

Avitaminoses, trace elements, lack of nutrients

# Disorders of nutrients in dental medicine

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2025/2026



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Title page  
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<https://www.naperville.dental/wp-content/uploads/2021/07/dental-fluorosis.png>

[https://www.peoplespharmacy.com/\\_next/image?url=https%3A%2F%2Fnyc3.digitaloceanspaces.com%2Fpeoplespharmacy%2FWoman-suffer-canker-sore.jpg&w=3840&q=60](https://www.peoplespharmacy.com/_next/image?url=https%3A%2F%2Fnyc3.digitaloceanspaces.com%2Fpeoplespharmacy%2FWoman-suffer-canker-sore.jpg&w=3840&q=60)

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# Food and energy intake

| Rank ↕ | Country ↕                                                                                       | Average daily dietary energy consumption per capita (2006-08) <sup>[4]</sup> |              |
|--------|-------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|--------------|
|        |                                                                                                 | kilocalories ↕                                                               | kilojoules ↕ |
| 1      |  United States | 3,800                                                                        | 15,900       |
| 2      |  Austria       | 3,750                                                                        | 15,690       |
| 3      |  Greece        | 3,710                                                                        | 15,520       |
| 4      |  Belgium       | 3,690                                                                        | 15,440       |
| 5      |  Luxembourg    | 3,680                                                                        | 15,400       |
| 6      |  Italy         | 3,650                                                                        | 15,270       |
| 7      |  Malta         | 3,600                                                                        | 15,060       |
| 8      |  Ireland       | 3,590                                                                        | 15,020       |
| 9      |  Portugal      | 3,580                                                                        | 14,980       |
| 10     |  Germany       | 3,540                                                                        | 14,810       |
| 11     |  Canada        | 3,530                                                                        | 14,770       |
| 12     |  France      | 3,530                                                                        | 14,770       |
| 13     |  Israel      | 3,530                                                                        | 14,770       |
| 14     |  Kazakhstan  | 3,510                                                                        | 14,690       |
| 15     |  Turkey      | 3,500                                                                        | 14,640       |
| 16     |  Romania     | 3,490                                                                        | 14,600       |
| 17     |  Hungary     | 3,470                                                                        | 14,520       |
| 18     |  Norway      | 3,450                                                                        | 14,430       |
| 19     |  Switzerland | 3,450                                                                        | 14,430       |

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ake](https://en.wikipedia.org/wiki/List_of_countries_by_food_energy_intake)

# Food and energy intake

- recommended average minimum energy intake is 1800 kcal (7500 kJ)
  - recommendation for USA is 2000-2800 kcal for both genders of age 31-35
  - recommendation for children 1000-2000 kcal
  - adolescents 1400-3200
    - for boys higher level
  - differs according daily activity
  - $1 \text{ kcal} = 4184 \text{ J}$
  - Slovakia No 69 with 2900 kcal
- energy intake



A 710-millilitre (24 US fl oz) energy drink with 1,400 kJ (330 kcal), more than a fast-food cheeseburger, and the equivalent of 18 single-serving packets of sugar

# Food and energy intake

- Intake of macronutrients per day
- