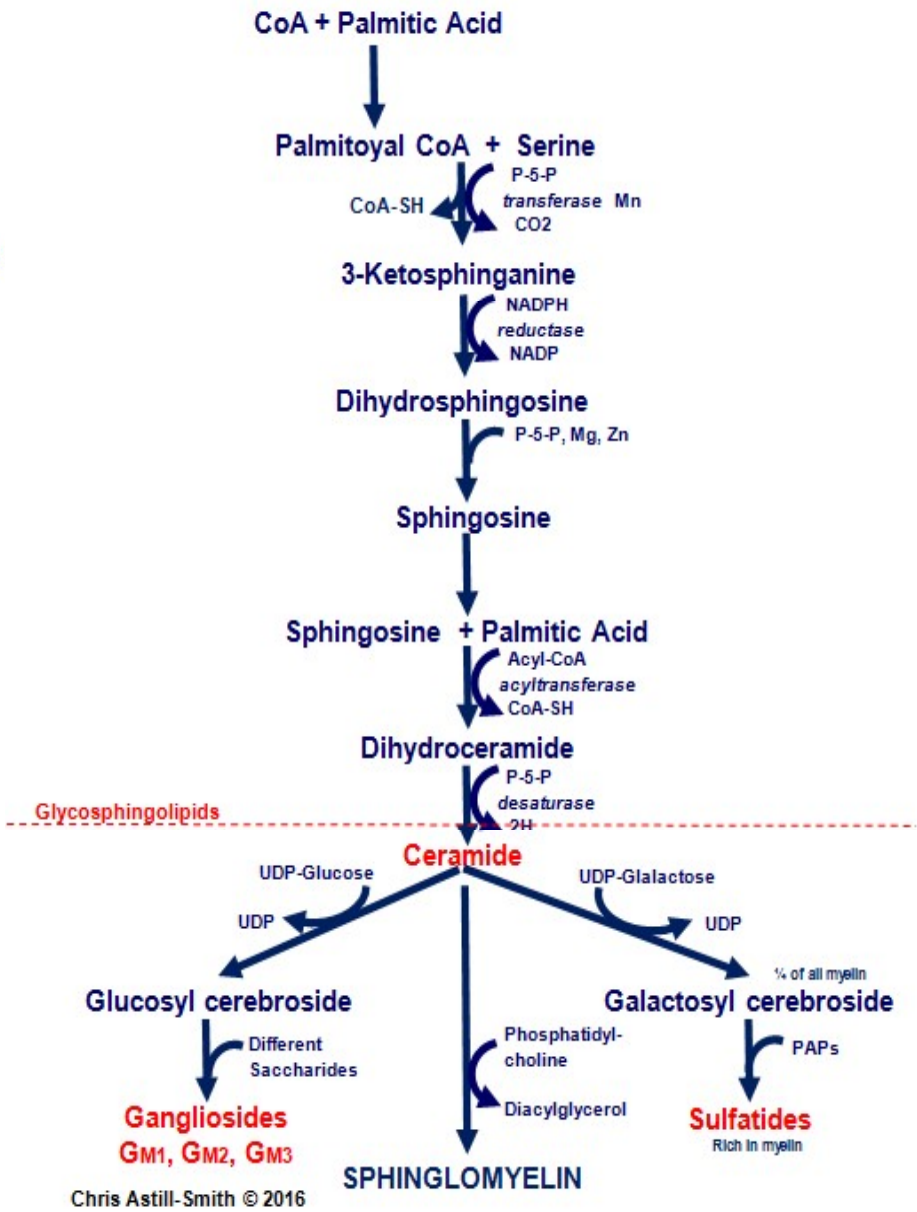
Sphinglomyelin synthesis



Chris Astill-Smith © 2016

Deficiency symptoms*

Burning foot syndrome, anorexia, indigestion, abdominal pain, respiratory infections, neuritis, cramps, tenderness of the heel, insomnia, fatigue, depression, psychoses, headaches, tachycardia and hypotension.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 338

Sources

Avocados • Beans and peas • Broccoli • Eggs • Milk • Mushrooms • Poultry • Seafood • Sweet potatoes • Whole grains • Yogurt

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

FDA Daily Value (RDA)

10mg

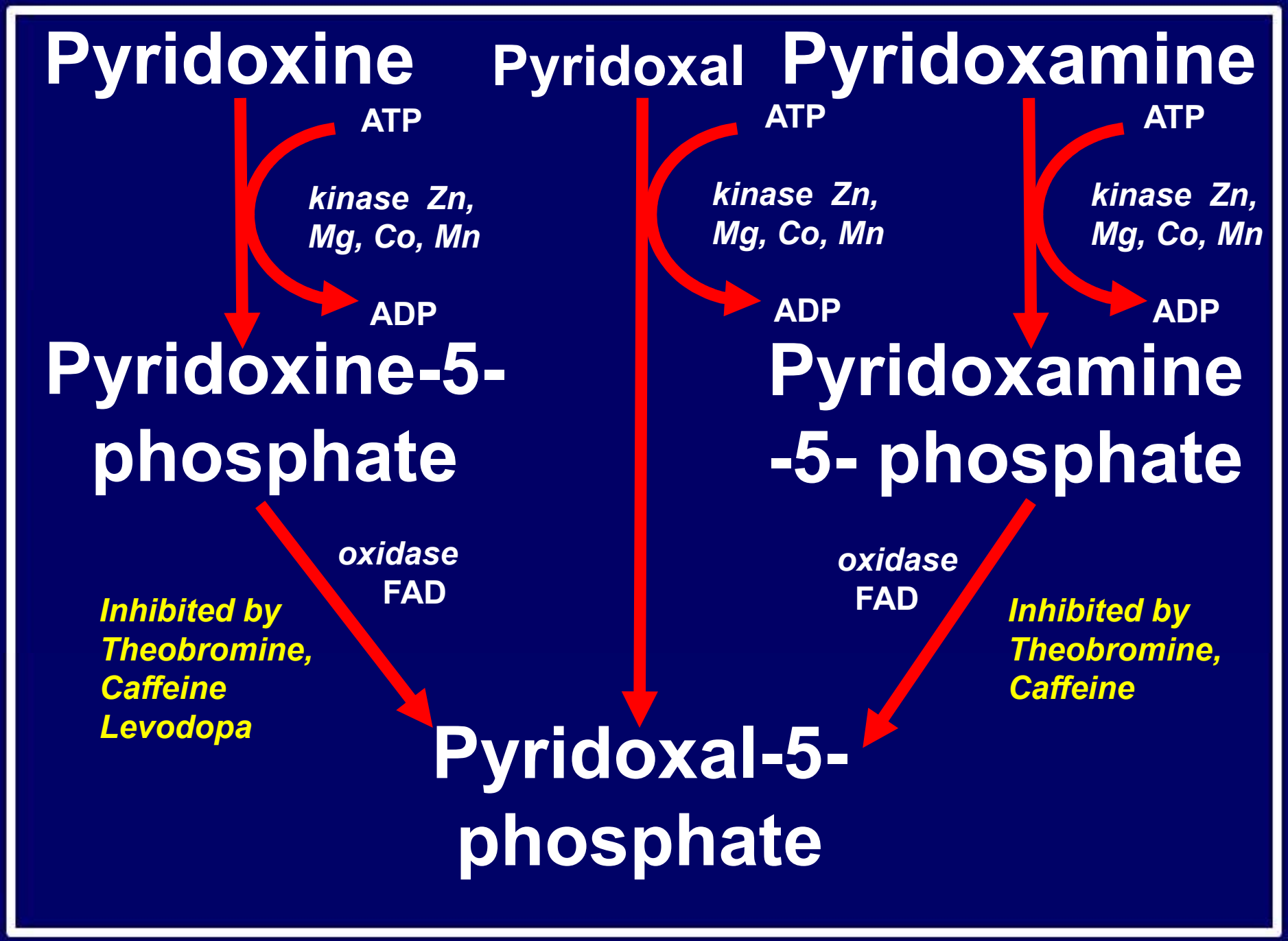
https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

Muscles associated with Vitamin B5*

Sartorius

*Applied Kinesiology Synopsis 2nd Edition by David Walther DC

Vitamin B6
Pyridoxine


Pyridoxine
Pyridoxal
Pyridoxamine
ATP
ATP
ATP
kinase Zn, Mg, Co, Mn
kinase Zn, Mg, Co, Mn
kinase Zn, Mg, Co, Mn
ADP
ADP
ADP
Pyridoxine-5-phosphate
Pyridoxamine -5- phosphate
oxidase FAD
oxidase FAD
Inhibited by Theobromine, Caffeine Levodopa
Inhibited by Theobromine, Caffeine
Pyridoxal-5-phosphate

Vitamin B6*, water-soluble, is found in three different natural forms: pyridoxine, pyridoxamine, and pyridoxal - all of which are normally found in foods. Humans depend on external sources to cover their vitamin B6 requirements and the pyridoxal 5`-phosphate (PLP) form is of major importance.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 376

Excellent sources of Vitamin B6* are chicken, beef liver, pork and veal. Good sources include fish (salmon, tuna, sardines, halibut, and herring), nuts (walnuts, peanuts), bread, corn and whole grain cereals. Generally, vegetables and fruits are rather poor sources of vitamin B6.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 286

An adequate intake of Vitamin B6* (pyridoxine) is essential as it helps the body to:

Convert food into glucose, which is used to produce energy.

Make neurotransmitters, which carry signals from one nerve cell to another.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 278

Produce hormones, red blood cells, and cells of the immune system

Control (along with vitamin B12 and vitamin B9) blood levels of homocysteine - an amino acid that may be associated with heart disease.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 278

The European Food Safety Authority (EFSA), which provides scientific advice to assist policy makers, has confirmed that clear health benefits have been established for the dietary intake of vitamin B6 in contributing to:

Normal protein and glycogen metabolism
The normal function of the nervous system
Normal red blood cell formation
The normal functioning of the immune system
The regulation of hormonal activity
Normal homocysteine metabolism
Normal energy-yielding metabolism
Normal cysteine synthesis
Normal psychological functions
The reduction of tiredness and fatigue.

A deficiency of Vitamin B6 alone is uncommon as any deficiency typically occurs in combination with a deficit in other B-complex vitamins (especially vitamin B2).

Population groups at risk of Vitamin B6 deficiency are pregnant and breast-feeding women (additional demands), women taking oral contraceptives, the elderly (due to lower food intake), underweight people, chronic alcoholics, and people with a high protein intake.

Symptoms of deficiency include nervous system disorders (irritability, depression, and confusion), impairment of the immune system and inflammation of skin and mucosa.

Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 285

Pyridoxal-5-phosphate (P5P)

Major form present in the plasma. It is distributed to all tissues.

Other forms are Pyridoxine-5-Phosphate and Pyridoxamine-5-Phosphate

Functions

1. Transamination
2. Decarboxylation
3. Neurotransmitter synthesis
4. Transulfation
5. Protoporphyrin synthesis

Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 278

6. Niacin synthesis

7. Polyamines synthesis (Growth factors, inhibition of some enzymes, stimulation of DNA / RNA synthesis, stabilization of membranes and DNA)

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There are 76 enzymes involved with amine metabolism that require P5P.

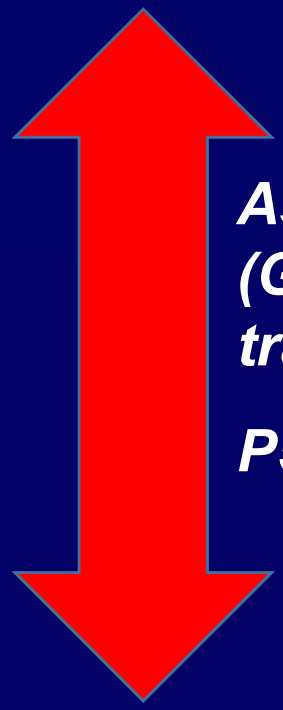
Transamination*

1.Aspartate aminotransferase (Glutamate oxaloacetate transaminase – GOT)

Glutamic acid + Oxaloacetic acid = Aspartic acid + alpha-ketoglutaric acid ↑ in liver disease, coronary heart disease and muscular diseases.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 278

Glutamic acid + Oxaloacetic acid



Aspartate aminotransferase (Glutamate oxaloacetate transaminase – SGOT)

P5P

10q	383nm
16q	390nm

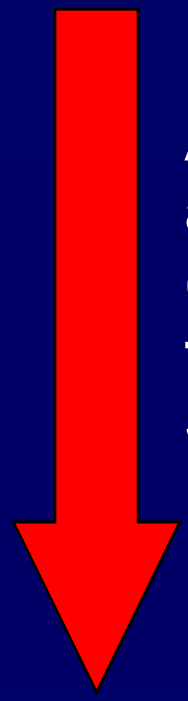
Aspartic acid
+
alpha-ketoglutaric acid

2. *Alanine aminotransferase (glutamate pyruvate transaminase – GPT)*

Glutamic acid + Pyruvic acid = alpha-ketoglutaric acid + Alanine

↑ in liver diseases such as hepatitis, cirrhosis, biliary disease and alcoholism.

Glutamic acid + Pyruvic acid



Alanine aminotransferase (glutamate pyruvate transaminase – GPT / SGPT 8q 381nm

P5P

alpha-ketoglutaric acid + Alanine

Decarboxylation*

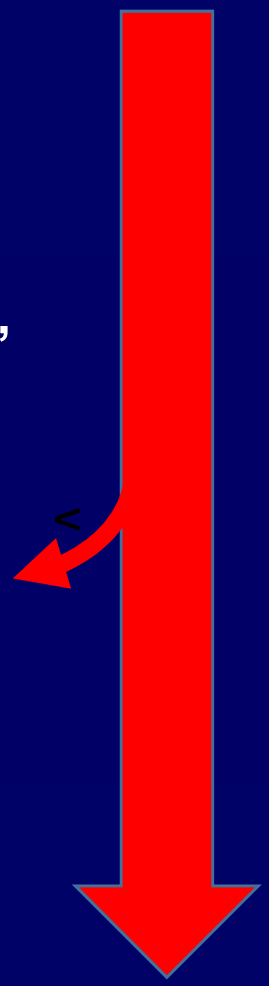
1. *Histidine decarboxylase* found in the mast cells of the skin, parietal cells of the stomach and other tissues. Stimulated by gastrin.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 282

HISTIDINE

Inhibited by high levels of CO2, Mg, Ca

histidine decarboxylase 7p 380nm
P-5-P
Zn, Glutathione, Light



HISTAMINE

Low stomach acid (hypochlorrhydria) causes the morning nausea and sickness often associated with pregnancy.

2. *DOPA decarboxylase*
converts L.DOPA to dopamine. Found mainly in the adrenal medulla, brain and sympathetic nerve endings.

TYROSINE

11p 384nm

H4 Biopterin

tyrosine hydroxylase

(stimulated by Vit D, Cu, Fe, S)

D4 Biopterin

O_2

Inhibited by Co, DDT, Mn, Ni, Zn)

NADH

Vit C

L.DOPA

dopamine decarboxylase

7p 380nm

P-5-P

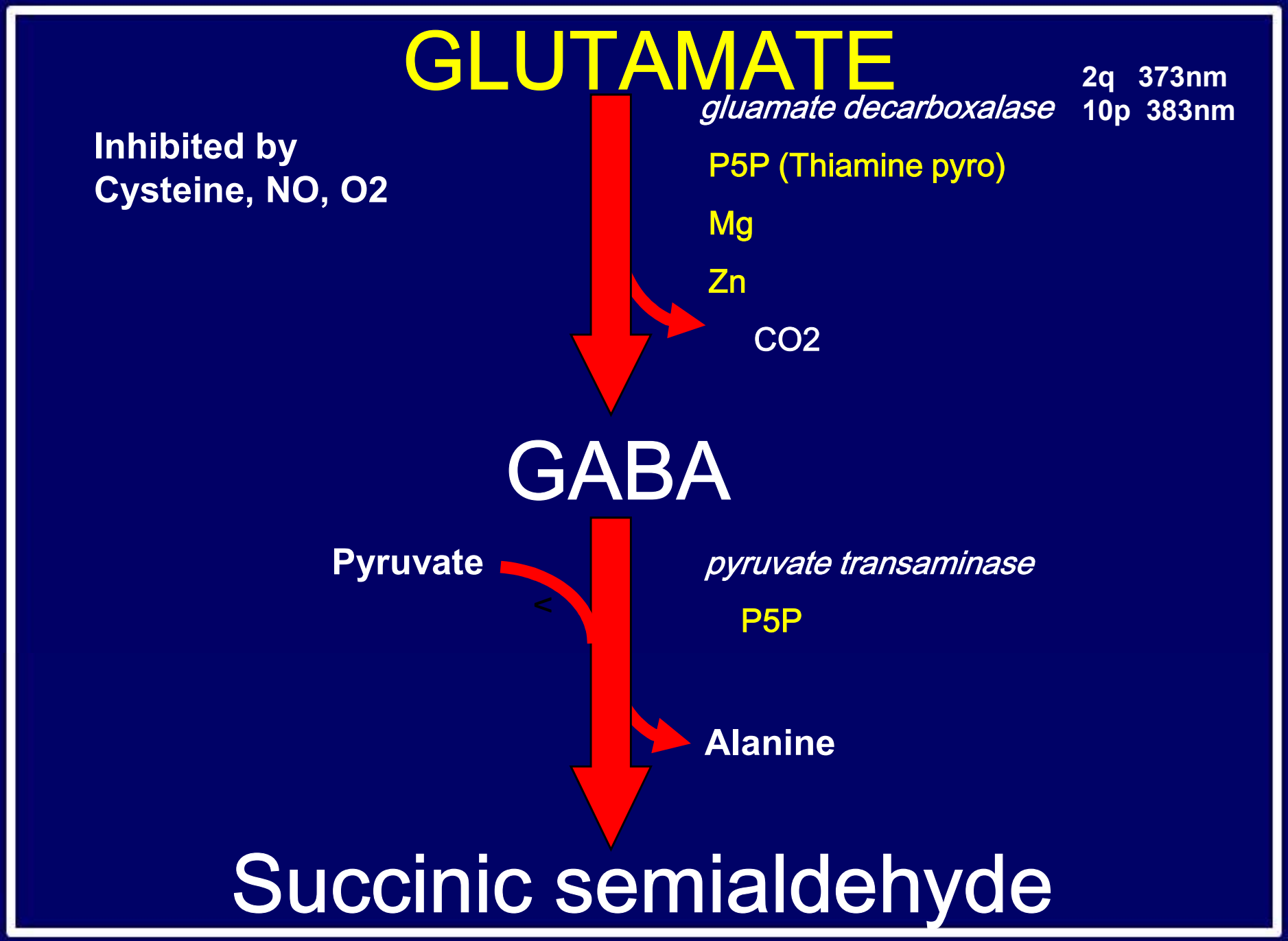
Zn, Glutathione, Light

Inhibited by high levels of CO2, Mg, Ca

CO_2

DOPAMINE

3. *Glutamate decarboxylase* catalyzes the conversion of glutamate to the inhibitory neurotransmitter - GABA.


GLUTAMATE
2q 373nm
10p 383nm
gluamate decarboxalase
Inhibited by
Cysteine, NO, O2
P5P (Thiamine pyro)
Mg
Zn
CO2
GABA
Pyruvate
pyruvate transaminase
P5P
Alanine
Succinic semialdehyde

4. *5-Hydroxytryptophan* decarboxylase

catalyzes the conversion of 5-hydroxytryptophan to serotonin. It is found in the pineal gland, CNS, argentaffin cells of the intestine, blood platelets and mast cells.

TRYPTOPHAN

O_2

Inhibited by Co, DDT, Mn, Ni, Zn)

H4 Biopterin

tryptophan hydroxylase

(stimulated by Vit D, Cu, Fe, S)

D4 Biopterin

11p 384nm

NADH

Vit C

5-Hydroxytryptophan

Inhibited by high levels of CO2, Mg, Ca

CO_2

dopamine decarboxylase

P-5-P

Zn, Glutathione, Light

7p 380nm

SEROTONIN

Kynureninase is involved with the conversion of tryptophan via 3-hydroxykynurenine to niacin (Vit B3)

High urinary levels of kynurenates are diagnostic of P5P deficiency.

Functional test

Tryptophan Metabolism

Hydroxykynurenine

Kynureninase

Xanthurenate

P5P

(weakens strong indicator muscle)

Hydroxyanthramilate

Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 283

Cystathione β transferase **catalyzes the conversion of homocysteine to cystathione.**

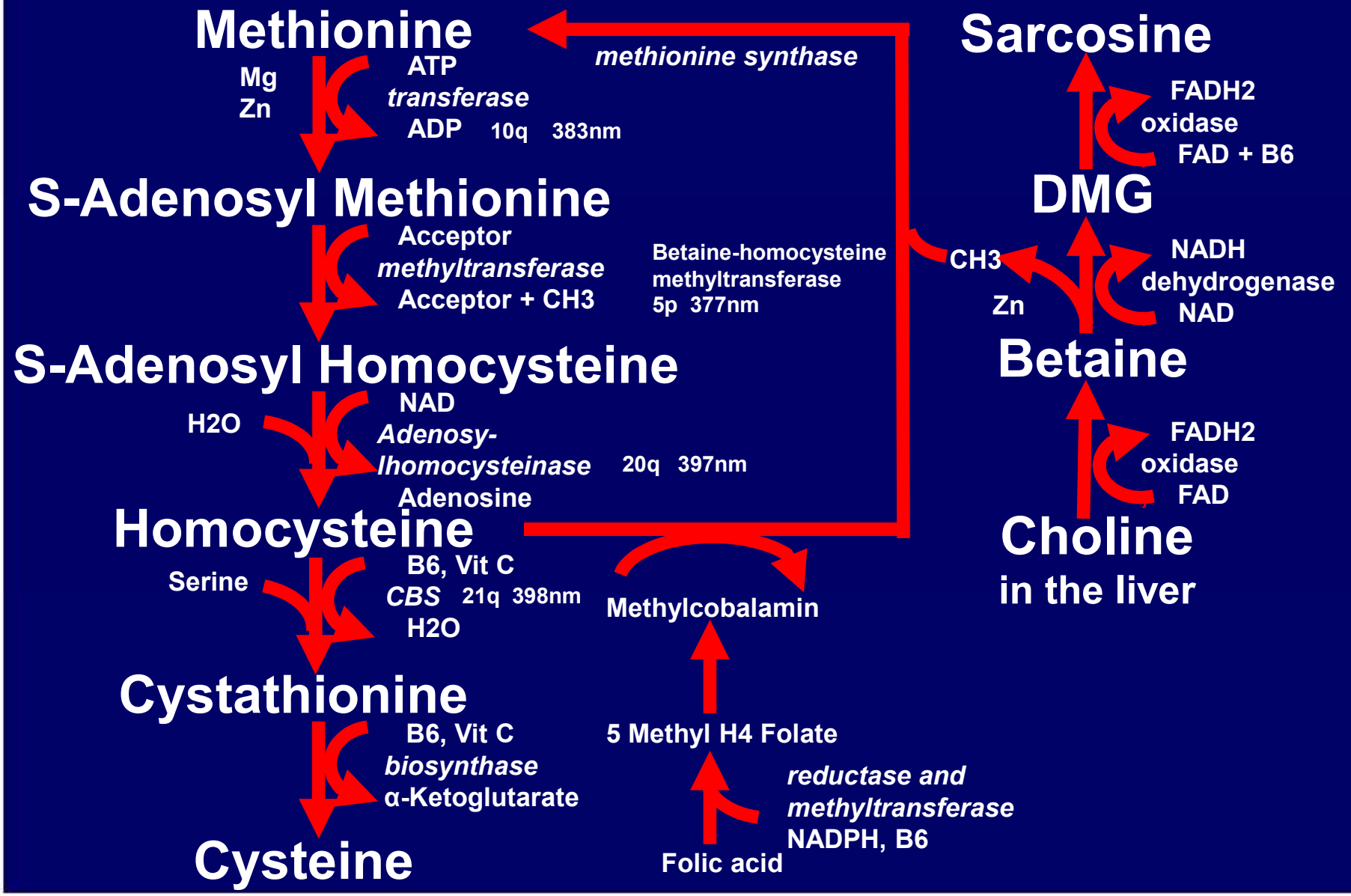
Cysteine biosynthase* **catalyzes the conversion of cystathione to cysteine.**

***Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 285**

Cystathionuria* is an inborn error of metabolism resulting in mental retardation and slow development.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 285

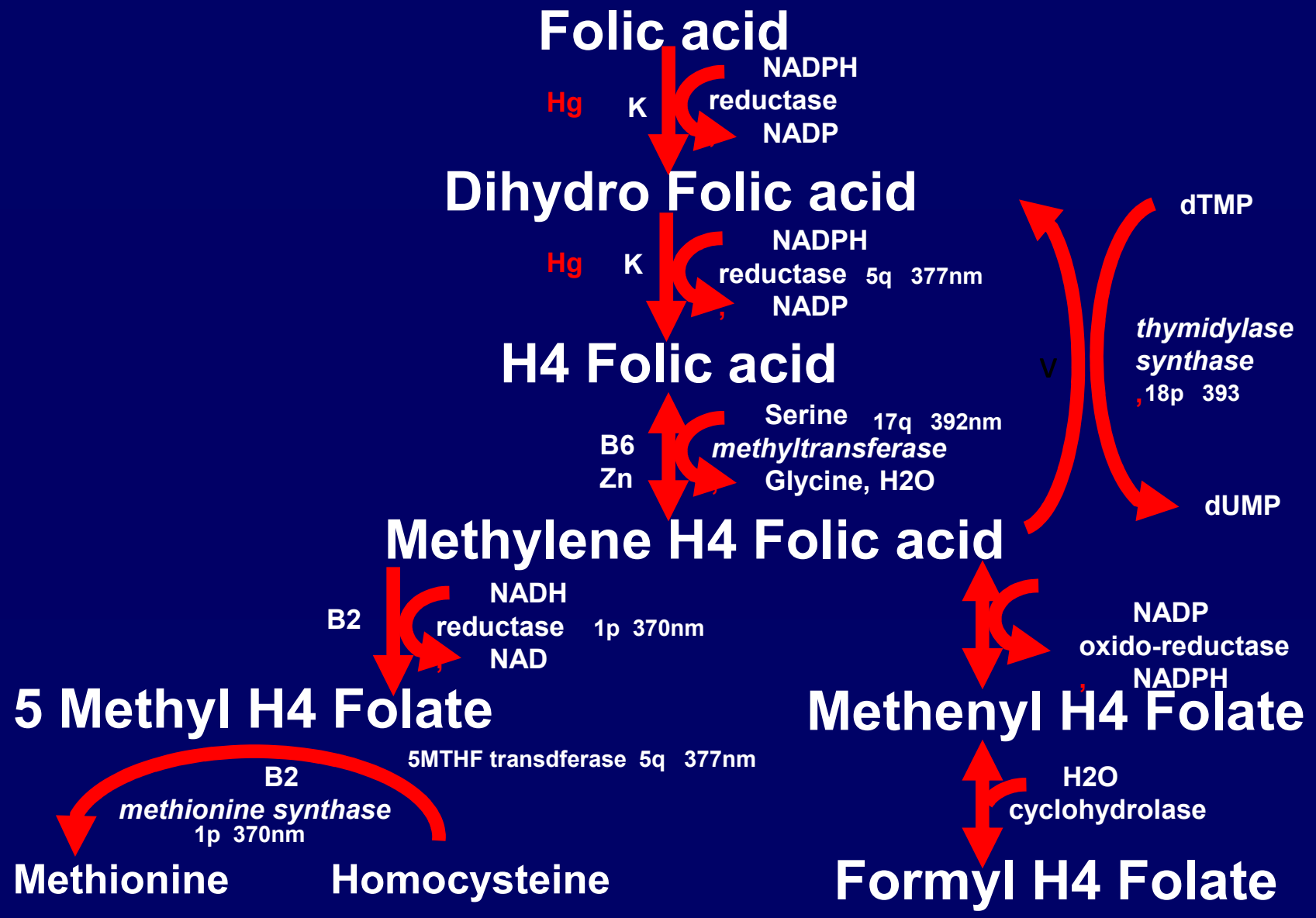
S Adenosylmethionine (SAM)



Methyltransferase* catalyzes the conversion of tetrahydrofolate to methylene tetrahydrofolate which is necessary to methylate uracil to thymidine.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 284

Folates


Folic acid
Hg
K
NADPH
reductase
NADP
Dihydro Folic acid
Hg
K
NADPH
reductase 5q 377nm
NADP
H4 Folic acid
B6
Zn
Serine 17q 392nm
methyltransferase
Glycine, H2O
Methylene H4 Folic acid
B2
NADH
reductase 1p 370nm
NAD
5 Methyl H4 Folate
5MTHF transdferase 5q 377nm
B2
methionine synthase
1p 370nm
Methionine
Homocysteine
V
dTMP
thymidylase
synthase
,18p 393
dUMP
NADP
oxido-reductase
NADPH
Methenyl H4 Folate
H2O
cyclohydrolase
Formyl H4 Folate

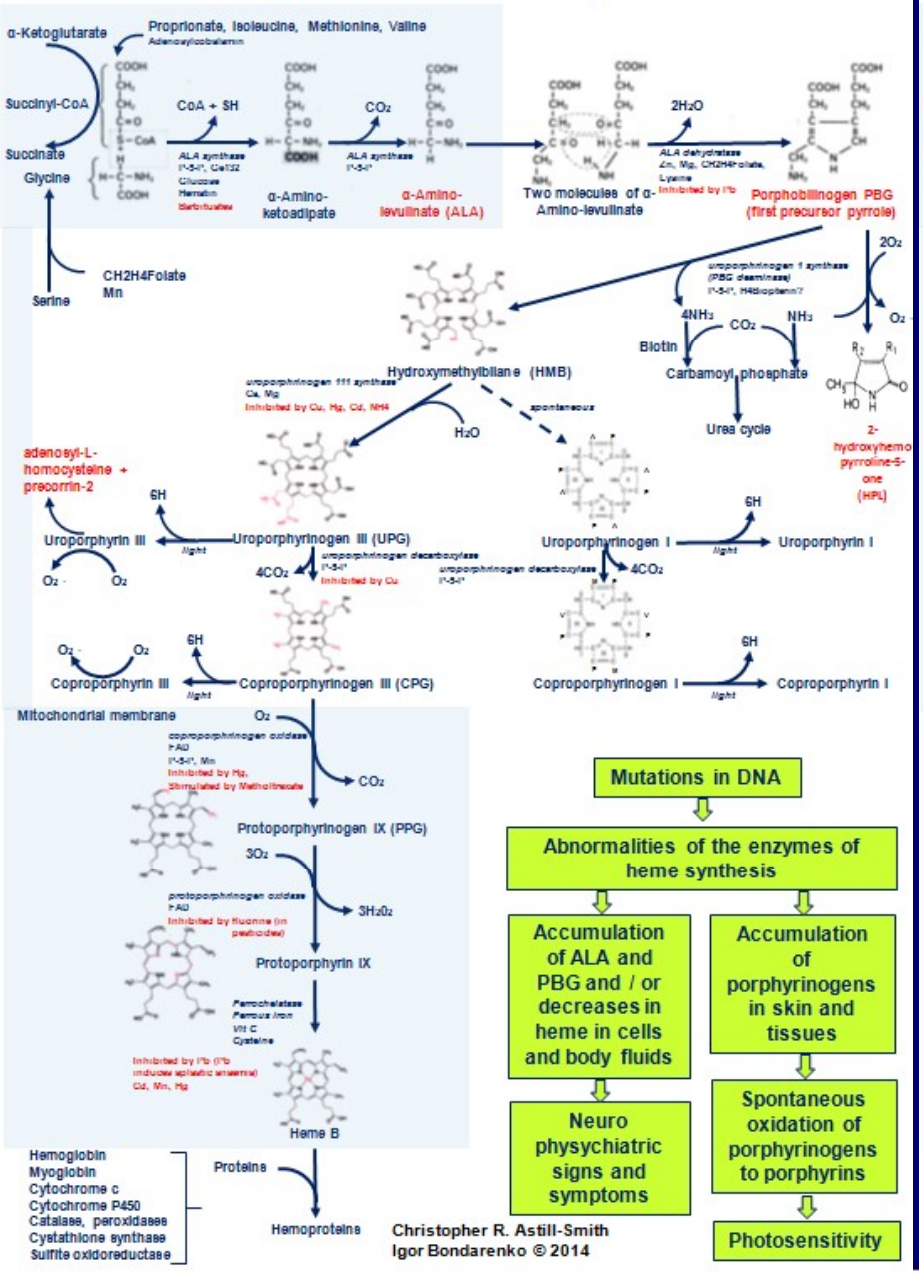
P5P deficiency affects the metabolism of alpha linolenic acid to docosahexaenoic acid (DHA). DHA and DPA are necessary in the growth and development of the CNS.

Deficiency can lead to attention deficit hyperactivity disorder (ADHD) and failure of proper development of the visual system.

Delta Aminolevulinate Synthase* in the first step in the production of porphyrins to make heme. It catalyses the conversion of Succinyl CoA + Glycine to produce delta aminolevulinate acid.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 284

Porphyrin and Heme Synthesis



Mutations in DNA

Abnormalities of the enzymes of heme synthesis

Accumulation of ALA and PBG and / or decreases in heme in cells and body fluids

Neuro physychiatric signs and symptoms

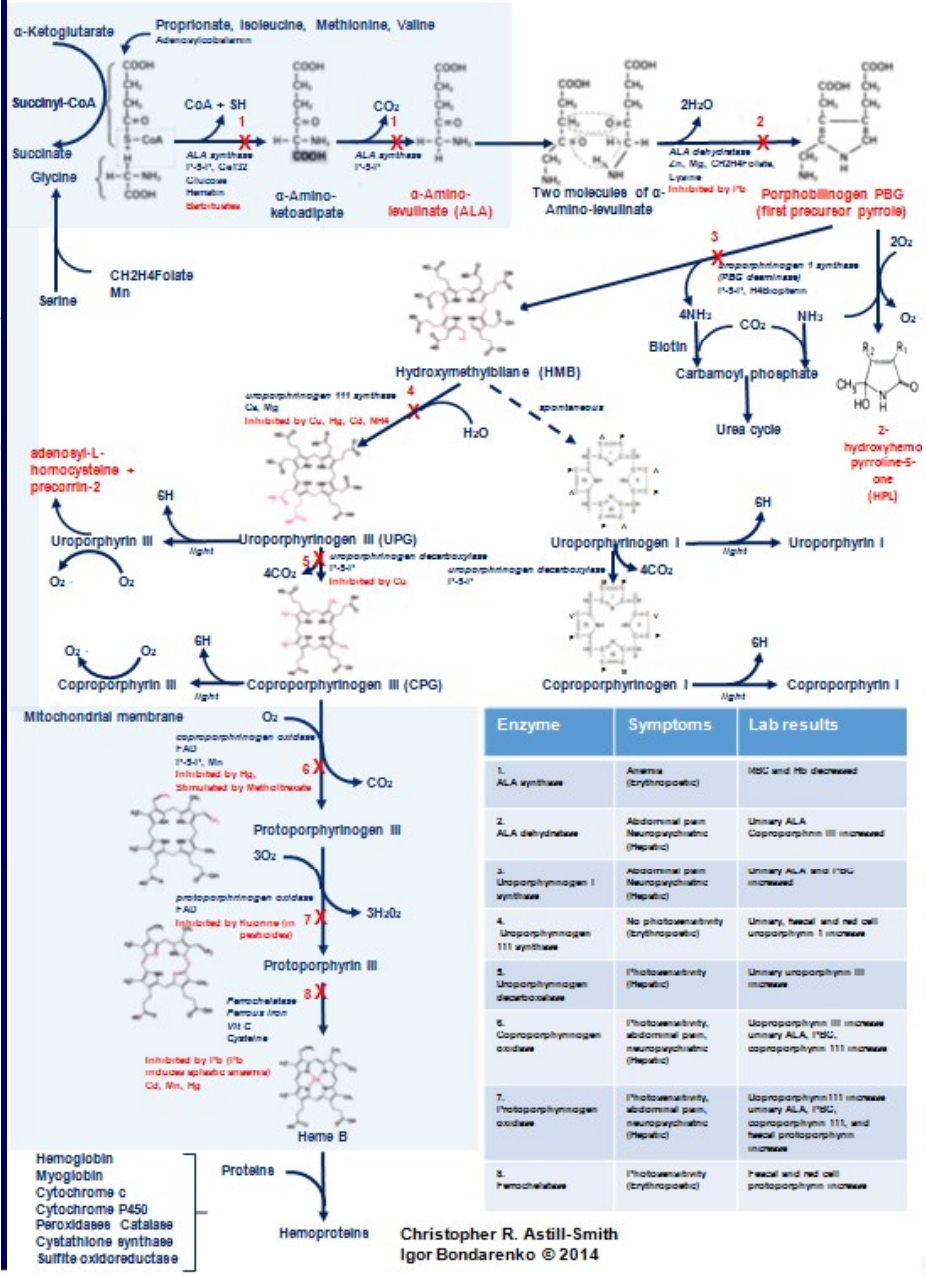
Accumulation of porphyrinogens in skin and tissues

Spontaneous oxidation of porphyrinogens to porphyrins

Photosensitivity

Christopher R. Astill-Smith
Igor Bondarenko © 2014

Hemoglobin Synthesis Polymorphisms



Enzyme	Symptoms	Lab results
1. ALA synthase	Anemia (erythropoetic)	RBC and Hb decreased
2. ALA dehydratase	Abdominal pain Neuropsychiatric (Hepatic)	Urinary ALA Coproporphrin III increased
3. Uroporphyrinogen I synthase	Abdominal pain Neuropsychiatric (Hepatic)	Urinary ALA and PBG increased
4. Uroporphyrinogen III synthase	No photosensitivity (erythropoetic)	Urinary, fecal and red cell uroporphyrin I increase
5. Uroporphyrinogen decarboxylase	Photosensitivity (Hepatic)	Urinary uroporphyrin III increase
6. Coproporphyrinogen oxidase	Photosensitivity, abdominal pain, neuropsychiatric (Hepatic)	Uoproporphyrin III increase urinary ALA, PBG, coproporphyrin III increase
7. Protoporphyrinogen oxidase	Photosensitivity, abdominal pain, neuropsychiatric (Hepatic)	Uoproporphyrin III increase urinary ALA, PBG, coproporphyrin III, and fecal protoporphyrin increase
8. Ferrochelatase	Photosensitivity (erythropoetic)	Fecal and red cell protoporphyrin increase

Christopher R. Astill-Smith
Igor Bondarenko © 2014

Deficiency symptoms

Dry rough skin, cracking lips, flaking nails, retarded healing, mouth ulcers, gastric and varicose ulcers. Anaemia.

Depression, PMS, menopausal symptoms.

Kidney stones.

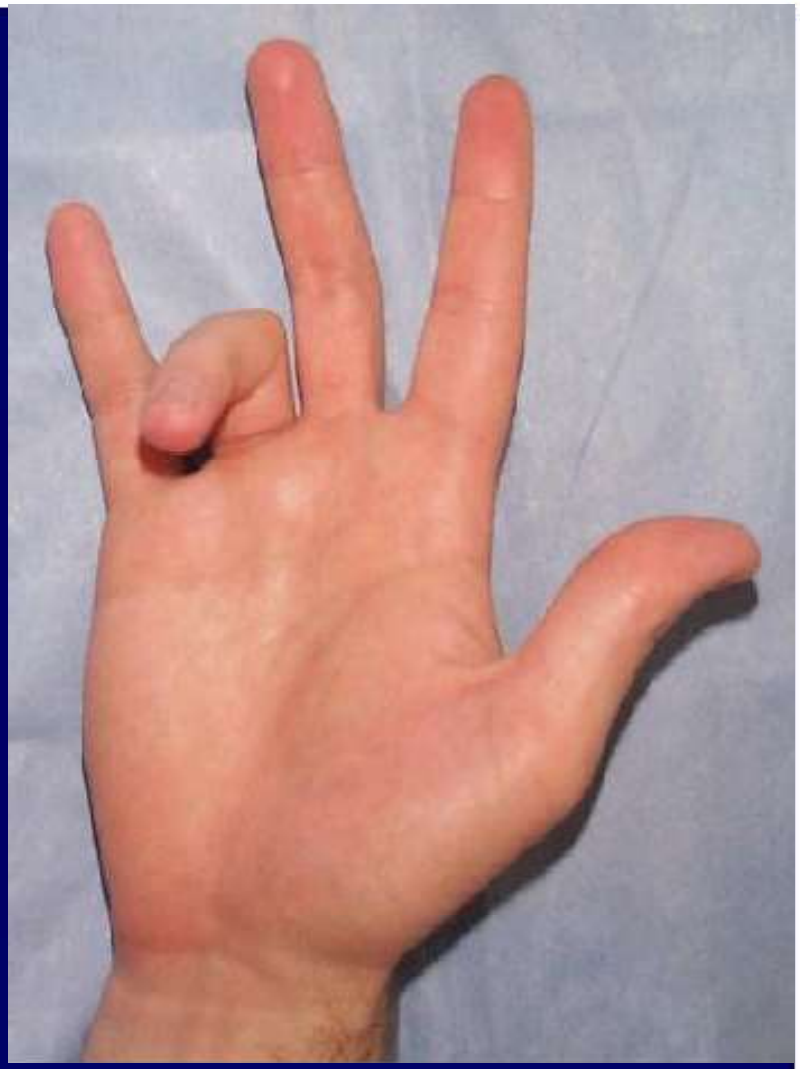
*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 285

High homocysteine levels inhibit lysyloxidase enzyme needed to synthesise collagen. This may lead to aneurysms, (Campbell de Morgan spots) CVA's, coronary infarction.

Methylation defects may lead to cancer formation.

Campbell de Morgan spots

Patients may complain of “this snapping finger” which is stenosing tenosynovitis of the flexor or extensor tendon. It is usually palpable.*



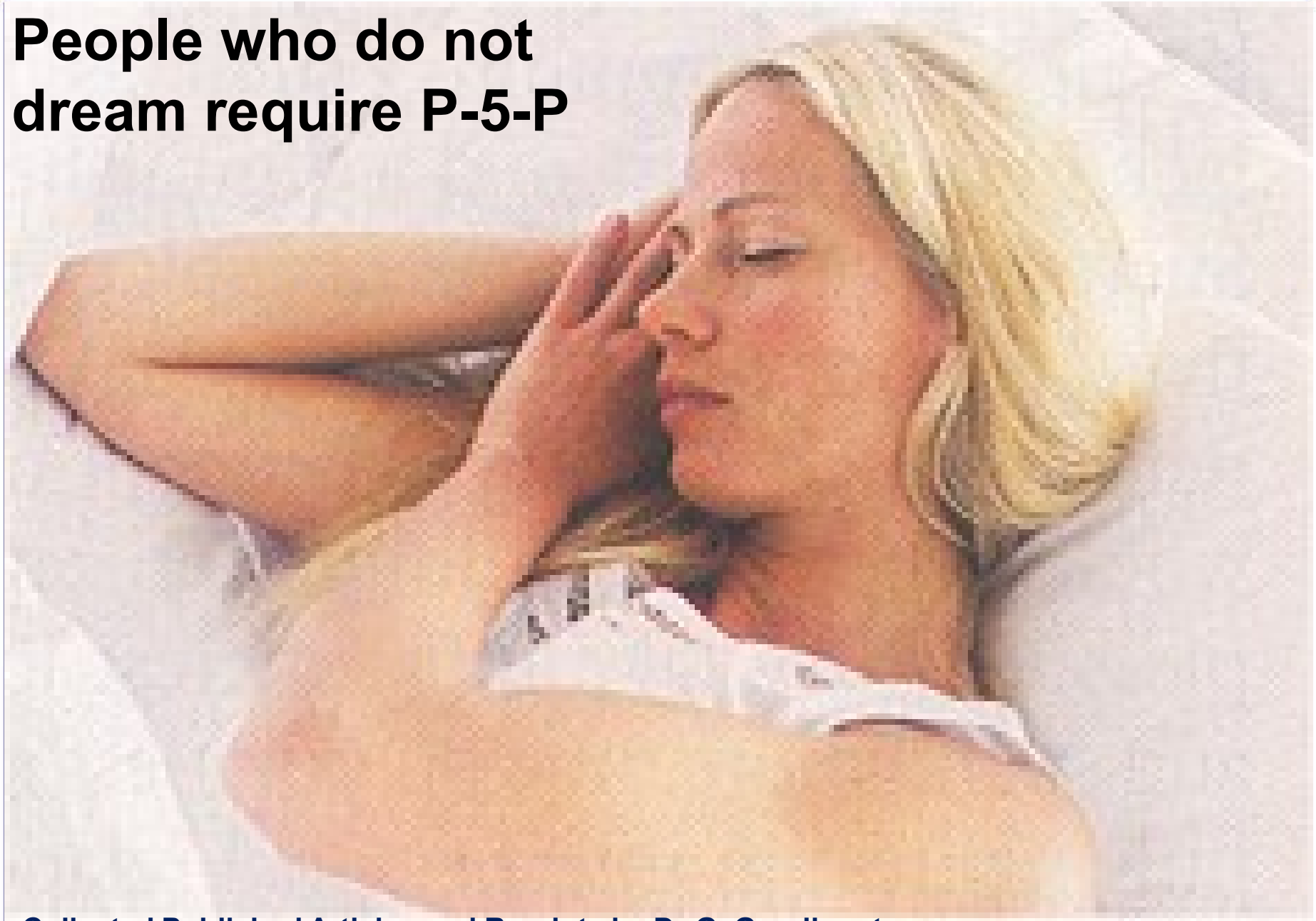
*Collected Published Articles and Reprints by Dr G. Goodheart

Sources

Yeast, Brown rice, Seeds, Cereals (Whole Wheat and Maize), Liver, Molasses, Fish (Salmon, Tuna)
Chickpeas
Fruits (other than citrus)
Potatoes

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

People who do not dream require P-5-P



Collected Published Articles and Reprints by Dr G. Goodheart

Dr Goodheart says

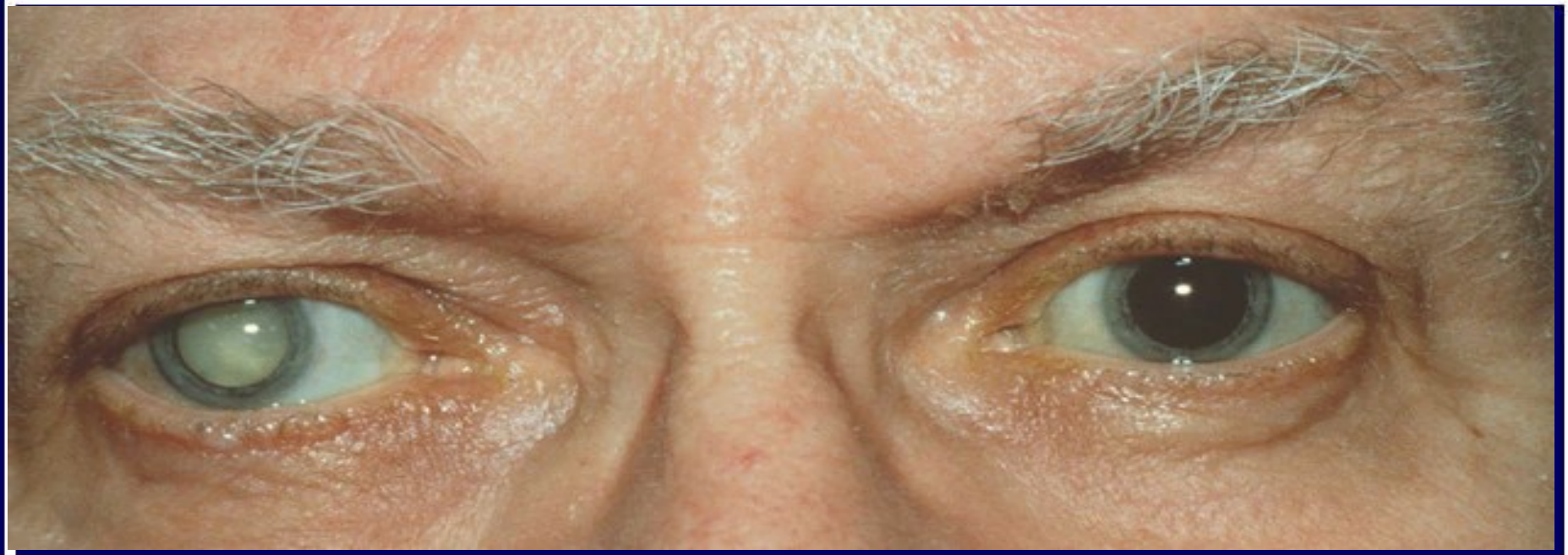
Think P5P in cases of acne.
Can also be used as a cream.

Also think Zinc (repairs genes) and Iodine (balances hormones)

Being a Family Doctor by George Goodheart and Walther H. Schmitt published by Lance West DC

Dr Goodheart says soft nails use Calcium.
Flaking nails Vitamin B6.
Lined nails Iron.

Being a Family Doctor by George Goodheart and Walther H. Schmitt published by Lance West DC



Dr Goodheart says use B6 and B. Complex for cataracts

Vitamin C is richest in the lens of the eye

Being a Family Doctor by George Goodheart and Walther H. Schmitt published by Lance West DC

Dr Goodheart says Use B6 and B. Complex for women using the contraceptive pill

Being a Family Doctor by George Goodheart and Walther H. Schmitt published by Lance West DC

Dr Goodheart says Use B6 and Vitamin E for mouth ulcers

Being a Family Doctor by George Goodheart and Walther H. Schmitt published by Lance West DC

FDA Daily Value (RDA)

2mg

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

Muscles associated with Vitamin B6*

Opponens digiti minimi

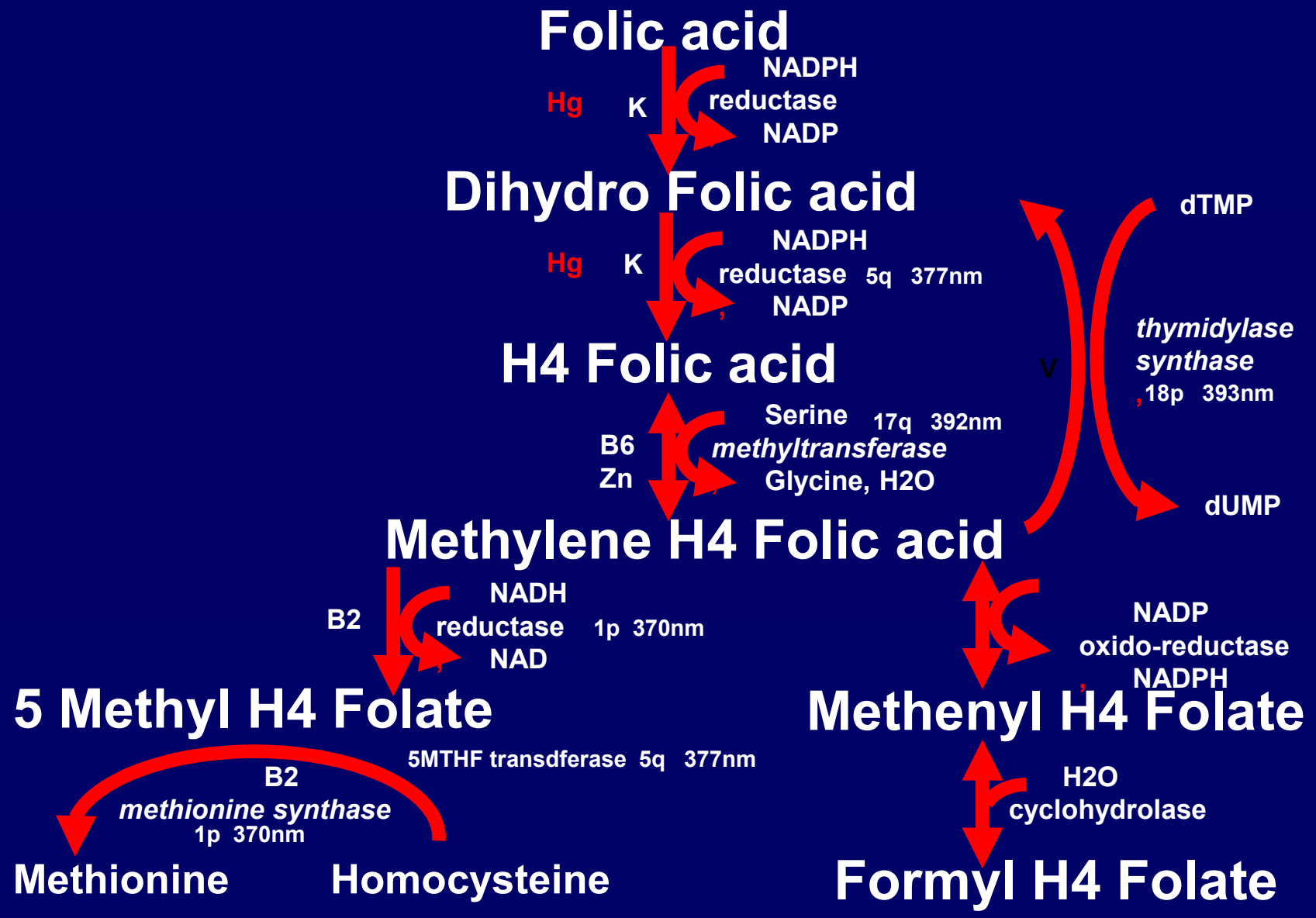
Sartorius

Sternocleidomastoid

*Applied Kinesiology Synopsis 2nd Edition by David Walther DC

The Folates
(Vitamin B9)

Folates


Folic acid
Hg
K
NADPH
reductase
NADP
Dihydro Folic acid
Hg
K
NADPH
reductase 5q 377nm
NADP
H4 Folic acid
B6
Zn
Serine 17q 392nm
methyltransferase
Glycine, H2O
Methylene H4 Folic acid
B2
NADH
reductase 1p 370nm
NAD
5 Methyl H4 Folate
5MTHF transdferase 5q 377nm
B2
methionine synthase
1p 370nm
Methionine
Homocysteine
V
dTMP
thymidylase
synthase
,18p 393nm
dUMP
NADP
oxido-reductase
NADPH
Methenyl H4 Folate
H2O
cyclohydrolase
Formyl H4 Folate

Folates

1. Necessary for the formation of Cytosine, Adenine methylate Uracil to and Guanine.
2. Necessary to methylate Uricil to Thymidine

Folic acid

Hg K NADPH reductase NADP

Dihydro Folic acid

Hg K NADPH reductase NADP

glutamate formiminotrans

H4 Folic acid

B6 Zn Serine *methyltransferase* Glycine, H2O

Necessary to recycle Homocysteine

5. 10-Methylene H4 Folic acid

B2 NADH reductase NAD

5-Methyl H4 Folate

Methylcobalamin

Cob

Necessary to synthesise Adenine and Guanine

5.10-Methenyl H4 Folate

NADP oxido-reductase NADPH

H2O cyclohydrolase

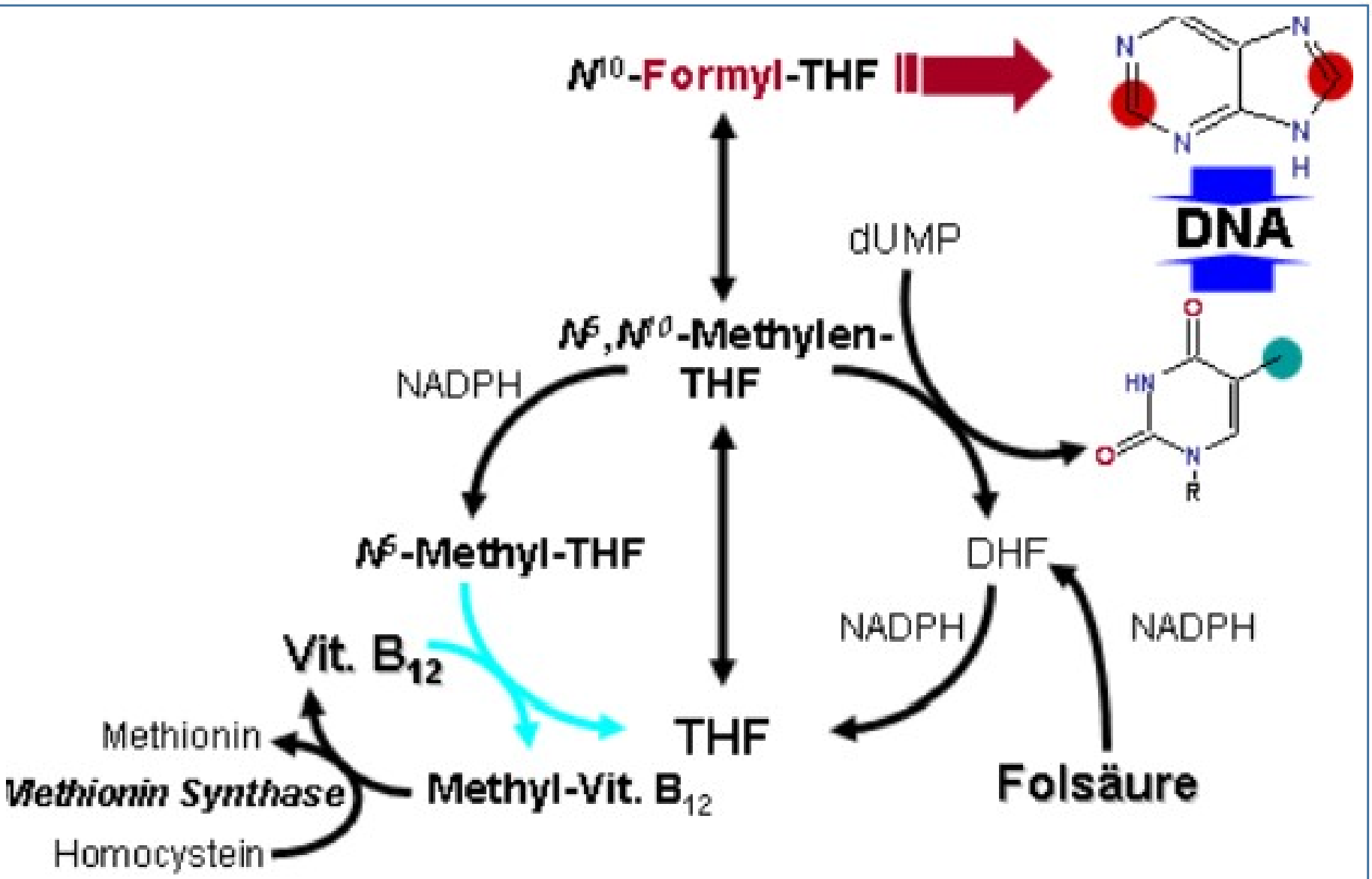
5-Formyl H4 Folate (Folinic acid)

V

dTMP

thymidylase synthase

dUMP



Author: PD Dr. med. habil. Stephan Gromer Shown is a simplified sketch of the metabolism of folic acid and the interaction with vitamin B12 metabolism.

Folic acid* is a synthetic folate compound used in vitamin supplements and fortified food because of its increased stability.

Folates are found in a wide variety of foods. The richest sources are liver, dark green leafy vegetables, beans, wheat germ and yeast. Other sources include egg yolk, milk and dairy products, beets, orange juice and whole wheat bread.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 297

It’s important that we have a sufficient intake of Vitamin B9 - in folate form (in foods) and folic acid (in supplements), because it helps the body as a coenzyme to:
Use amino acids, the building blocks of proteins
Produce nucleic acids (like DNA), the body's genetic material.

Form blood cells in the bone marrow to

Ensure rapid cell growth in infancy, adolescence, and pregnancy.

Control (together with vitamin B6 and vitamin B12) blood levels of the amino acid homocysteine, associated with certain chronic conditions like heart disease.

Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page301

The European Food Safety Authority (EFSA), which provides scientific advice to policy makers, has confirmed that clear health benefits have been established for the dietary intake of folate (vitamin B9) in contributing to:

Normal blood formation
Normal homocysteine
A normal metabolism of the immune system
Normal cell division
Normal maternal tissue growth during pregnancy
Normal amino acid synthesis
Normal psychological functions
The reduction of tiredness and fatigue

Folate deficiency is one of the most common vitamin deficiencies. It can result from inadequate intake, defective absorption, abnormal metabolism or increased requirements.

Early symptoms of folate deficiency are non-specific and can include tiredness, irritability and loss of appetite. Severe folate deficiency leads to megaloblastic anemia – where the bone marrow produces oversized, immature red blood cells.

Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page304

Pregnant and breast-feeding women are at a higher risk of Vitamin B9 deficiency* which can result in devastating and sometimes fatal birth defects (like neural tube defects). They therefore need to take more folate/folic acid because of the rapid tissue growth duri.ng pregnancy (along with losses through the milk during breast-feeding.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page304

The intestine cell has on the surface of the brush border a specific folic acid binding protein. It transfers folic acid to the inside of the cell. Here dihydrofolate reductase twice reduces the folic acid to tetrahydrofolate.

Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 299

Methylation then occurs either directly or indirectly via the formation of N10 formyltetrahydrofolate to N5, N10 methyltetrahydrofolate.*

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 299

It is used in the synthesis of the purines adenine and guanine found in the RNA and DNA of intestinal cells. The average half-life of the intestinal cell is 3 days*.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 298

Most folate in the serum is in the methyltetrahydrofolate (5MTHF) form. Serum folic acid levels decrease in pregnancy reaching their lowest level at full term. Look out for post-pregnant cervical dysplasia and gum dysplasia.*

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page304

Methylene tetrahydrofolate is the active form of folate to prevent neural tube defects

Function

One carbon group transfer

- Nucleotide synthesis
- Glycine synthesis
- Homocysteine recycling

Folate deficiency limits cell division, erythropoiesis, production of red blood cells, is hindered and leads to megaloblastic anemia, which is characterized by large immature red blood cells.

This pathology results from persistently thwarted attempts at normal DNA replication, DNA repair, and cell division, and produces abnormally large red cells called megaloblasts with abundant cytoplasm capable of RNA and protein synthesis, but with clumping and fragmentation of nuclear chromatin.

Folic acid is itself not biologically active, but its biological importance is due to tetrahydrofolate and other derivatives after its conversion to dihydrofolic acid in the liver.

H4Folate Tetrahydrofolate

CHH4Folate Methenyl tetrahydro folate

CH2H4Folate Methylene tetrahydro folate

CH3H4Folate Methyl tetrahydro folate

Folate coenzymes (including Folinic Acid and L-5-MTHF) are responsible for the following important metabolic functions and benefits: 1) Formation of purines and pyrimidines, which in turn are needed for synthesis of the nucleic acids DNA and RNA. This is especially important during fetal development in the first trimester in preventing birth defects, such as neural tube defects, 2) Formation of heme, the iron-containing protein in hemoglobin, 3) Interconversion of the 3-carbon amino acid serine from the 2-carbon amino acid glycine,

4) Formation of the amino acids tyrosine from phenylalanine and glutamic acid from histidine, 5) Formation of the amino acid methionine from homocysteine (Vitamin B12
as methylcobalamin also is needed for this conversion). In the reconversion of homocysteine to methionine the body uses the methionine to make the important amino acid s-adenosylmethionine (SAMe) which is known to be helpful in cases of depression, 6) Synthesis of choline from ethanolamine, 7) Formation and maturation of red and white blood cells, and 8) Conversion of nicotinamide to N'-methylnicotinamide.

Deficiency symptoms*

Birth defects
Retarded growth
Scaling dermatitis
Alopecia
Megaloblastic anaemia
Cervical dysplasia
Mouth ulcers
Depression

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page304

Dr Goodheart says in cases of a bad hematoma use pancreatic enzymes and folic acid.

Collected Published Articles and Reprints by Dr G. Goodheart

90% of folates are lost by steaming vegetables. Hence the importance of drinking the vegetable water.*

70-90% lost by frying in an open pan.

*A review of the impact of preparation and cooking on the nutritional quality of vegetables and legumes
Author links open overlay panel Adriana D.T.Fabbri Guy A.Crosby

International Journal of Gastronomy and Food Science
Volume 3, April 2016, Pages 2-11

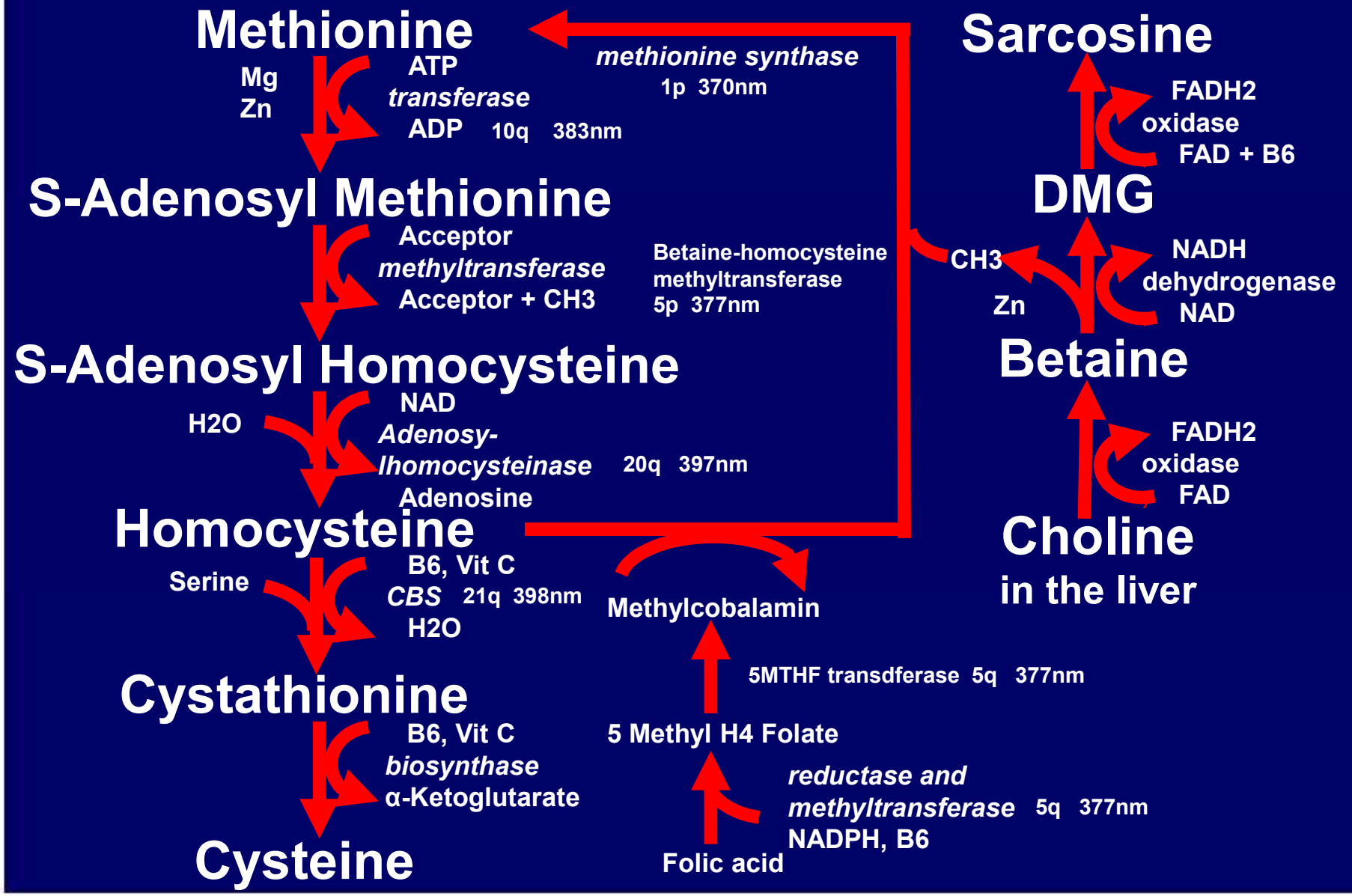
Dr Wally Schmitt says a yellow tongue is a need for folic acid.

In pernicious anemia, there is a rise in serum levels of methyltetrahydrofolate and there is an increase excretion of formiminoglutamic acid (Figlu).*

Check this especially in MS patients.

*Collected Published Articles and Reprints by Dr G. Goodheart

S Adenosylmethionine (SAM)

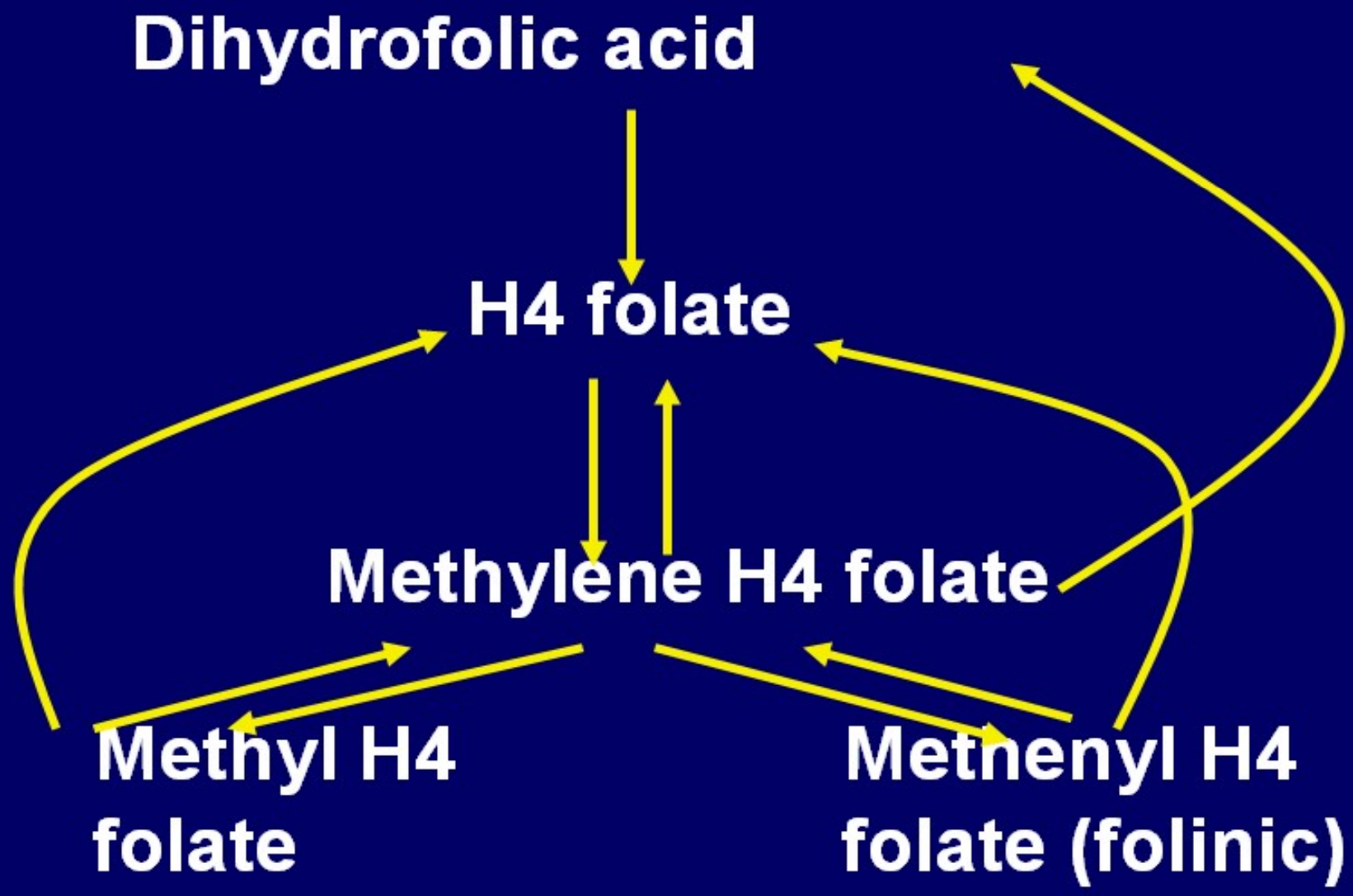


Dr Goodheart says

Use up to 10-20 mg of folic acid per day during attacks of gout.

And Zinc

Functional tests



Folate deficiency clinical expression times*

Homocysteinemia	10days
Low serum folate	22days
High urine FIGLU	95days
Low RBC folate	123days
Megaloblastic marrow	134days
Anemia	137days

So **homocysteinemia** is the best functional marker for folate deficiency.

*Laboratory evaluations in Molecular Medicine, j. A.Bradley page 24

Sources

Asparagus • Avocado • Beans and peas • Enriched grain products (e.g., bread, cereal, pasta, rice) • Green leafy vegetables (e.g., CABBAGE, spinach), Yeast, Liver, Orange juice

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

FDA Daily Value (RDA)

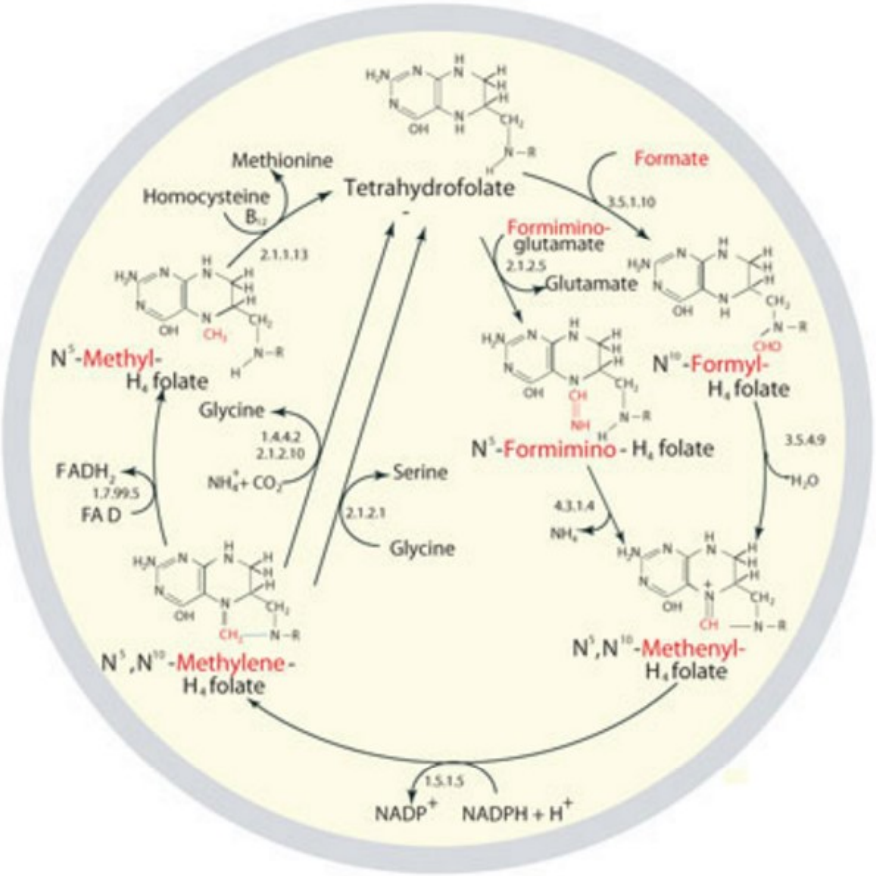
400mcg

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

Muscles associated with Folic acid*

None specific

*Applied Kinesiology Synopsis 2nd Edition by David Walther DC

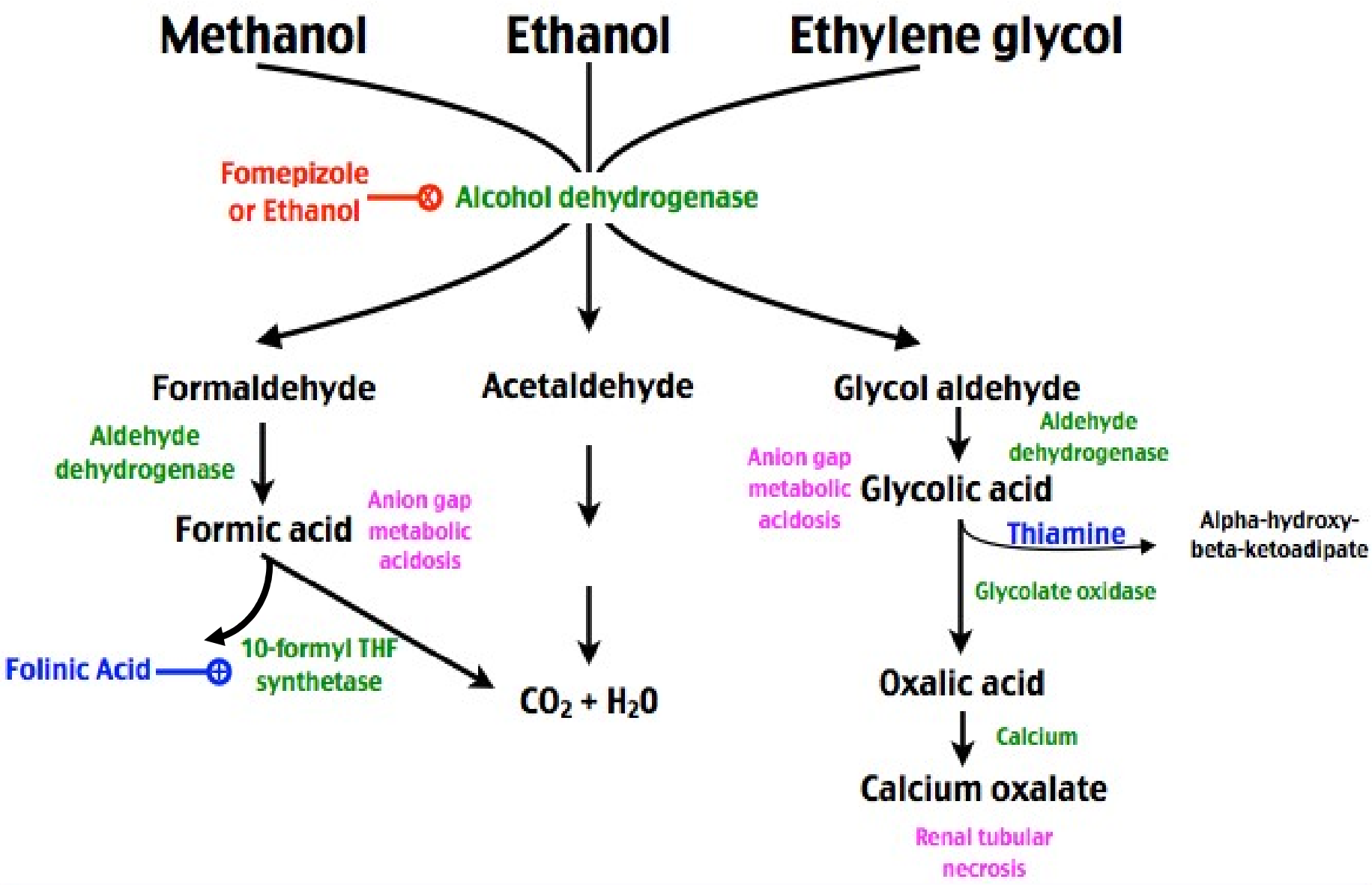


Enzymes

1.4.4.2 Glycine dehydrogenase (decarboxylating)
1.5.1.3 Dihydrofolate reductase
1.5.1.5 Methylene-THF dehydrogenase ($NADP^+$)
1.7.99.5 5,10-Methylene-THF reductase ($FADH_2$)
2.1.1.13 5-Methyl-THF-homocysteine S-methyltransferase
2.1.1.45 Thymidylate synthase
2.1.2.1 Glycine hydroxymethyltransferase
2.1.2.2 Phosphoribosylglycinamide formyltransferase
2.1.2.3 Phosphoribosylamidoimidazole-carboxamide formyltransferase
2.1.2.5 Glutamate formiminotransferase
2.1.2.10 Aminomethyltransferase
3.5.1.10 Formyl-THF deformylase
3.5.4.9 Methenyl-THF cyclohydrolase
4.3.1.4 Formimino-THF cyclodeaminase
6.3.4.3 5-Formyl-THF cyclo-ligase
6.3.3.2 Formate-tetrahydrofolate ligase

Figure 1. The metabolic cycling and regeneration of tetrahydrofolate. As implied by the image, THF metabolism is not linear but may shift to create one-carbon-donating substrates as needed for particular cellular processes. The one-carbon donor molecules are colored red in the illustrated structures.

Toxic Alcohol Metabolism



Too much synthetic folic acid may interfere with absorption of bioactive folate, warns study

By Tim Cutcliffe

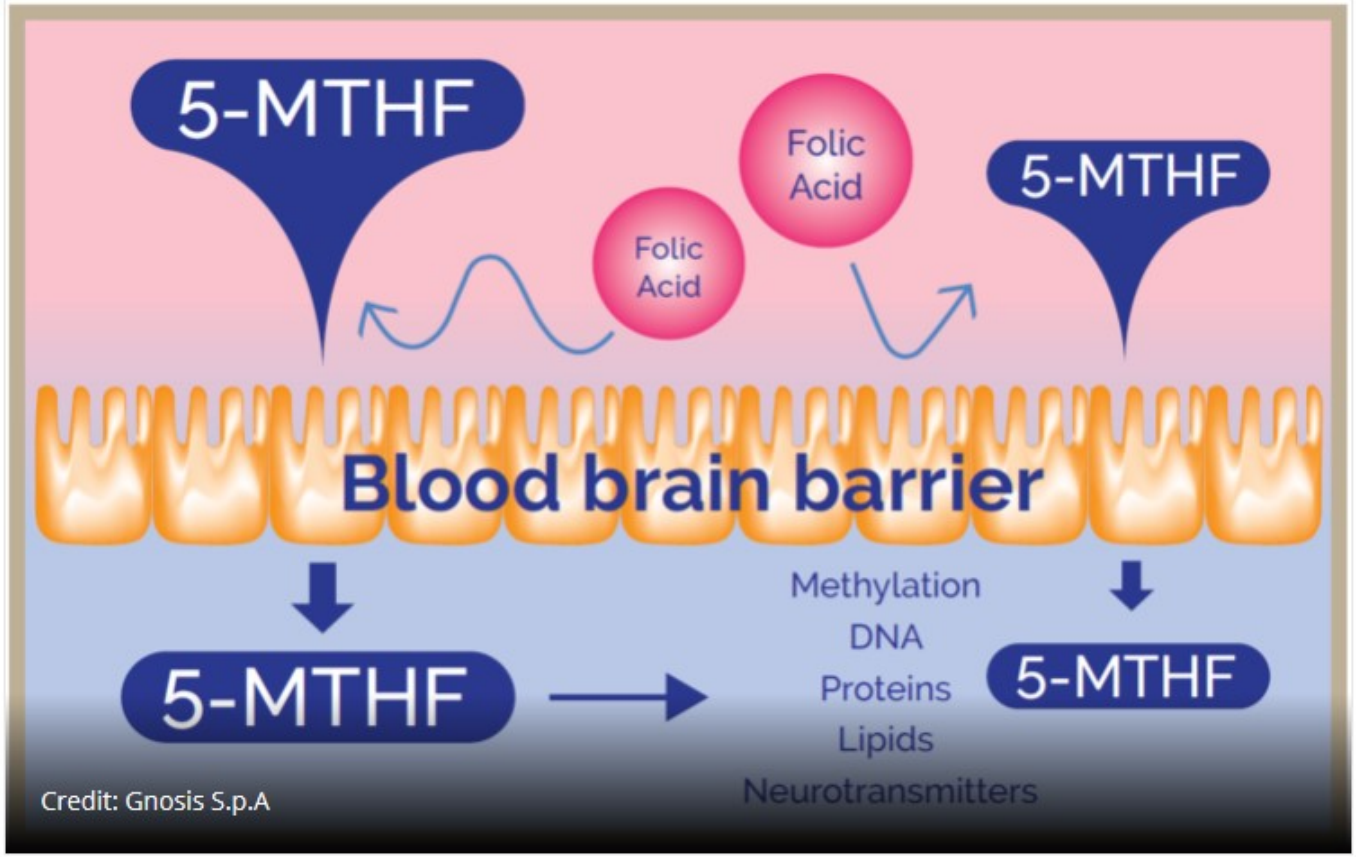
01-Nov-2017 - Last updated on 02-Nov-2017 at 03:56 G

Source: *Journal of Cardiovascular Pharmacology*

Volume 70, issue 4, pp 271–275. DOI: 10.1097/FJC.0000000000000514

"Folic Acid Impairs the Uptake of 5-Methyltetrahydrofolate in Human Umbilical Vascular Endothelial Cells"

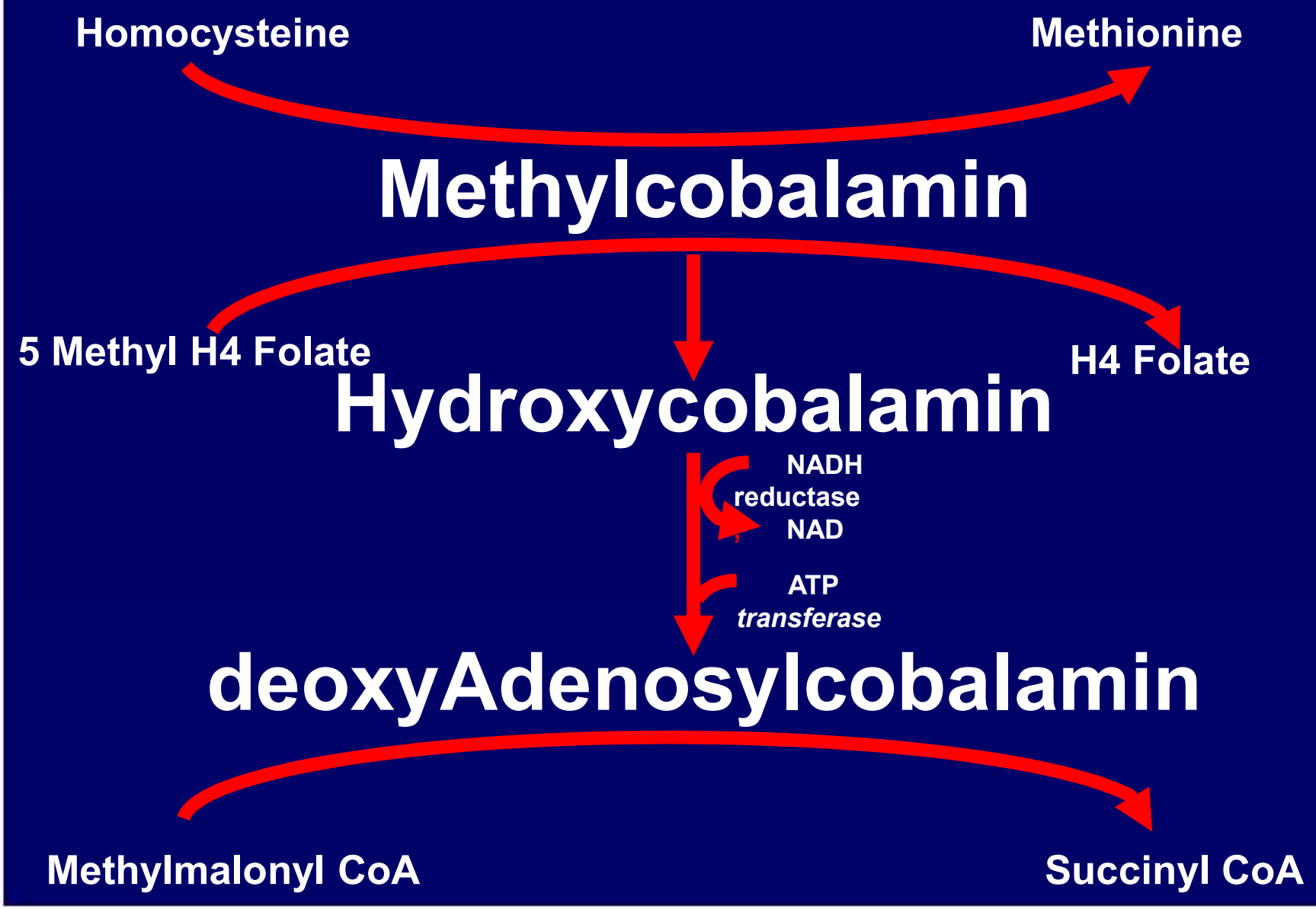
Authors: Desiree Smith, Yvo M. Smulders *et al*



Unmetabolised folic acid (UMFA) may reduce the uptake of the bioactive form of the vitamin, suggests recent research in the Journal of Cardiovascular Pharmacology.

Vitamin B12
Cobalamin

Vitamin B12


Homocysteine
Methionine
Methylcobalamin
5 Methyl H4 Folate
H4 Folate
Hydroxycobalamin
NADH
reductase
NAD
ATP
transferase
deoxyAdenosylcobalamin
Methylmalonyl CoA
Succinyl CoA

Vitamin B12* is the largest and most complex of all the vitamins. Vitamin B12 comprises the only cobalt-containing molecules (so-called ‘cobalamins’) associated with biological activity in humans. (The cobalt gives this water-soluble vitamin its distinctive red colour.)

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 286

Vitamin B12* is produced exclusively by microbial synthesis in the digestive tract of animals. Therefore, animal protein products, in particular organ meats (eg liver, kidney) and lamb, are the primary source of vitamin B12 in the human diet. Other good sources are fish, eggs and dairy products.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 291

A sufficient intake of Vitamin B12* is important as it helps the body to:

Convert food into glucose, which is used to produce energy.

Maintain healthy nerve cells

Produce nucleic acids (DNA), the body's genetic material.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 286

Regulate, together with Vitamin B9 (folate), the formation of red blood cells

Control, together with vitamin B6 and vitamin B9, blood levels of the amino acid homocysteine, a potential marker for heart disease risk.*

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 286

The European Food Safety Authority (EFSA), which provides scientific advice to assist policy makers, has confirmed that clear health benefits have been established for the dietary intake of vitamin B12 in contributing to:

Normal red blood cell formation
Normal cell division
Normal energy metabolism
A normal function of the immune system
Normal homocysteine metabolism
Normal neurological and psychological functions
The reduction of tiredness and fatigue

Mild deficiencies of Vitamin B12 are not uncommon in elderly people (10–15% of individuals over the age of 60), either because of poor diet or because they have less stomach acid, which the body needs to absorb vitamin B12.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 290

Low levels of B12 can cause a range of symptoms including fatigue, shortness of breath, diarrhea, nervousness, numbness, or a tingling sensation in the fingers and toes. Severe deficiency of B12 causes neurological damage.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 290

Produced by bacteria in the guts of ruminants and plant micro-organisms.*

Similar structure to heme but contains cobalt instead of iron.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 291

Intrinsic Factor

Intrinsic Factor is a protein secreted by the parietal cells (which also secretes HCl) and binds with B12. The reaction forms a B12 / Intrinsic factor complex in the stomach.

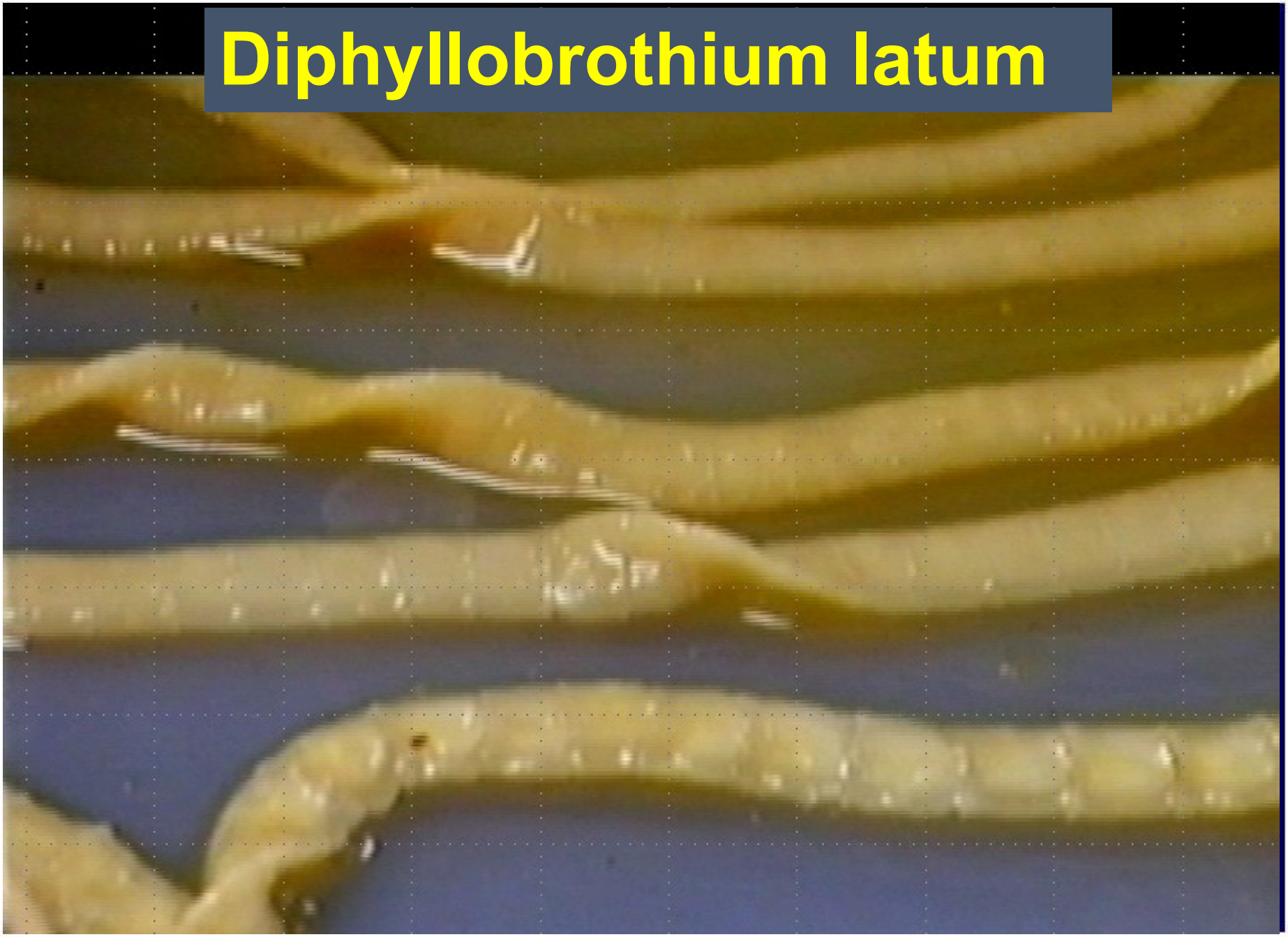
*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 290

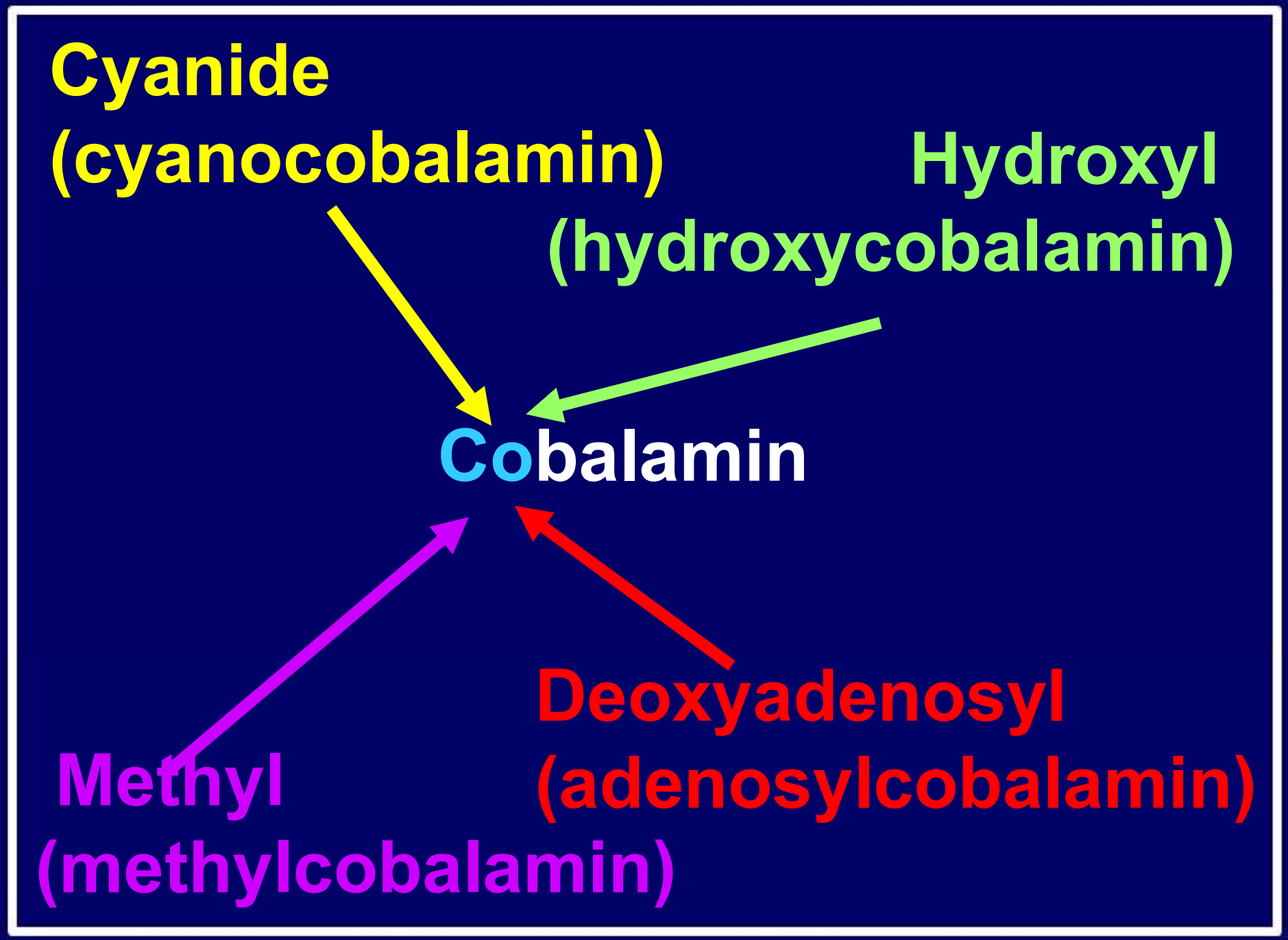
Specialised cells in the distal part of the ileum recognise this complex and absorb the B12. Intrinsic factor requires P-5-P for its activation.

So often hypochlorhydria is associated with a B12 deficiency.

People with intestinal parasites especially cestodes such as Diphyllobrothium latum, may develop B12 deficiency as the worms live in the lower part of the ileum and compete for the B12.

Diphyllobrothium latum




Cyanide
(cyanocobalamin)
Hydroxyl
(hydroxycobalamin)
Cobalamin
Deoxyadenosyl
(adenosylcobalamin)
Methyl
(methylcobalamin)

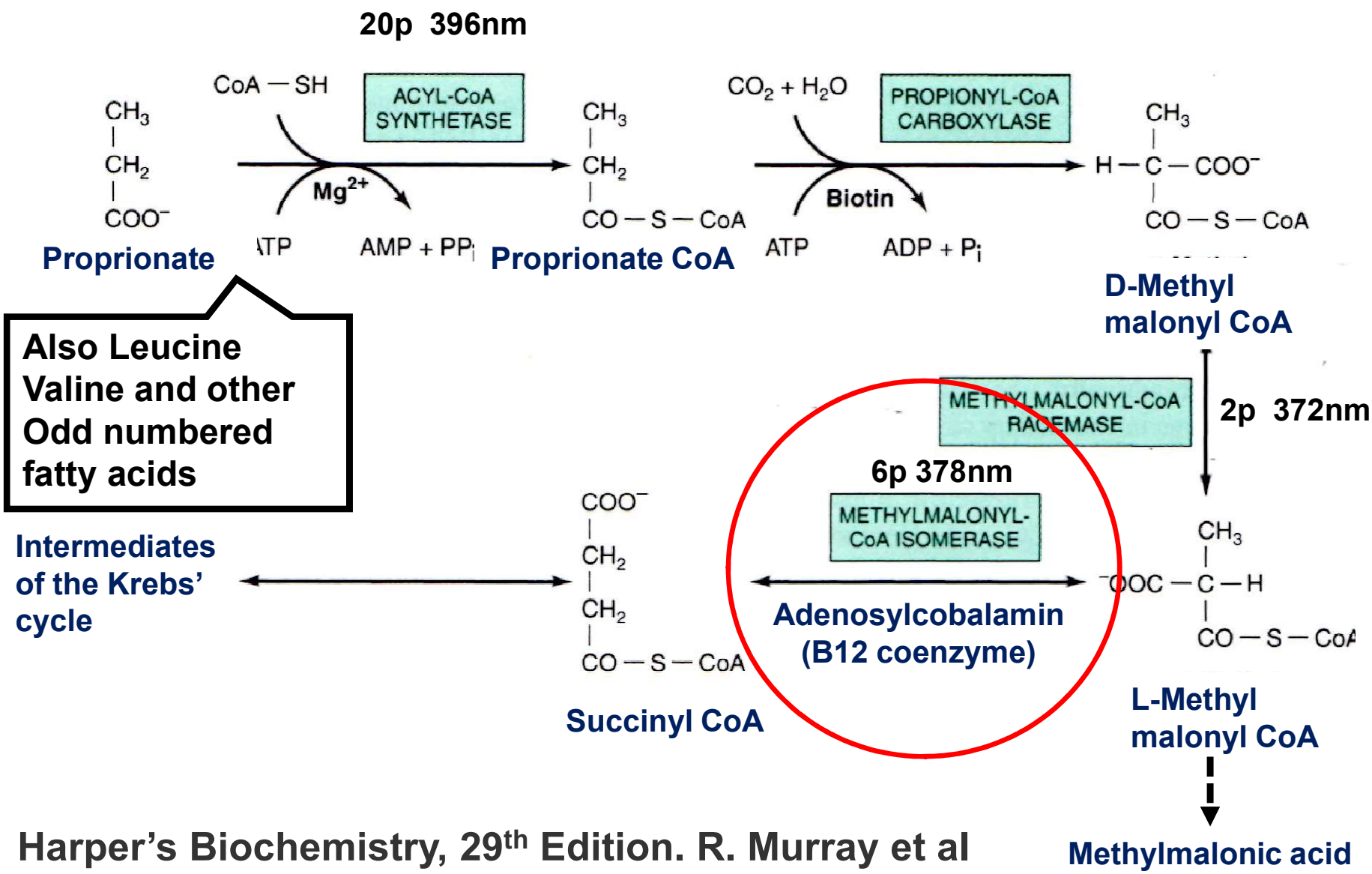
Function test

deoxyAdenosylcobalamin

Conversion of proprionates to succinates.

Functional test

Strong muscle weakens to Methylmalonic acid



Harper's Biochemistry, 29th Edition. R. Murray et al

Deficiency of Adenosylcobalamin results in the accumulation of proprionate and subsequent build up of odd numbered fatty acids.

Bacteria in the gut of ruminants produce large amounts of proprionate, which is absorbed and enters the metabolism.

Consequently, intake of animal and dairy products results in higher levels of odd numbered fatty acids.

A similar process occurs in humans who suffer from gut dysbiosis.

The association between B12 and abnormal fatty acid synthesis provides a rationale for the neuropathy of B12 deficiency.

Odd chained fatty acids build up in the CVN lipid membranes with B12 deficiency resulting in altered myelin integrity and demyelination.

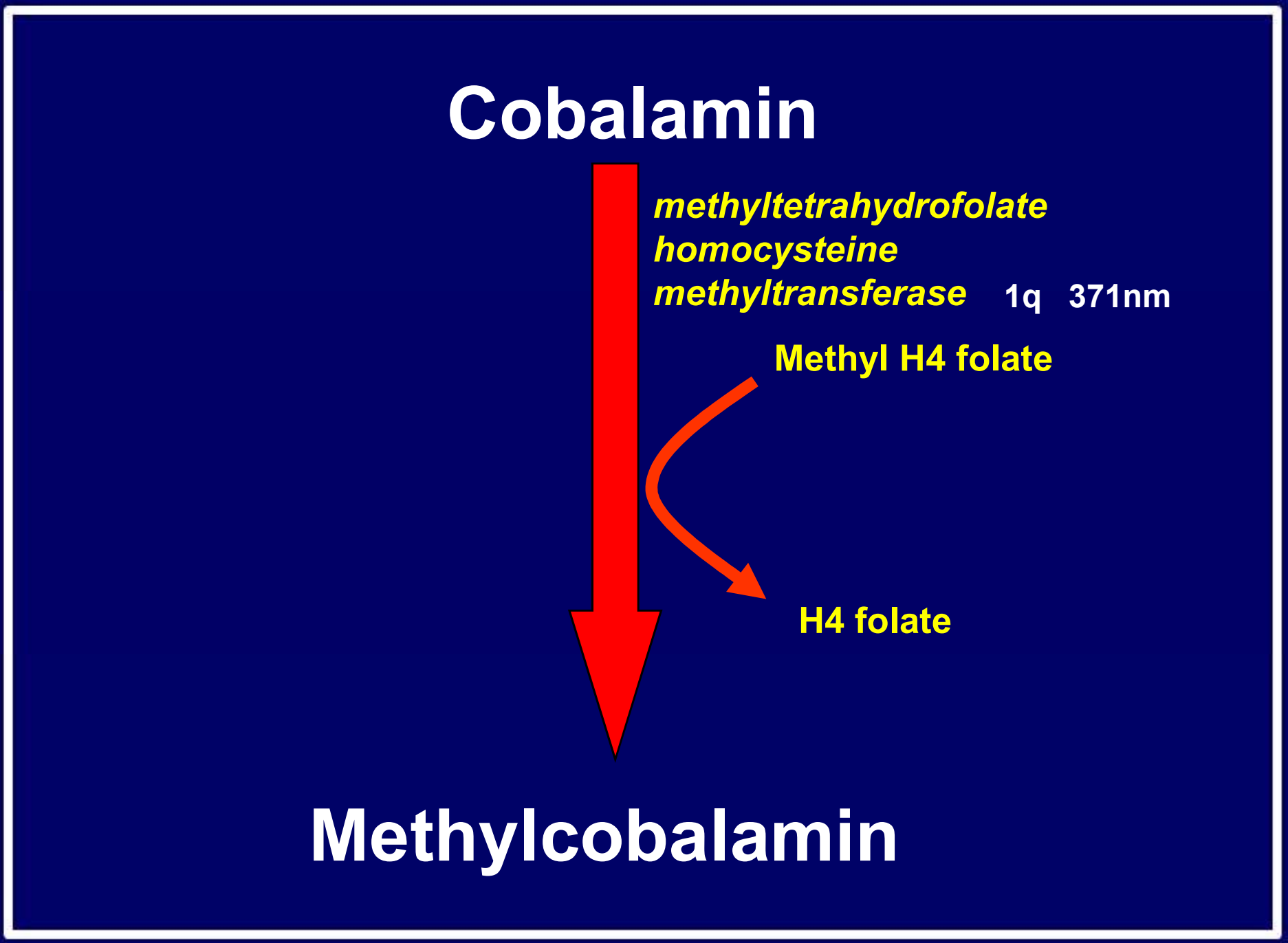
Brain Maker: The Power of Gut Microbes to Heal and Protect Your Brain - for Life Paperback – 7 May 2015 by David Perlmutter

Functional test

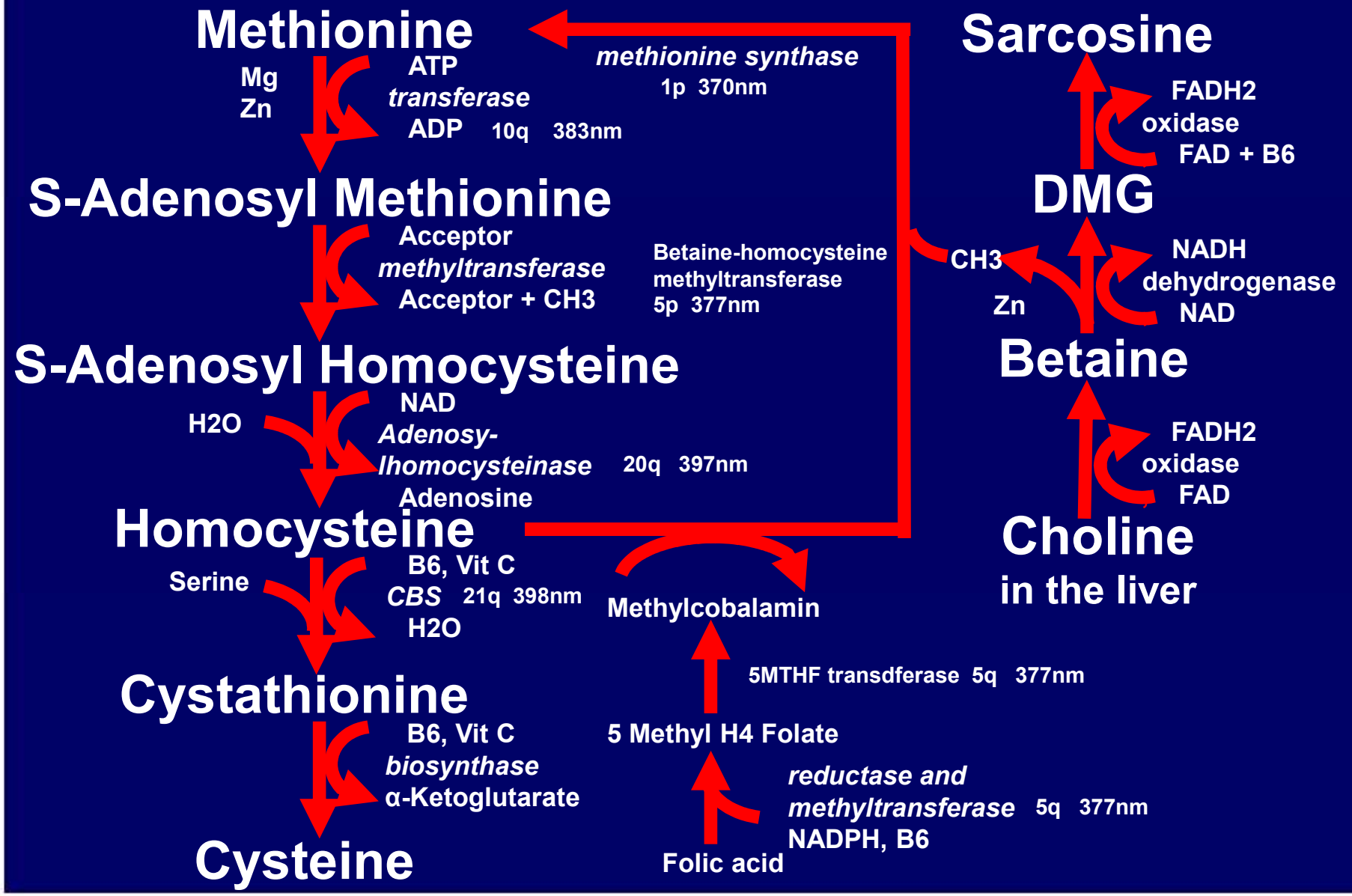
Methylcobalamin

Recycling of homocysteine.

Strong muscle weakens to homocysteine


Cobalamin
methyltetrahydrofolate
homocysteine
methyltransferase
1q
371nm
Methyl H4 folate
H4 folate
Methylcobalamin

S Adenosylmethionine (SAM)



Deficiency symptoms
deoxyAdenosylcobalamin
Hypoxia, fatigue, dementia.

Methylcobalamin
Pernicious anaemia
CV diseases.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 290

Bacterial synthesis of B12 occurs in the human colon, but little is absorbed!

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 291

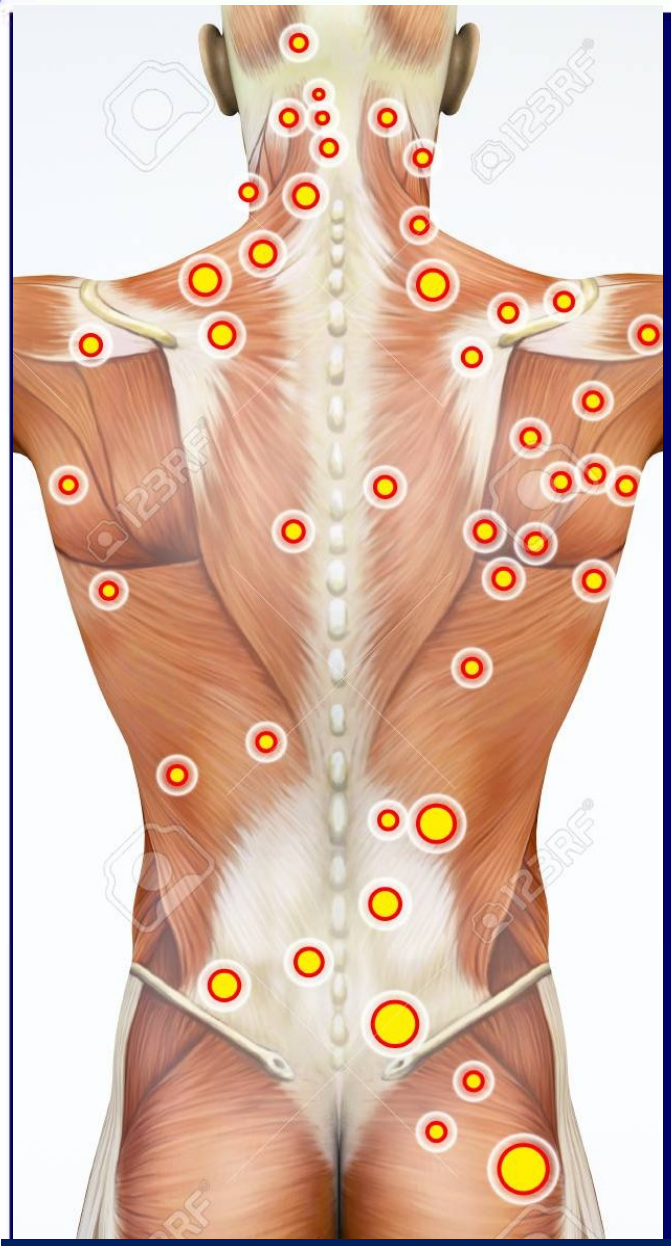
Dr Goodheart says don't forget to give the patient B12 with fascial agglutination problems.

Collected Published Articles and Reprints by Dr G. Goodheart

Dr Goodheart says

Use Vitamin 12 and Tryptophan for depression

Being a Family Doctor by George Goodheart and Walther H. Schmitt published by Lance West DC



Dr Goodheart says

Use Vitamin 12 for painful and recurrent trigger points

Being a Family Doctor by George Goodheart and Walther H. Schmitt published by Lance West DC

Sources

Liver
Meats especially LAMB and other red meats • Poultry
Seafood (e.g., clams, trout, salmon, haddock, tuna)
Eggs
Dairy products

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

FDA Daily Value (RDA)

6mcg

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

Muscles associated with Vitamin B12*

None specific

*Applied Kinesiology Synopsis 2nd Edition by David Walther DC

Tetrahydrobiopterin
H4Biopterin

Folinic acid + Glycine + Glutamine + Aspartic acid + CO_2 ↓ +3x ATP

Guanosine triphosphate (GTP)

↓ *GTP cyclohydrolase* I

7,8-Dihydroneopterin triphosphate

↓ NADPH, Mg

6-pyruvoyltetrahydropterin synthase

6-Pyruvoyl-tetrahydropterin

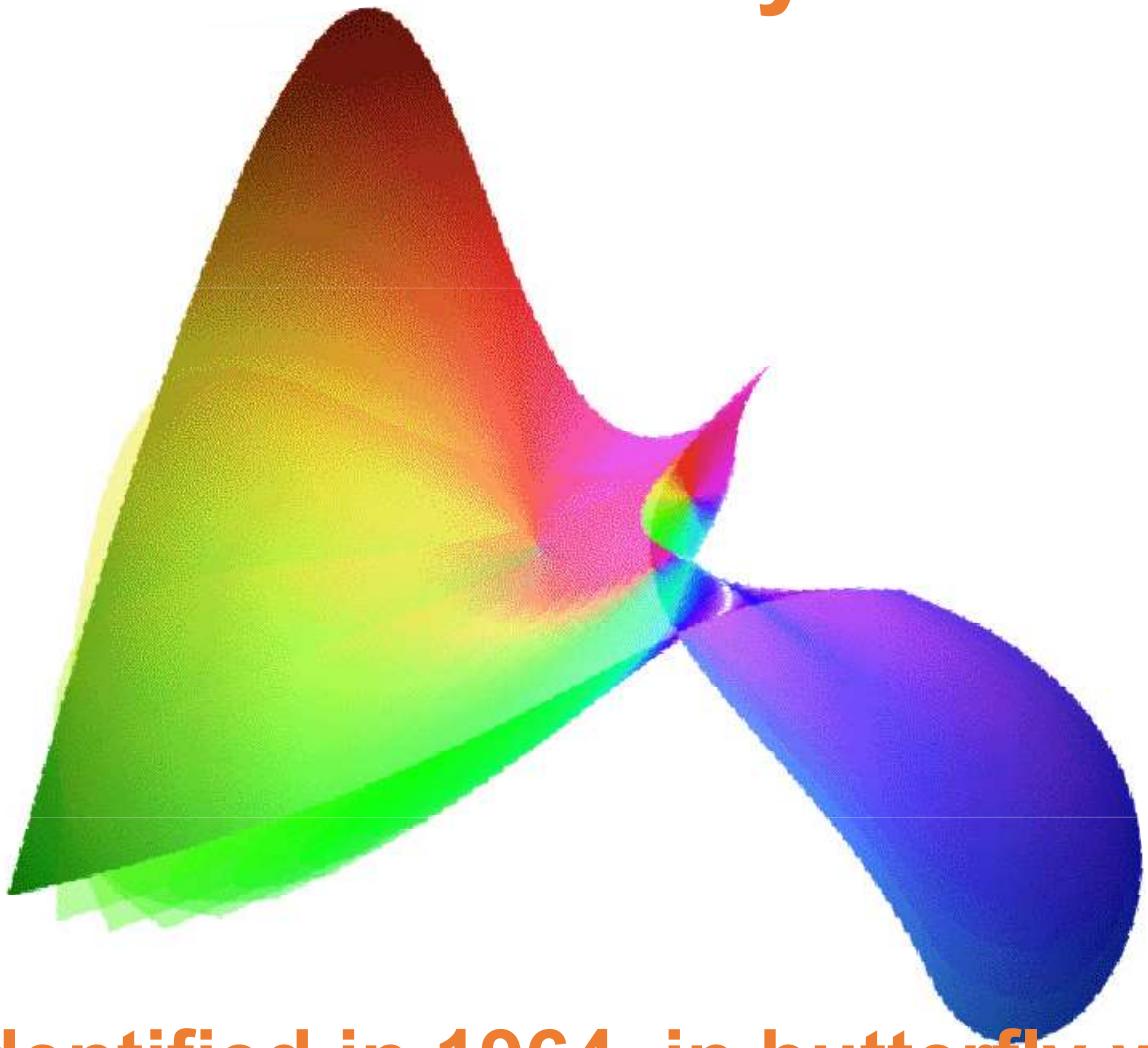
↓ NADP

sepiapterin-reductase

2p 372nm

Tetrahydrobiopterin

Tetrahydrobiopterin



First identified in 1964 in butterfly wings

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 306

This co-enzyme functions as a hydrogen donor to 4 hydroxylase enzymes.

1. Phenylalanine hydroxylase
2. Tyrosine hydroxylase
3. Tryptophan hydroxylase
4. Nitric oxide synthase

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 306

H4 Biopterin* clinically has been found to have an important role in the synthesis of collagen via the conversion of

Lysine to Hydroxylysine
Proline to Hydroxyproline

*Chris Astill-Smith

Collagen Synthesis
(Gly-X-Y-Gly-X-Y-)

Intracellular

DNA transcription to RNA
in the ribosomes.

Zinc

Proline — Glycine — Lysine

prolyl hydroxylase ↓ (Fe, Vit C, α-ketoglutarate)

lysyl hydroxylase 1p 370nm 3p 374nm ↓ (Fe, Vit C, α-ketoglutarate)

Hydroxyproline — Hydroxylysine

Endoplasmic Reticulum

glucose or galactose ↓ (Vit A, Manganese)

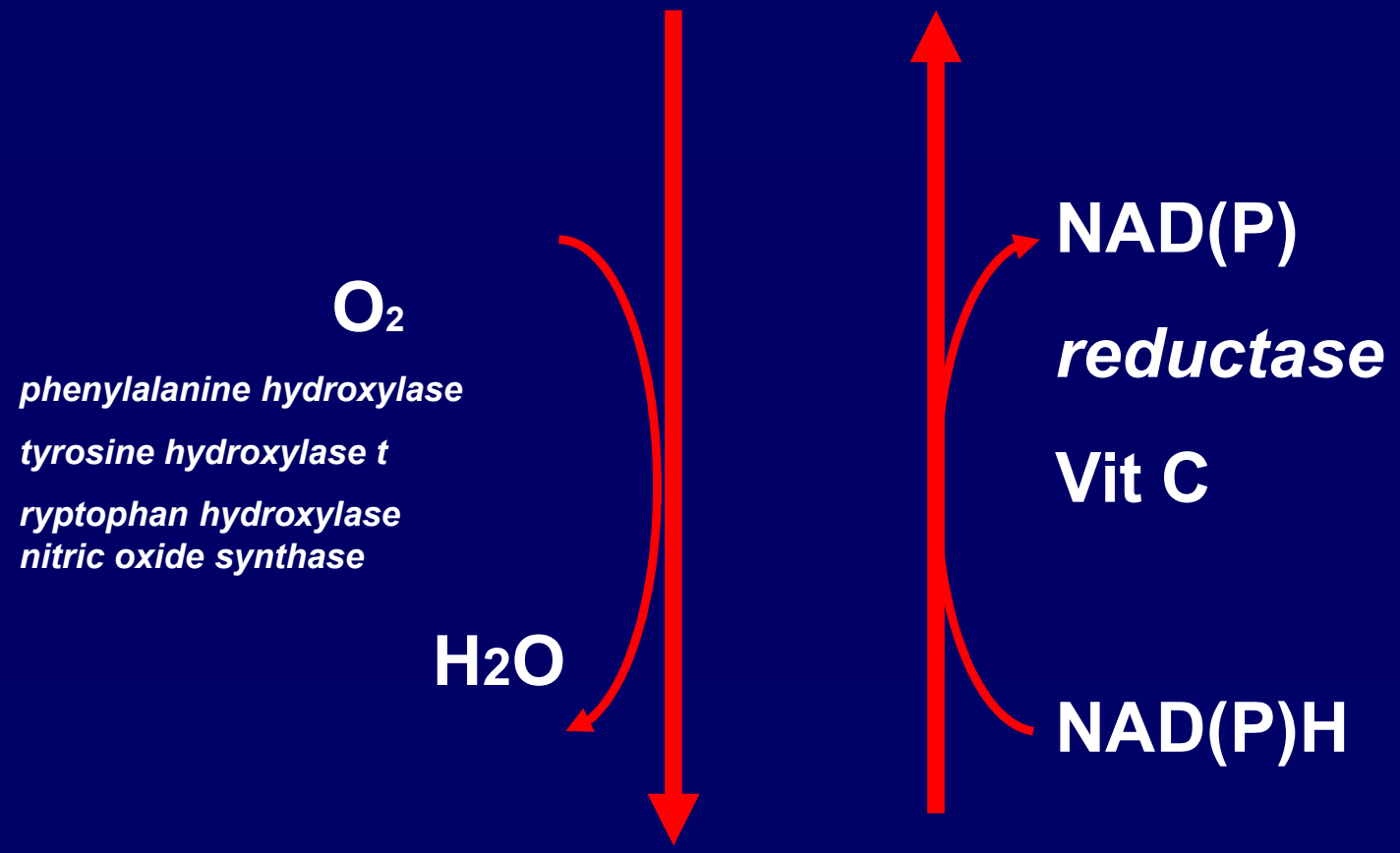
Pro-chains — Glycosylated hydroxylysine

Golgi apparatus

Pro-collagen Triple helix

Interchain and Intrachain disulfide bonds

TETRAHYDROBIOPTERIN



DIHYDROBIOPTERIN

Sources

Synthesized only in the body

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

FDA Daily Value (RDA)

None known

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

Muscles associated with H4 Biopterin*

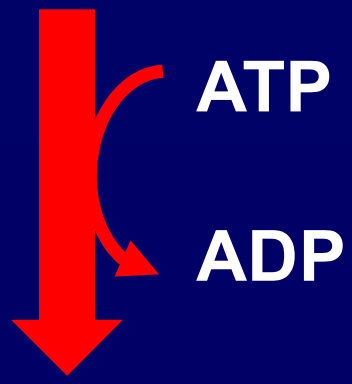
None specific

*Applied Kinesiology Synopsis 2nd Edition by David Walther DC

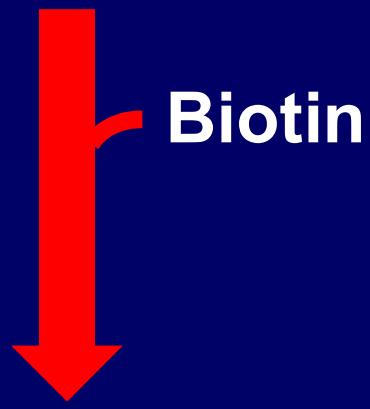
Biotin

Carboxybiotin

HCO_3



Carbonic Phosphoric anhydrase



Carboxybiotin

Biotin* can only be synthesized by bacteria, moulds, yeasts or algae, and by certain plant species.

The richest sources of biotin are yeast, liver and kidney.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 292

Egg yolk, soybeans, nuts and cereals are also good sources* (for example 100g of liver contains circa 100 micrograms (mcg) of biotin; whereas most other meats, vegetables and fruits only contain circa 1mcg biotin/100g).

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 292

Biotin enables the body to:

Convert food into glucose, which is used to produce energy.

Produce fatty acids and amino acids (the building blocks of protein).

Activate protein/amino acid metabolism in the hair roots and fingernail cells.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 293

The European Food Safety Authority (EFSA), which provides scientific advice to policy makers, has confirmed that clear health benefits have been established for the dietary intake of biotin (vitamin B7) in contributing to:

Normal macronutrient metabolism

Normal energy yielding metabolism

The maintenance of normal skin and mucous membranes

The normal function of the nervous system

The maintenance of normal hair

Normal psychological functions.

Groups at risk of biotin deficiency* include patients maintained on total intravenous nutrition, hemodialysis patients, diabetes mellitus patients, and patients with an impaired uptake of vitamins from food. In addition, pregnancy may be associated with marginal biotin deficiency.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 295

Symptoms* include hair loss, dry scaly skin, cracking in the corners of the mouth, swollen and painful tongue, dry eyes, loss of appetite, fatigue, insomnia, and depression.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 296

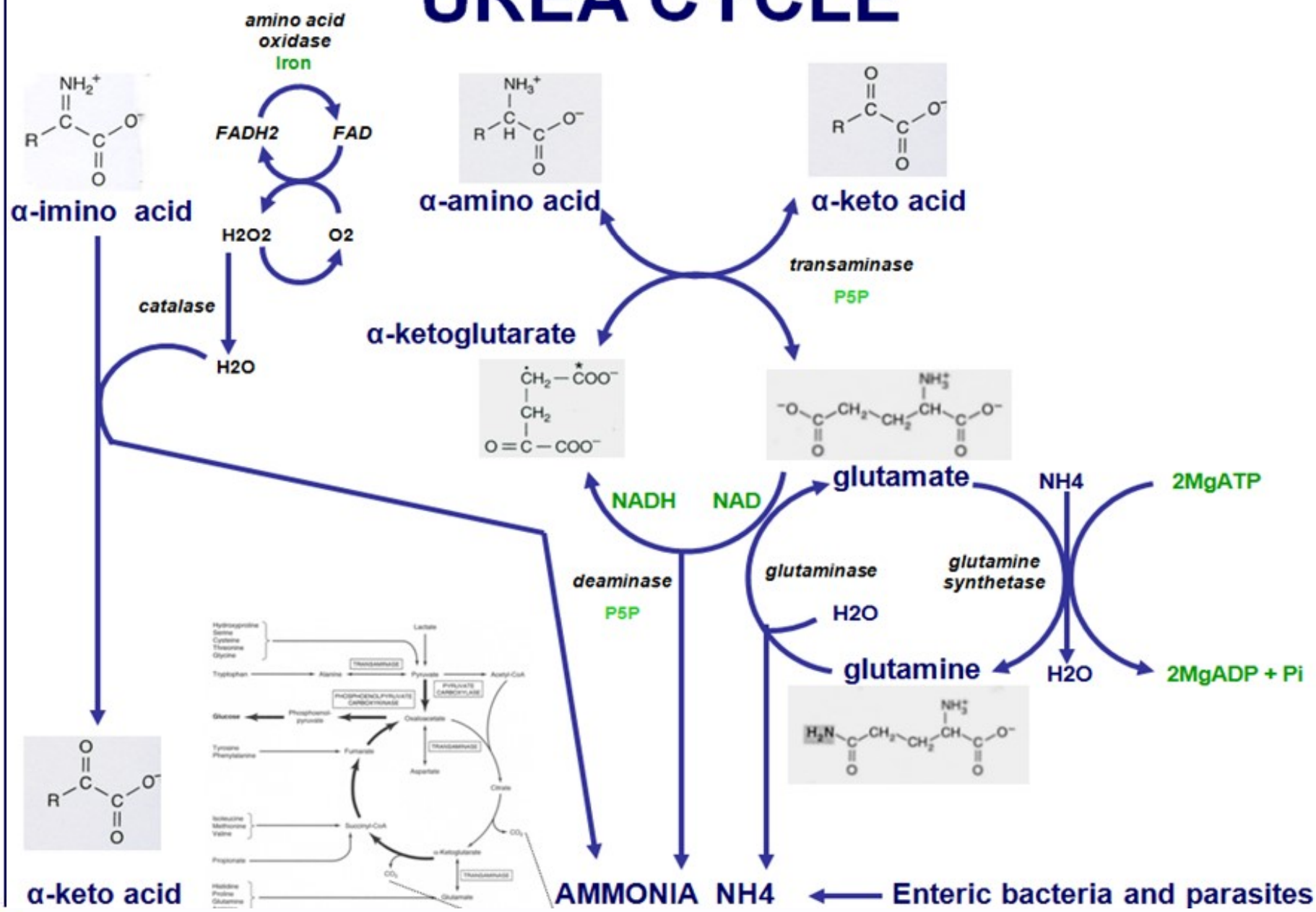
Four Biotin dependant enzymes

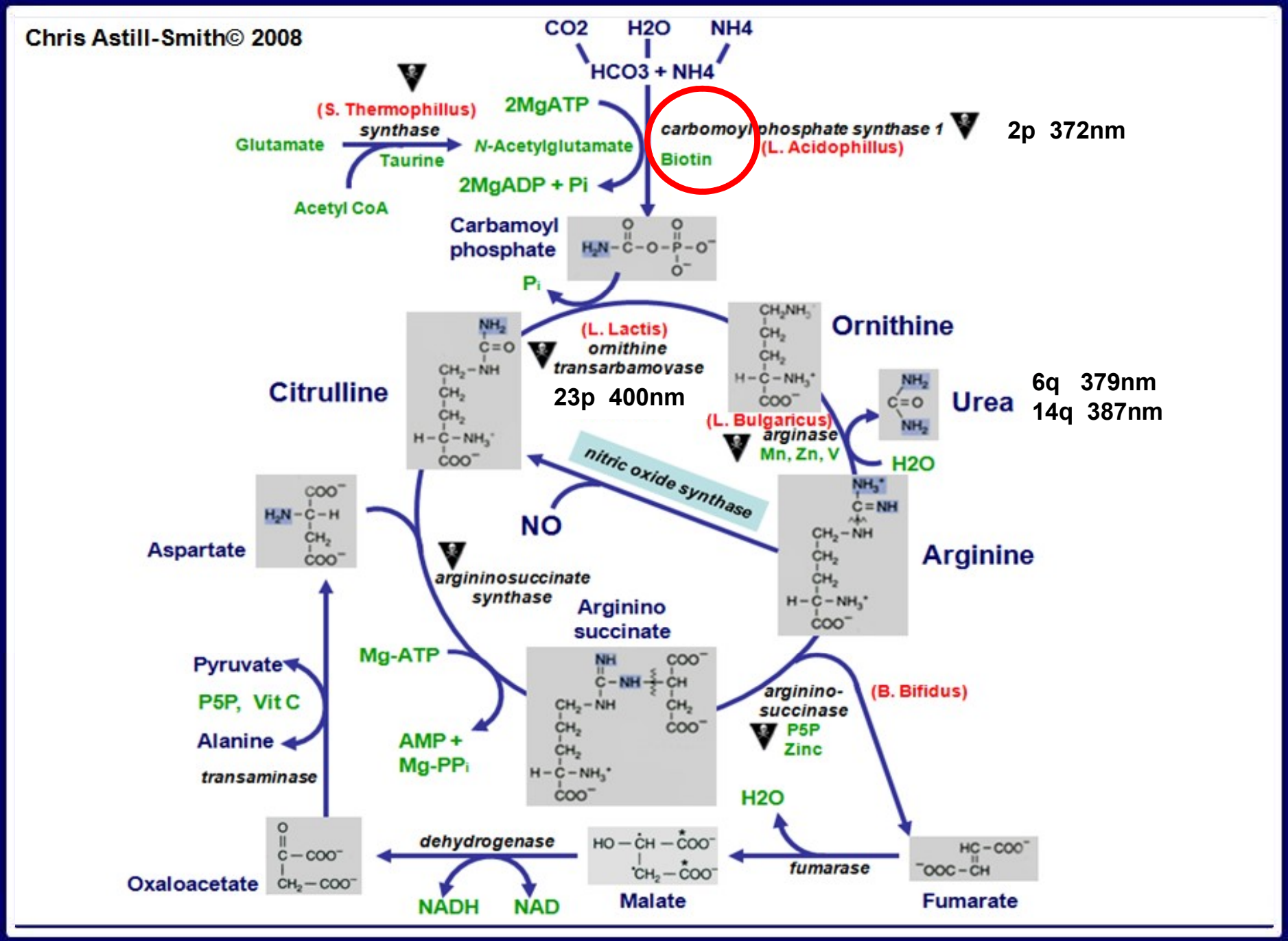
1. Carbomoyl phosphate synthase (high ammonia)
2. Carboxylase – acetylCoA to malonyl CoA
3. Pyruvate carboxylase
4. Proprionyl CoA carboxylase (high propionic acid)

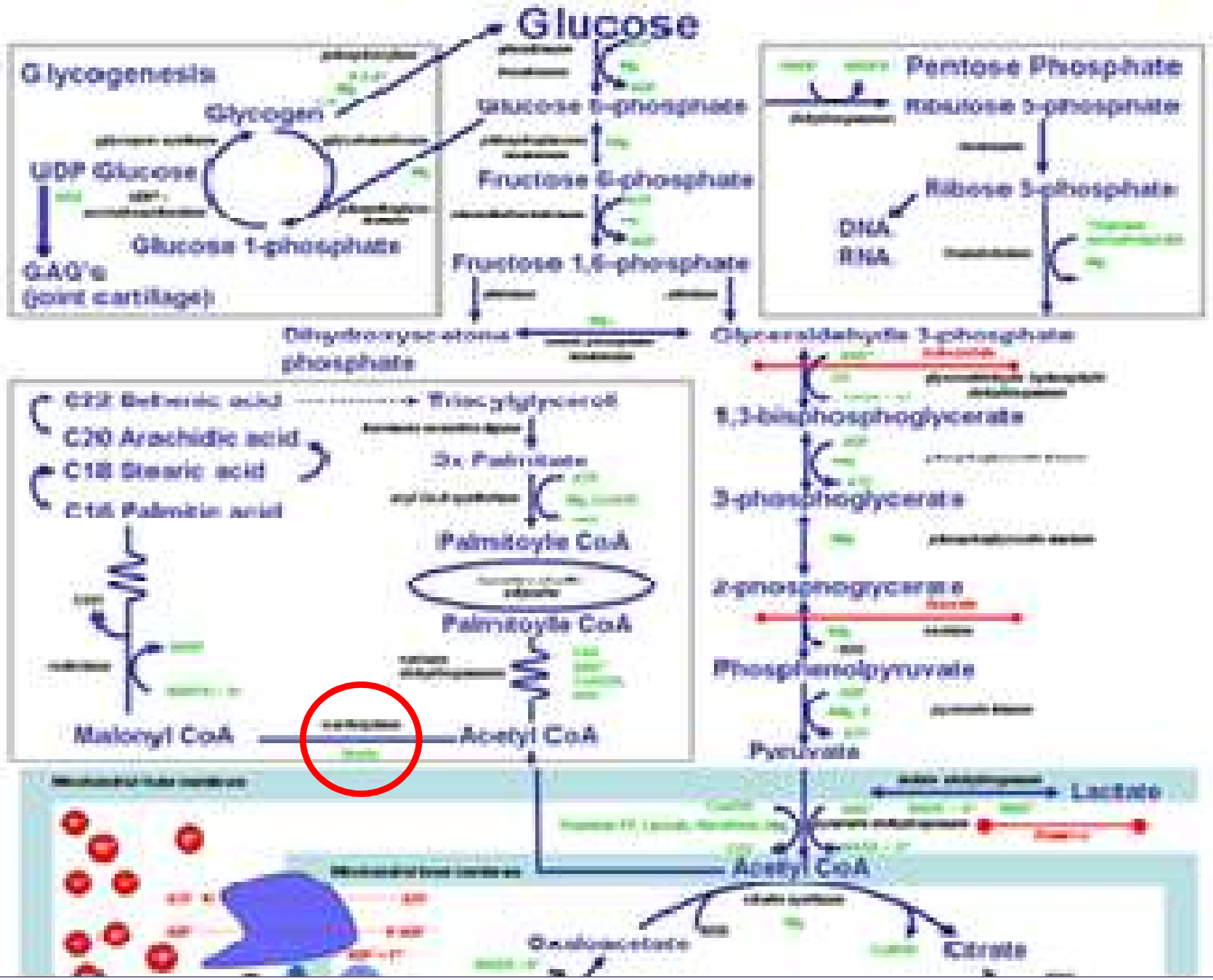
*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 294

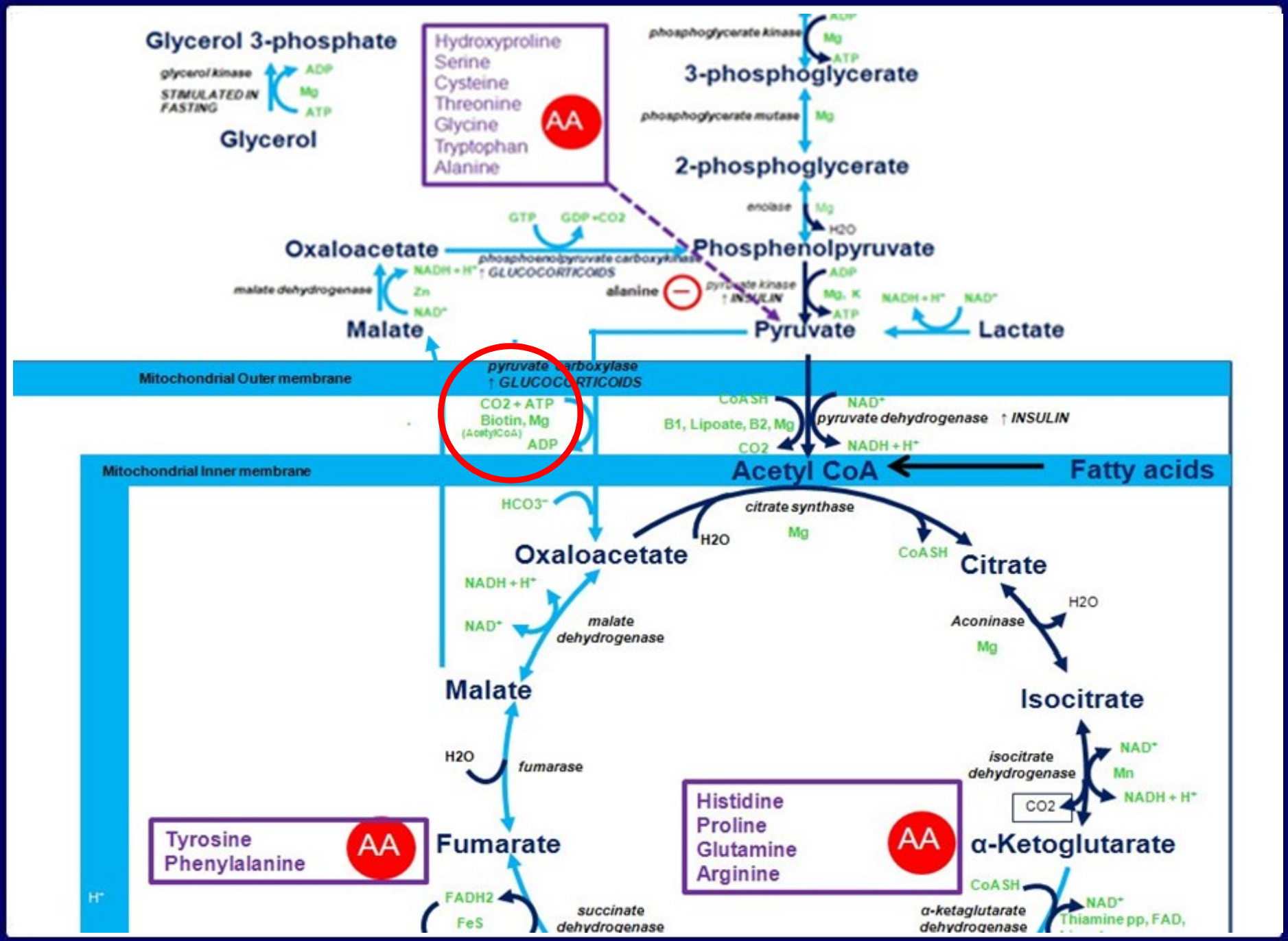
UREA CYCLE

Chris Astill-Smith© 2008

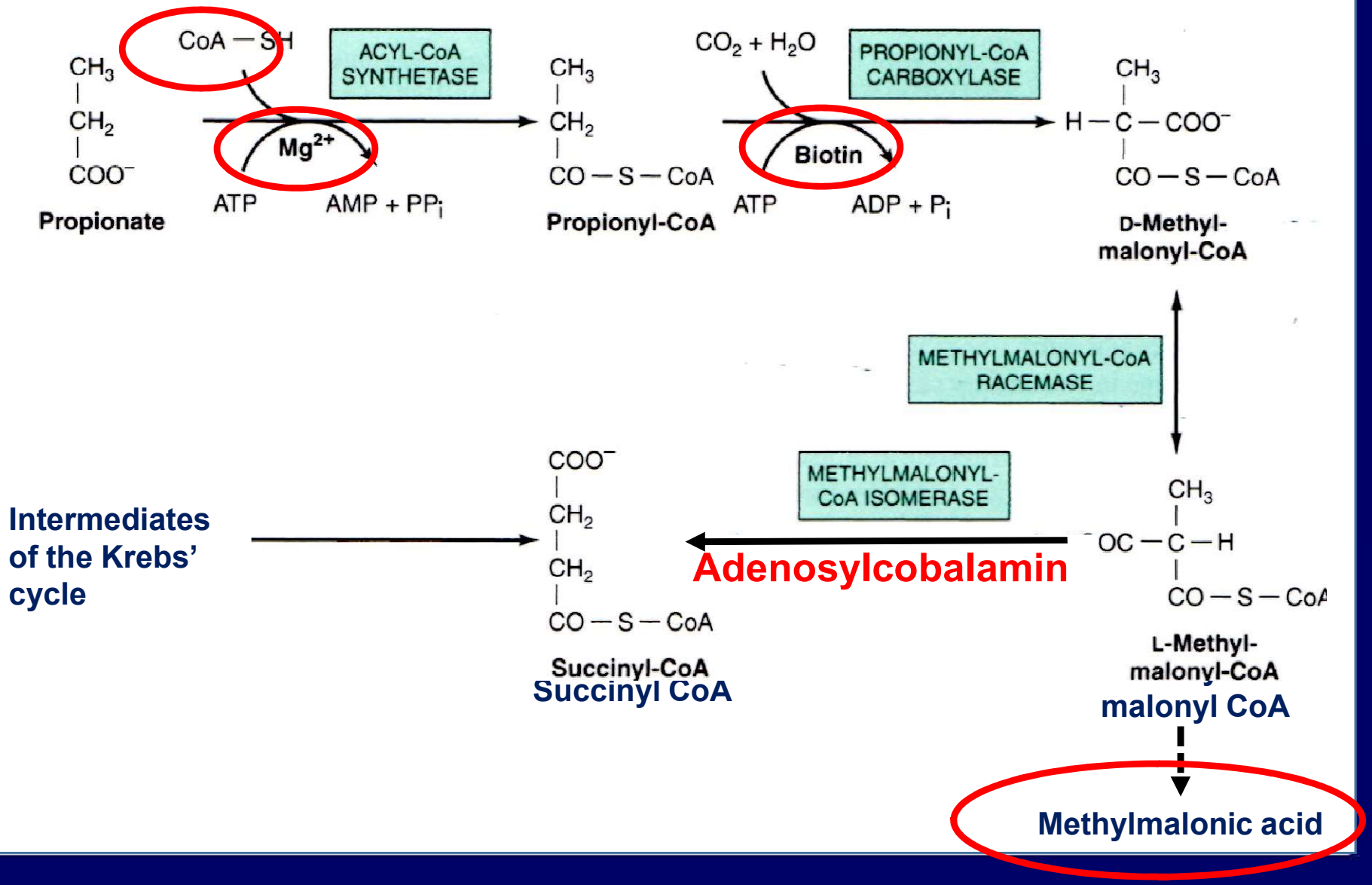



Chris Astill-Smith© 2008
CO2
H2O
NH4
HCO3 + NH4
(S. Thermophillus)
synthase
Glutamate
Taurine
N-Acetylglutamate
Acetyl CoA
2MgATP
2MgADP + Pi
carbomoyl phosphate synthase 1
(L. Acidophillus)
Biotin
2p 372nm
Carbamoyl phosphate
Pi
(L. Lactis)
ornithine transarbamoyase
23p 400nm
Citrulline
Ornithine
(L. Bulgaricus)
arginase
Mn, Zn, V
Urea
6q 379nm
14q 387nm
H2O
nitric oxide synthase
NO
Aspartate
argininosuccinate synthase
Arginine
Arginino succinate
Mg-ATP
AMP + Mg-PPi
Pyruvate
P5P, Vit C
Alanine
transaminase
arginino-succinase
P5P
Zinc
(B. Bifidus)
H2O
dehydrogenase
fumarase
Oxaloacetate
NADH
NAD
Malate
Fumarate


Glucose
Glycogenesis
Glycogen
UDP Glucose
Glucose 1-phosphate
GAG's
(joint cartilage)
Glucose 6-phosphate
Fructose 6-phosphate
Fructose 1,6-phosphate
Pentose Phosphate
Ribulose 5-phosphate
Ribose 5-phosphate
DNA
RNA
Dihydroxyacetone phosphate
Glyceraldehyde 3-phosphate
C22 Behenic acid
Triacylglycerol
C20 Arachidic acid
C18 Stearic acid
C16 Palmitic acid
3x Palmitate
Palmitoyl CoA
Palmitoyl CoA
Malonyl CoA
Acetyl CoA
1,3-bisphosphoglycerate
3-phosphoglycerate
2-phosphoglycerate
Phosphenolpyruvate
Pyruvate
Lactate
Acetyl CoA
Oxaloacetate
Citrate


Glycerol 3-phosphate
glycerol kinase
STIMULATED IN FASTING
ADP
Mg
ATP
Glycerol
Hydroxyproline
Serine
Cysteine
Threonine
Glycine
Tryptophan
Alanine
AA
phosphoglycerate kinase
3-phosphoglycerate
phosphoglycerate mutase
2-phosphoglycerate
enolase
H2O
Oxaloacetate
GTP
GDP +CO2
phosphoenolpyruvate carboxykinase
↑ GLUCOCORTICOIDS
Phosphenolpyruvate
malate dehydrogenase
NADH + H+
Zn
NAD+
alanine
pyruvate kinase
↑ INSULIN
Mg, K
Malate
Pyruvate
Lactate
Mitochondrial Outer membrane
pyruvate carboxylase
↑ GLUCOCORTICOIDS
CO2 + ATP
Biotin, Mg
(AcetylCoA)
ADP
CoASH
B1, Lipoate, B2, Mg
pyruvate dehydrogenase
↑ INSULIN
CO2
Mitochondrial Inner membrane
Acetyl CoA
Fatty acids
HCO3−
citrate synthase
Oxaloacetate
Citrate
Aconinase
Isocitrate
malate dehydrogenase
Malate
fumarase
isocitrate dehydrogenase
Mn
Tyrosine
Phenylalanine
Fumarate
Histidine
Proline
Glutamine
Arginine
α-Ketoglutarate
FADH2
FeS
succinate dehydrogenase
α-ketaglutarate dehydrogenase
Thiamine pp, FAD,
H+

Test for Propionic acid



Sources

Royal jelly, Yeast, Liver, Kidney

Whole rice, Egg yolk, Nuts, Soy bean, Chocolate, Avocados, Cauliflower, Fruits (e.g., raspberries), Salmon

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

FDA Daily Value (RDA)

300mcg

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

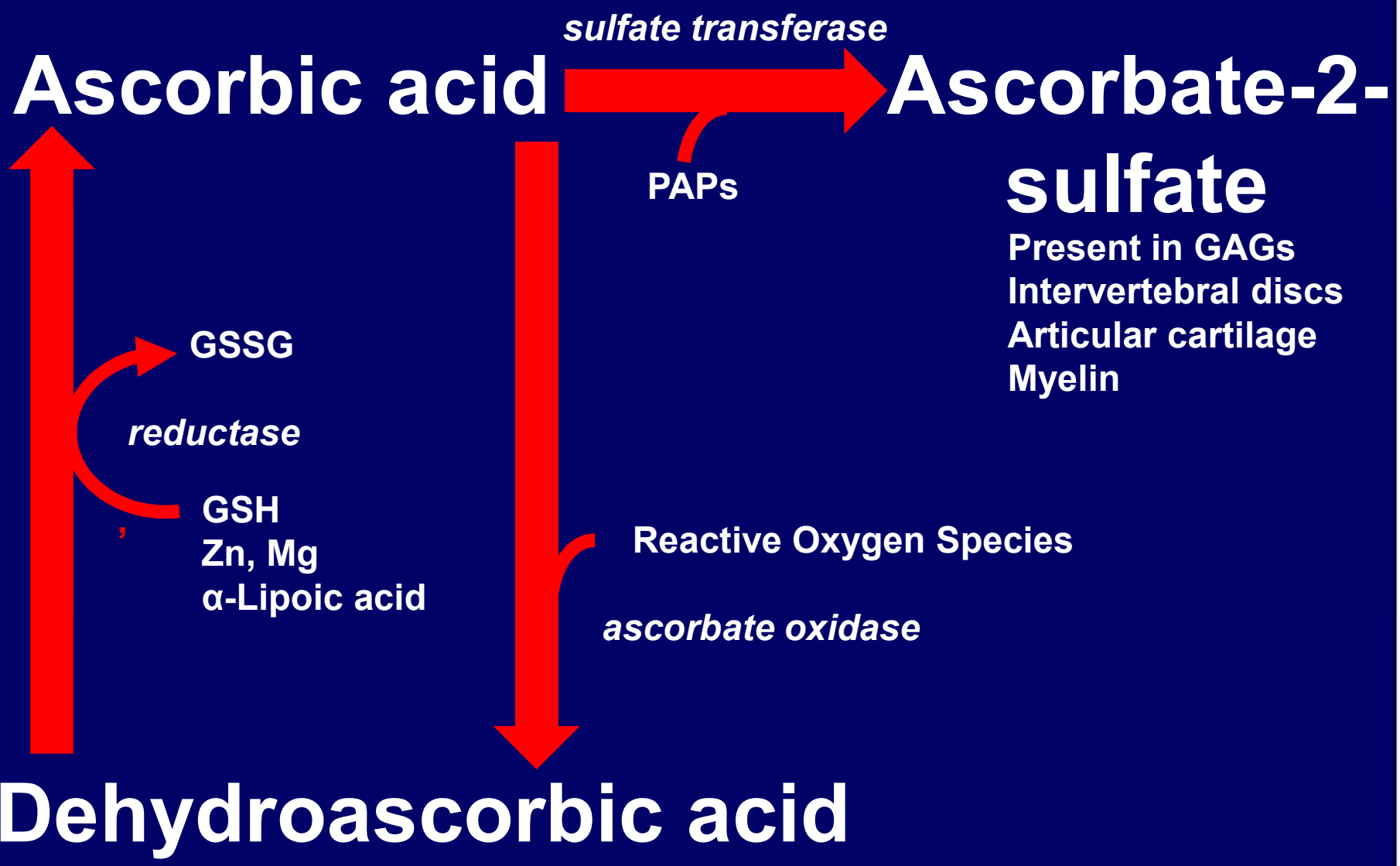
Muscles associated with Biotin*

None specific

*Applied Kinesiology Synopsis 2nd Edition by David Walther DC

Vitamin C
Ascorbic acid

Vitamin C


sulfate transferase
Ascorbic acid
Ascorbate-2-sulfate
PAPs
Present in GAGs
Intervertebral discs
Articular cartilage
Myelin
GSSG
reductase
GSH
Zn, Mg
α-Lipoic acid
Reactive Oxygen Species
ascorbate oxidase
Dehydroascorbic acid

Vitamin C*, is a water-soluble vitamin and an essential health ingredient that the body cannot produce itself and that needs to absorb through our diet or by supplements.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 346

Vitamin C is widely found in fruits and vegetables including citrus fruits, blackcurrants, peppers, green vegetables (such as broccoli), brussels sprouts, and fruits like strawberries, guava, mango and kiwi.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 353

The synthesis of Vitamin C was achieved by Reichenstein in 1933, and this was followed by industrial production five years later by F. Hoffmann-La Roche Ltd. Today, synthetic vitamin C, identical to that occurring in nature, is produced from glucose on an industrial scale by chemical and biotechnical synthesis.

The most prominent role of Vitamin C is its immune-stimulating effect. It's important for defence against infections such as common colds. It also acts as an inhibitor of histamine, a compound that is released during allergic reactions.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 349

As a powerful antioxidant it can neutralize harmful free radicals and it aids in neutralizing pollutants and toxins. It is thus able to prevent the formation of potentially carcinogenic nitrosamines in the stomach (due to consumption of nitrite-containing foods, such as smoked meat).*

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 349

A sufficient intake of Vitamin C (ascorbic acid), is important as it helps the body to make collagen - an important protein in skin, cartilage, tendons, ligaments, and blood vessels and which supports the growth and repair of tissues and heals wounds.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 348

It repairs and maintains bones and teeth, synthesizes neurotransmitters and blocks some of the damage caused by free radicals by working as an antioxidant along with vitamin E, beta-carotene and many other plant-based nutrients.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 348

Low levels of Vitamin C have been associated with a number of cardiovascular disorders, including heart disease, hypertension, stroke, and atherosclerosis, and some cancers. It can have the following effects: Fatigue, lassitude, irritability, feeling run down, loss of appetite, low resistance to infection, drowsiness and insomnia.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 352

Smoking cigarettes lowers the amount of Vitamin C in the body, so smokers are more at risk of deficiency.

1 cigarette destroys 25mg Vitamin C.*

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 348

Signs of vitamin deficiency include dry and splitting hair, inflammation of the gums, bleeding gums, rough, dry, scaly skin, decreased wound-healing rate, easy bruising, nosebleeds, and a decreased ability to ward off infection.

A severe form of vitamin C deficiency is known as scurvy.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 352


dr. Massimo Mazza

The recommended daily intake of Vitamin C varies according to age, sex, risk group cigarette smokers, alcohol users, institutionalized elderly (and subjects on certain drugs), as well as criteria applied in individual countries.

* "Vitamin C". *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids*. Washington, D.C.: The National Academies Press. pp. 95–185.

The recommended dietary allowances for Vitamin C in the USA were recently revised upwards to 90 mg/day for men and 75 mg/day for women based on pharmacokinetic data.

* "Vitamin C". *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids*. Washington, D.C.: The National Academies Press. pp. 95–185.

For smokers, these recommended dietary allowances for Vitamin C are increased by an additional 35 mg/day and higher amounts are recommended for pregnant (and lactating women (85 mg/day and 120 mg/day respectively). RDAs are in a similar range in other countries. Recent evidence sets the estimate for maintaining optimal health at around 100 mg per day.

Although as much as 6-10 g Vitamin C per day (more than 100 times the RDA) has been ingested regularly by many people, there is no evidence of side effects from large doses and there is no reliable scientific evidence that large amounts of vitamin C (up to 10 grams/day in adults) are toxic.*

*"Vitamin C". *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids*. Washington, D.C.: The National Academies Press. pp. 95–185.

In the year 2000, the US Food and Nutrition Board recommended a tolerable upper intake level (UL) for Vitamin C of two grams daily in order to prevent most adults from several health and safety issues, such as experiencing osmotic diarrhoea and GI disturbances.*

*"Vitamin C". *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids*. Washington, D.C.: The National Academies Press. pp. 95–185.

The highest concentration of Vitamin C is in the adrenal glands and the pituitary gland. Decreasing then are the eye lens, liver, brain, spleen, pancreas, kidney, lungs, heart and testes.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 346

Vitamin C has a half life of 16 days with a turn over of 1mg / kilogram of body weight / day. (70mg)

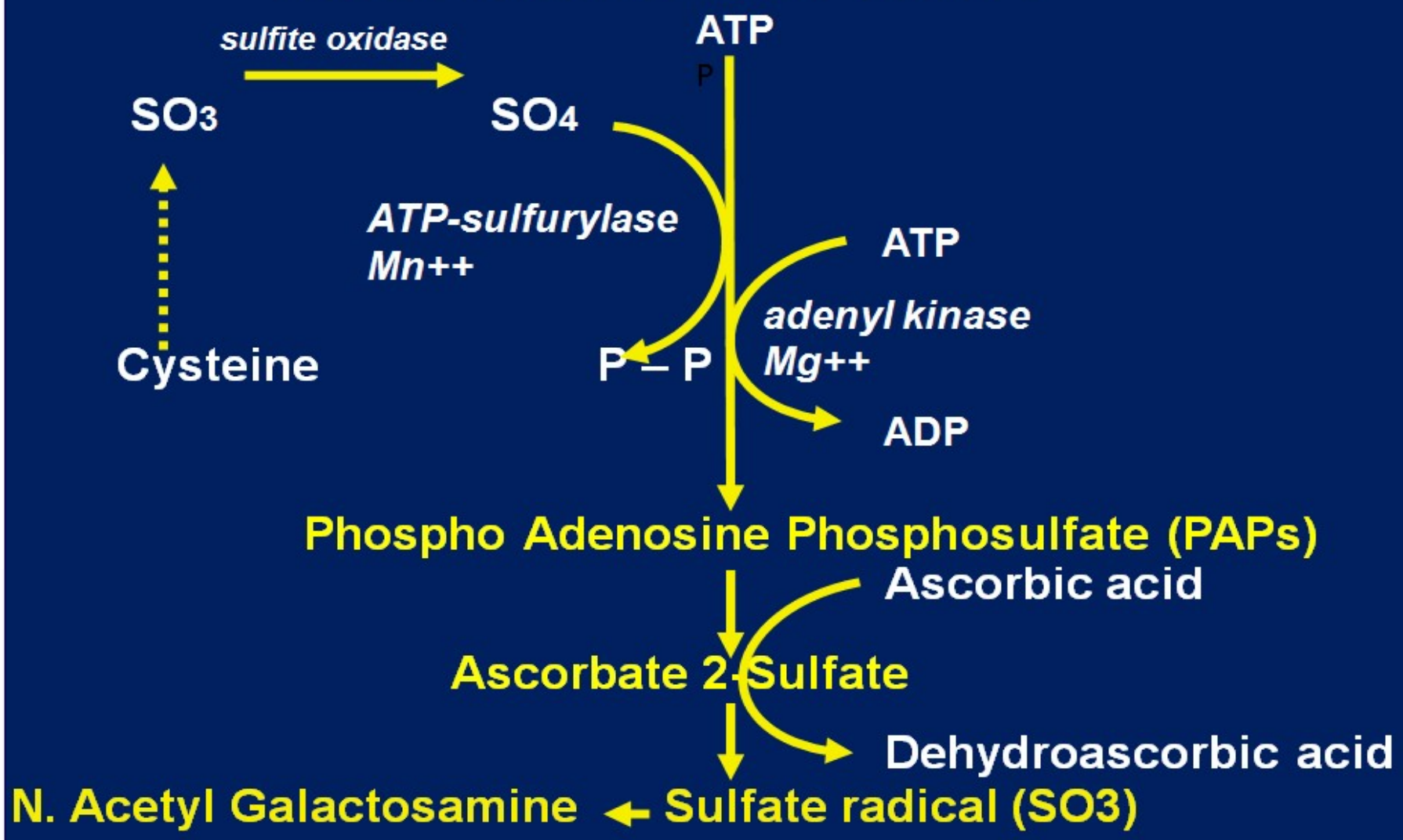
*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 346

There is a body pool of 22mg of Vitamin C per kilogram of body weight. (1540mg)

Following a oral dose, the peak of plasma occurs in 3 hours.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 346

ACTIVATED SULFATE



Function

Collagen synthesis
Degradation of Tyrosine
Synthesis of Noradrenalin
Bile acid formation
Adrenal cortex
Absorption of iron
Antioxidant

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 348

Vitamin C is necessary for the formation of hydroxyproline and hydroxylysine found in collagen. Hydroxylysine is necessary for the cross-linkage which gives the tensile strength to collagen.

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 348

Deficiency of Vitamin C, most of the pathological changes are associated with defective collagen in blood vessels and intracellular cement substances.

Collagen Synthesis
(Gly-X-Y-Gly-X-Y-)

Intracellular

DNA transcription to RNA
in the ribosomes.

Zinc

Proline — Glycine — Lysine

prolyl hydroxylase ↓ (Fe, Vit C, α-ketoglutarate)

lysyl hydroxylase ↓ (Fe, Vit C, α-ketoglutarate)

Hydroxyproline — Hydroxylysine

Endoplasmic Reticulum

glucose or galactose ↓ (Vit A, Manganese)

Pro-chains — Glycosylated hydroxylysine

Golgi apparatus

Pro-collagen Triple helix

Interchain and Intrachain disulfide bonds

Vitamin C is required as a cofactor for prolyl hydroxylase and lysyl hydroxylase; these enzymes need an Fe^{2+} ion to be present. The problem being, that Fe^{2+} is unstable and will oxidize very easily. **Vitamin C** though, will end up keeping the Fe from going to the more stable 3+ form, rather keeping it at the required 2+ form.

Vitamin C is important for many metabolic processes, including:

Collagen formation – collagen is used in different ways throughout the body. Its primary role is to strengthen the skin, blood vessels and bone. The body also relies on collagen to heal wounds.

Antioxidant function – the metabolism of oxygen within the body releases molecular compounds called 'free radicals', which damage cell membranes. Antioxidants are substances that destroy free radicals, and vitamin C is a powerful antioxidant.

Iron absorption – the process of iron absorption is aided by vitamin C, particularly non-haem iron (the form of iron found in plant foods such as beans and lentils).

Infection fighting – the immune system, particularly cells called lymphocytes, requires vitamin C for proper functioning.

Other roles – vitamin C is used to produce other important substances in the body such as brain chemicals (neurotransmitters). Metabolises histamine.

Vitamin C is required in the biosynthesis of carnitine, a compound that transports the long chain fatty acids across the mitochondrial membrane.*

**"Enzymology of the carnitine biosynthesis pathway". *IUBMB Life*. 62 (5): 357–62.

Thus without adequate Vitamin C, mitochondria cannot oxidise fatty acids.*

So Vitamin C may have a role in weight control and heart disease.

*"Enzymology of the carnitine biosynthesis pathway". *IUBMB Life*. 62 (5): 357–62.

Deficiency symptoms

Lassitude, weakness, irritability, muscle and joint pains, loss of weight, bleeding gums, gingivitis, loosening of teeth. Petechial and other haemorrhages.

Recurrent infections

*Role of Nutrition in Health and Disease by W.E. Cornatzer, Pub Thomas. Page 352

Men generally need more Vitamin C than women.

Dr Goodheart says 2gm for men, 1gm for women.

Men have a higher risk of heart attacks.

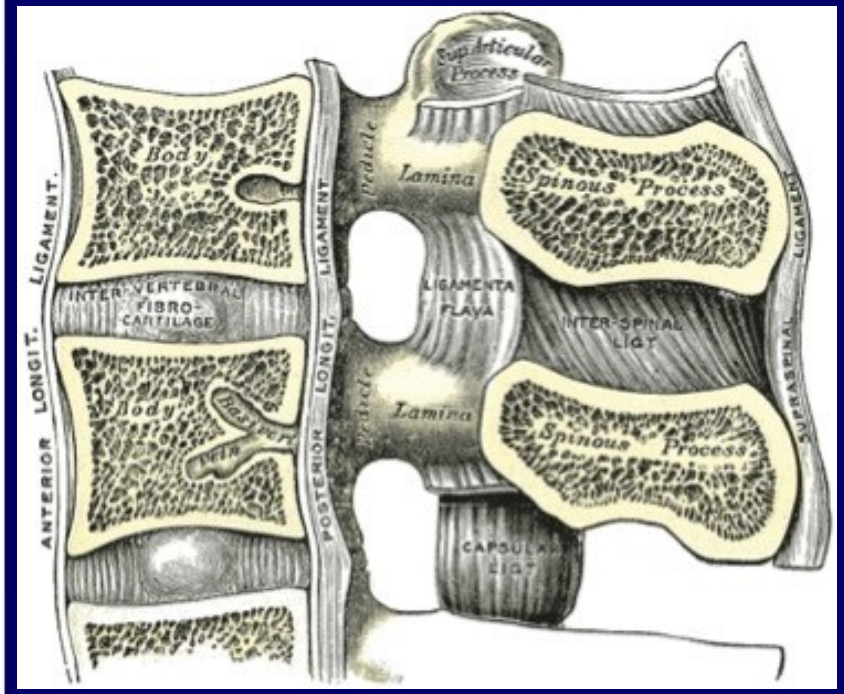
Dr Goodheart says

Challenge patients who bruise easily against
Vitamin C,
Bioflavonoids and
Vitamin K.

Also Pyridoxal-5-phosphate.

Collected Published Articles and Reprints by Dr G. Goodheart

Dr Goodheart says

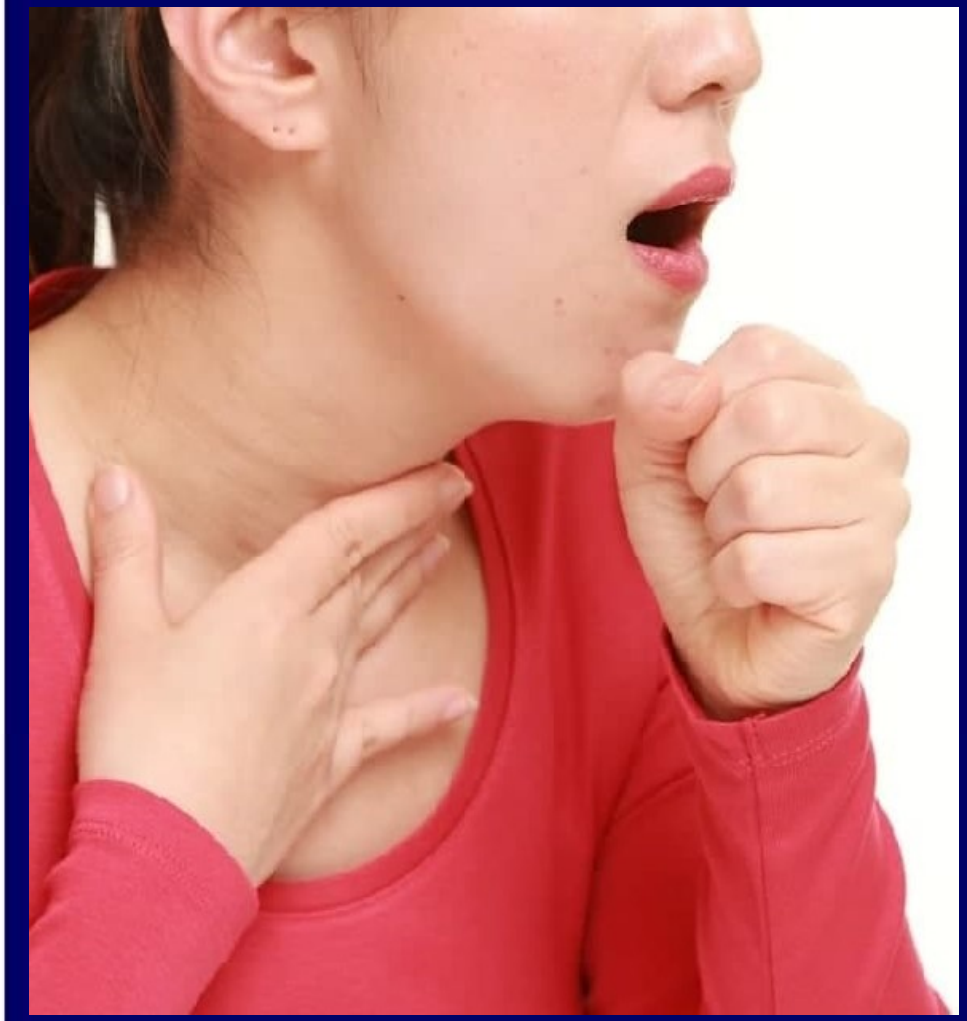


Use Vitamin C and Manganese for disc problems.

Cataracts

Collected Published Articles and Reprints by Dr G. Goodheart

Dr Goodheart says



Use Vitamin C for excessive mucus along with Iodine

Collected Published Articles and Reprints by Dr G. Goodheart

Sources

Guava, Black currants, Kale, Broccoli, Brussels sprouts, Cantaloupe, Citrus fruits and juices (e.g., oranges and grapefruit), Kiwifruit, Peppers, Strawberries, Tomatoes and tomato juice

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

FDA Daily Value (RDA)

60mg

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

Functional test for Vitamin C

1. Strong muscle weakens to either proline or lysine
2. Weakness negated either hydroxyproline or hydroxylysine respectively
3. Weakness negates with Vitamin C

Muscles associated with Vitamin C*

Coracobrachialis
Deltoid
Diaphragm
Mid and Lower trapezius
Quadratus lumborum
Sacrospinalis
Sartorius
Serratus anterior
Subscapularis

*Applied Kinesiology Synopsis 2nd Edition by David Walther DC

Lipoic acid
Thioctic acid

Lipoic acid

Octanoic acid + Cysteine

↓ Thiamine pyrophosphate

α-Lipoic acid

↓ Lysine

Lipoamide

↓ H_2

Dihydrolipoamide

Lipoic acid (LA), also known as α-lipoic acid or thioctic acid is an organosulfur compound derived from octanoic acid. It is made in animals normally, and is essential*

For aerobic metabolism.

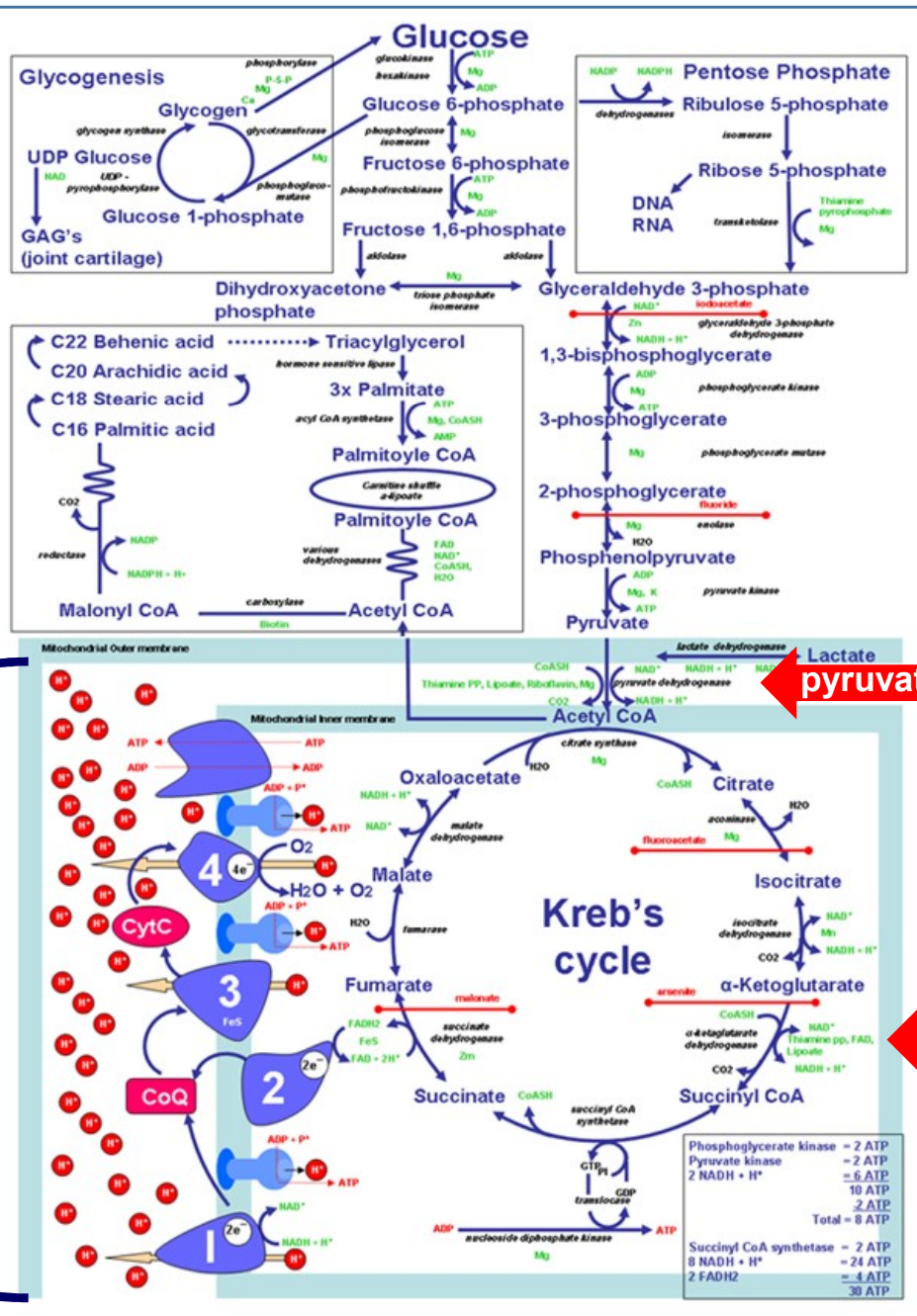
As an antioxidant.

Toxic metal chelator.

Blood glucose modulator.

* Pharmacopeial Forum". 34 (5): 1209.

Energy pathway



Glycolysis

pyruvate dehydrogenase

Citric Acid Cycle

aKeto dehydrogenase

Electron transport or Oxidative phos-phorylation pathway

Chris Astill-Smith© 2008

Gastrointestinal absorption is variable and decreases with the use of food. It is therefore recommended that dietary LA be taken 30-60 minutes before or at least 120 minutes after a meal. Maximum blood levels of LA are achieved 30-60 minutes after dietary supplementation.*

* McIlduff, Courtney E; Rutkove, Seward B (2011-01-01). "Critical appraisal of the use of alpha lipoic acid (thioctic acid) in the treatment of symptomatic diabetic polyneuropathy" *Therapeutics and Clinical Risk Management*. 7: 377–385.

Sources

Kidney, heart, liver, spinach, broccoli, and yeast extract

Durrani, AI; Schwartz, H; Nagl, M; Sontag, G (October 2010). "Determination of free [alpha]-lipoic acid in foodstuffs by HPLC coupled with CEAD and ESI-MS". *Food Chemistry* 120 (4): 38329–36. doi:10.1016/j.foodchem.2009.11.045

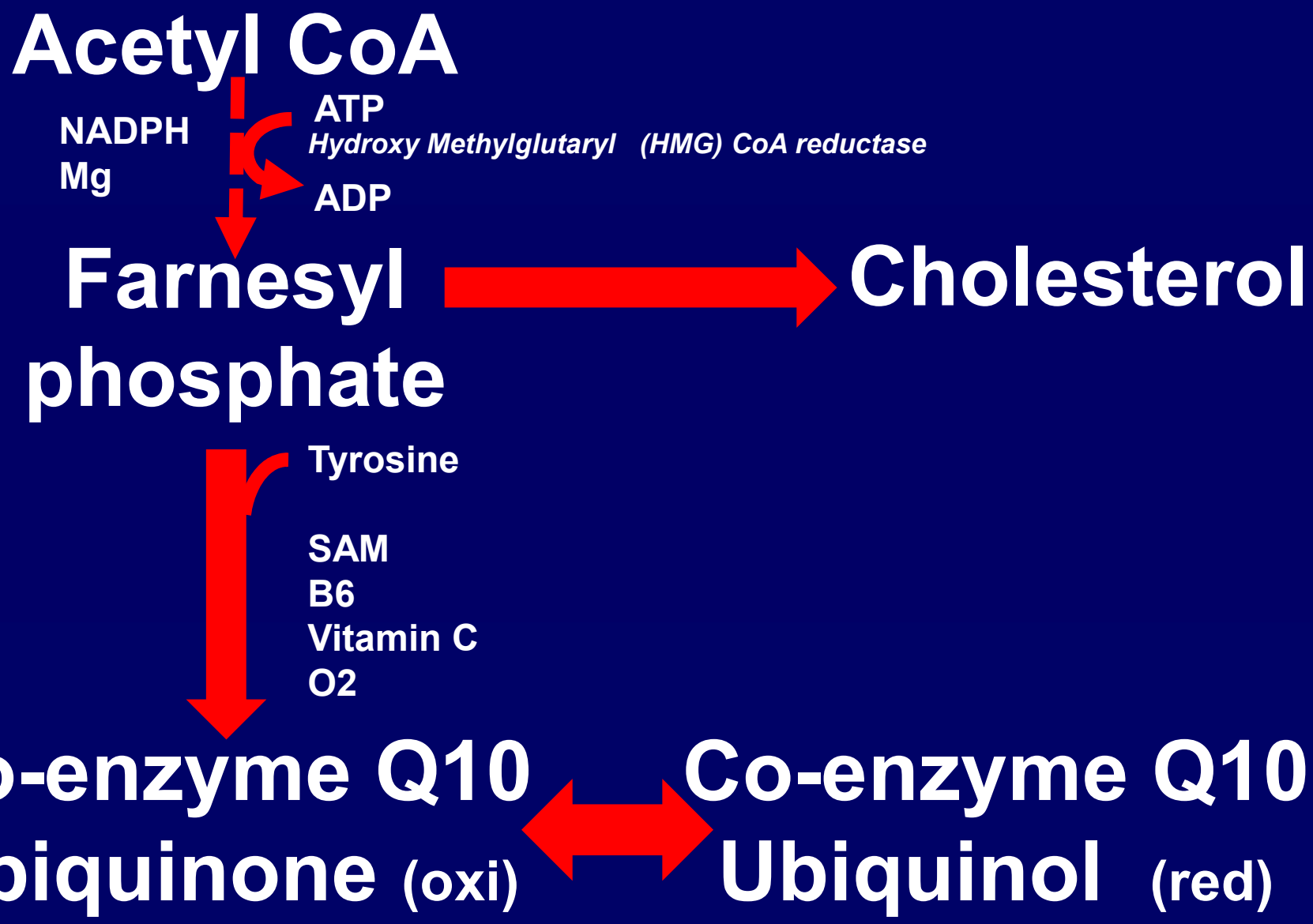
FDA Daily Value (RDA)

None known

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

Co-Enzyme Q10
Ubiquinone - Ubiquinol

Co-enzyme Q10



Co-enzyme Q10 is a fat-soluble substance, is present in most eukaryotic cells, primarily in the mitochondria. It is a component of the electron transport chain and participates in aerobic cellular respiration, which generates energy in the form of ATP.*

* Ernster, L.; Dallner, G. (1995). "Biochemical, physiological and medical aspects of ubiquinone function". *Biochimica et Biophysica Acta*. 1271 (1): 195–204

Ninety-five percent of the human body's energy is generated this way.* Therefore, those organs with the highest energy requirements—such as the heart, liver, and kidney—have the highest CoQ_{10} concentrations.

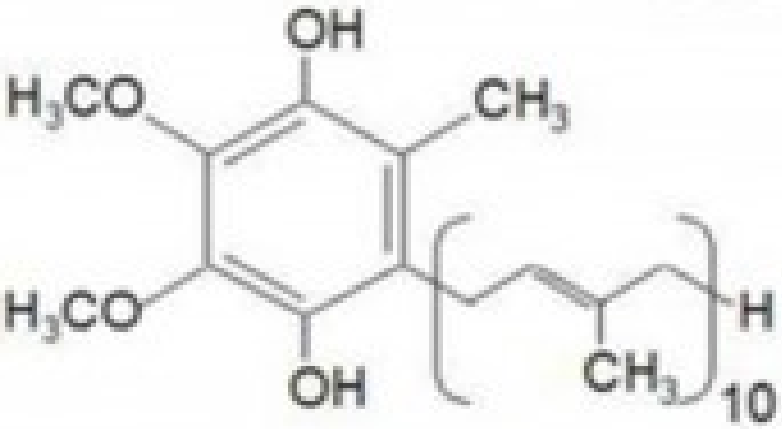
* Okamoto, T.; Matsuya, T.; Fukunaga, Y.; Kishi, T.; Yamagami, T. (1989). "Human serum ubiquinol-10 levels and relationship to serum lipids". *International Journal for Vitamin and Nutrition Research*. 59(3): 288–292.

There are three redox states of CoQ_{10}: fully oxidized (ubiquinone), semiquinone (ubisemiquinone), and fully reduced (ubiquinol).
The capacity of this molecule to act as a two-electron carrier (moving between the quinone and quinol form) and-

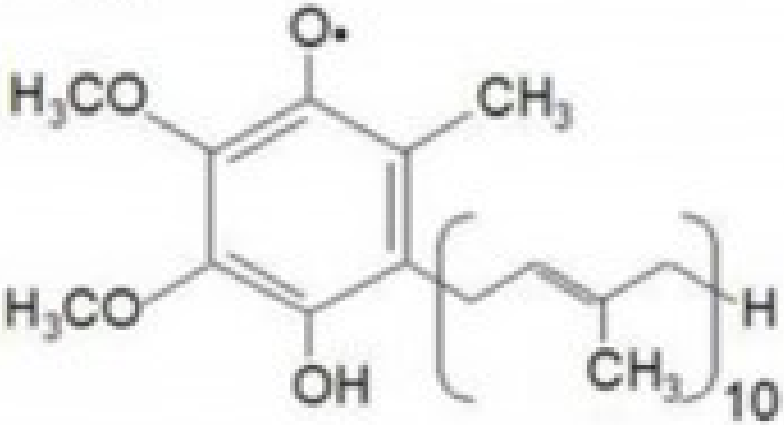
a one-electron carrier (moving between the semiquinone and one of these other forms) is central to its role in the electron transport chain due to the iron–sulfur clusters that can only accept one electron at a time, and as a free radical-scavenging antioxidant.*

** Aberg, F.; Appelkvist, E. L.; Dallner, G.; Ernster, L. (1992). "Distribution and redox state of ubiquinones in rat and human tissues". Archives of Biochemistry and Biophysics. 295 (2): 230–234.*

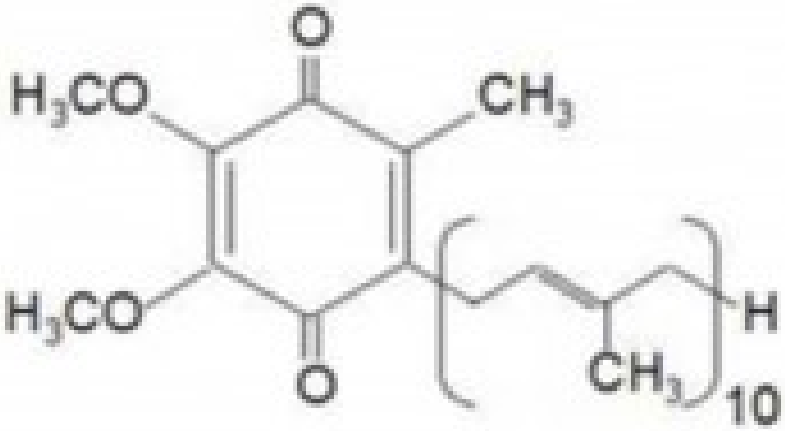
Coenzyme Q_{10}



Ubiquinol ($CoQH_2$)



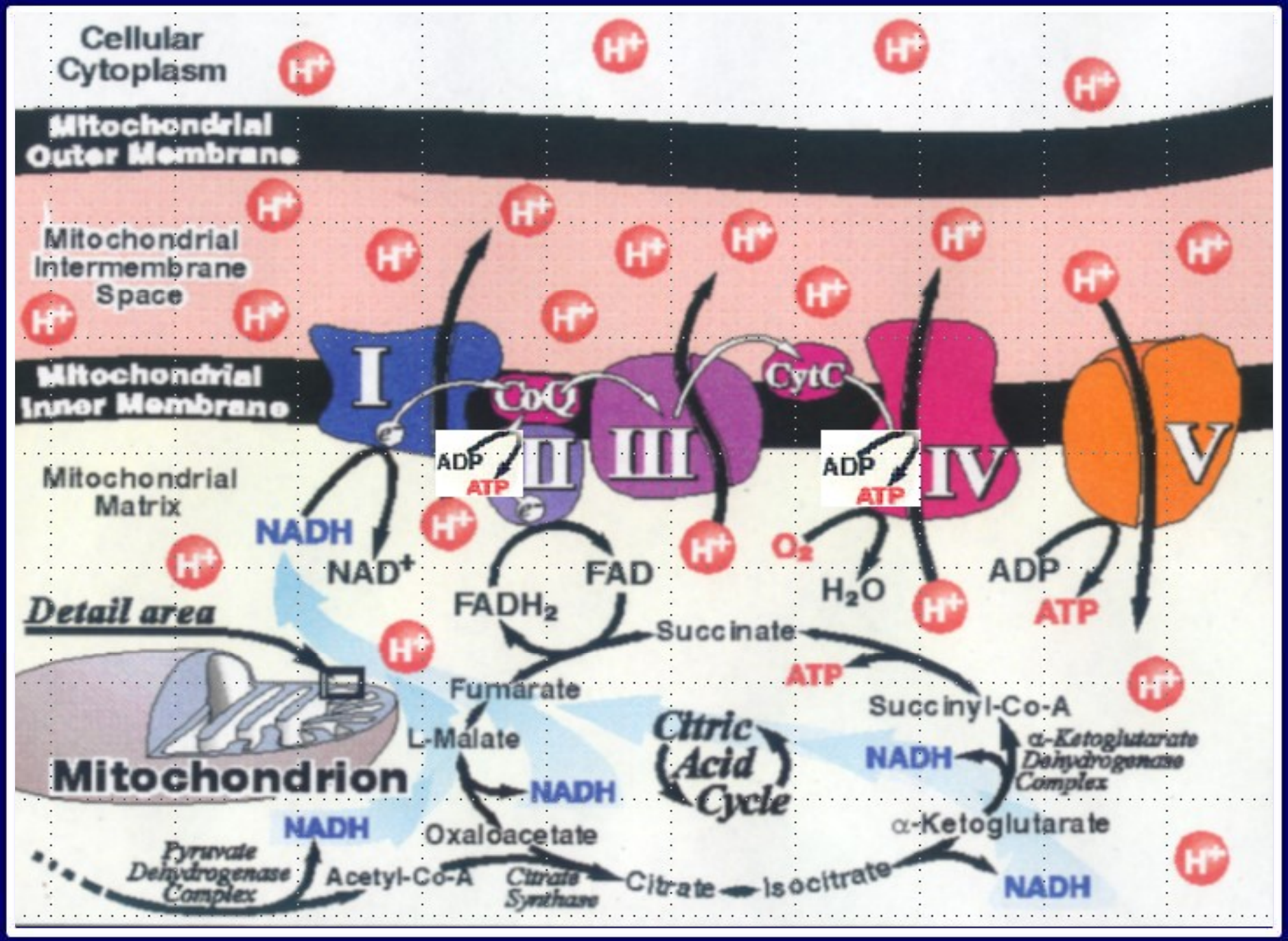
Semiquinone radical (CoQH·)



Ubiquinone (CoQ)

Functions of CoQ10

- Mitochondrial energy coupling
- Antioxidant
- Generation of intracellular signals
- Control of membrane structure and phospholipid composition


Cellular Cytoplasm
Mitochondrial Outer Membrane
Mitochondrial Intermembrane Space
Mitochondrial Inner Membrane
Mitochondrial Matrix
H+
I
II
III
IV
V
CoQ
CytC
ADP
ATP
NADH
NAD+
FAD
FADH2
O2
H2O
Detail area
Mitochondrion
Succinate
Fumarate
L-Malate
Oxaloacetate
Citric Acid Cycle
Succinyl-Co-A
α-Ketoglutarate Dehydrogenase Complex
α-Ketoglutarate
Pyruvate Dehydrogenase Complex
Acetyl-Co-A
Citrate Synthase
Citrate
Isocitrate

CoQ deficiency in humans

Basis	Tissue	% decrease
Age	Myocardium	72
Age	Heart	58
Age	Pancreas	83
Age	Adrenal	50
Age	Kidney	45
Age	Epidermis	75
Age	Liver	17
Statins	Serum	20-30
Diabetes	Serum	65

Food Sources of CoQ10

There are foods with CoQ10 that you can eat if you want to increase your body's levels. It's said that if you consume a balanced diet, you're likely to get enough CoQ10. Notable examples include:[6,7]

- Fish like wild-caught Alaskan salmon and herring
- Grass fed beef and organ meats
- Organic pastured meats
- Sesame seeds
- Broccoli

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CoQ10's Potential Capabilities for Your Health

Lately, research has highlighted the impact of eating chlorophyll-rich vegetables and sun exposure in improving the body's conversion of CoQ10 to ubiquinol. Chlorophyll that's consumed is transported to the blood, and once the skin is exposed to significant amounts of sunlight, chlorophyll absorbs solar radiation and promotes CoQ10 conversion into ubiquinol. You can increase your chlorophyll intake by eating these vegetables:[8]

Spinach	Asparagus	Beet greens
Green bell peppers	Bok choy	Brussels sprouts
Green cabbage	Celery	Collard greens
Cucumber	Green beans	Green peas
Kale	Leeks	Mustard greens
Green sea vegetables	Swiss chard	Turnip greens

Fruits like green grapes or kiwis (provided that these are eaten in moderation), as well as parsley and pistachio nuts, are other chlorophyll-rich foods to consider.

Coenzyme Q_{10} has potential to inhibit the effects of warfarin* (Coumadin), a potent anticoagulant, by reducing the INR, a measure of blood clotting.

** Wyman, M.; Leonard, M.; Morledge, T. (Jul 2010). "Coenzyme Q_{10}: a therapy for hypertension and statin-induced myalgia?". Cleveland Clinic Journal of Medicine. 77 (7): 435–442.*

The structure of coenzyme Q_{10} is very much similar to the structure of Vitamin K, which competes with and counteracts warfarin's anticoagulation effects. Coenzyme Q_{10} should be avoided in patients currently taking warfarin due to the increased risk of clotting.*

** Wyman, M.; Leonard, M.; Morledge, T. (Jul 2010). "Coenzyme Q_{10}: a therapy for hypertension and statin-induced myalgia?". Cleveland Clinic Journal of Medicine. 77 (7): 435–442.*

Sperm use CoQ10 as their source of energy via the mitochondria in their tails. When their tails drop of they can no longer swim. Important in sub-fertile couples.

Sources*

Beef heart, liver and muscle, Pork heart liver and muscle, sardines, Red fish, Soy bean, Olive, Grape seed and Rapeseed oils

*Pravst, Igor; Žmitek, Katja; Žmitek, Janko (2010). "Coenzyme Q_{10} Contents in Foods and Fortification Strategies". *Critical Reviews in Food Science and Nutrition*. 50 (4): 269–280. doi:10.1080/10408390902773037. PMID 20301015

FDA Daily Value (RDA)

None known*

Up to 3500mg considered to be safe. **

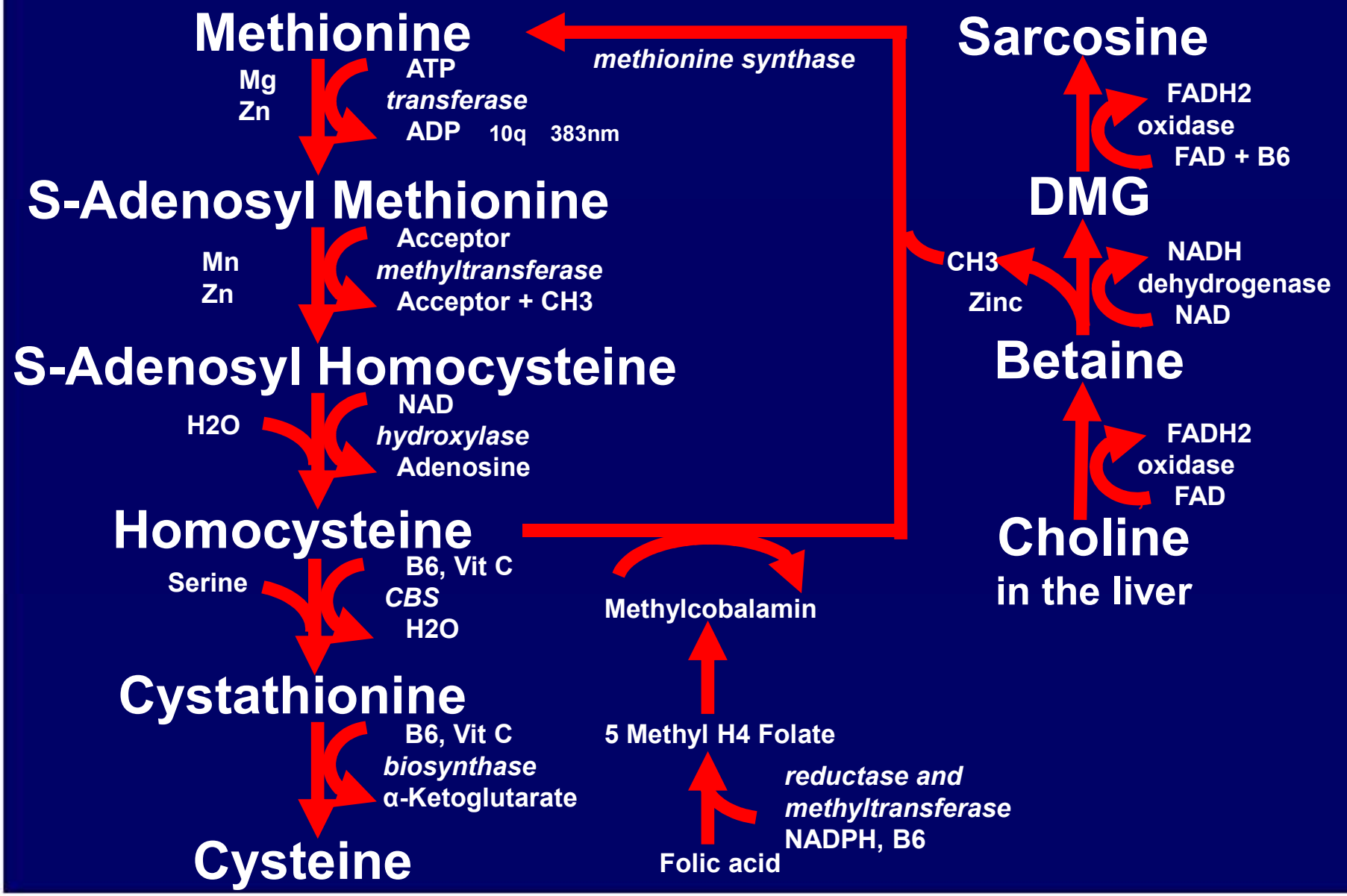
Clinically best taken last thing at night as acid inhibits absorption.

*** Hyson, H. C.; Kieburtz, K.; Shoulson, I.; et al. (Sep 2010). "Safety and tolerability of high-dosage coenzyme Q_{10} in Huntington's disease and healthy subjects". Movement Disorders. 25 (12): 1924–1928.*

*https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf

S. Adenosyl Methionine (SAMe)

S Adenosylmethionine (SAM)



SAMe is a common co-substrate involved in methyl group transfers, trans-sulfuration, and aminopropylation. Although these anabolic reactions occur throughout the body, most SAM-e is produced and consumed in the liver.*

*Cantoni, GL (1952). "The Nature of the Active Methyl Donor Formed Enzymatically from L-Methionine and Adenosinetriphosphate". *J Am Chem Soc*. 74 (11): 2942–3.

More than **40 methyl transfers** from SAM-e are known, to various substrates such as nucleic acids, proteins, lipids and second ary metabolites. It is made from adenosine triphosphate (ATP) and methionine by methionine adenosyltransferase.* (Chromosome 10q 383nm)

*Cantoni, GL (1952). "The Nature of the Active Methyl Donor Formed Enzymatically from L-Methionine and Adenosinetriphosphate". *J Am Chem Soc*. 74 (11): 2942–3.

Sources

Synthesized in the body from methionine, which is present in all protein rich foods.

http://www.nutrientsreview.com/proteins/amino-acids/derivatives/s-adenosylmethionine-same.html

FDA Daily Value (RDA)

None known

https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/factsheets/Vitamin_and_Mineral_Chart.pdf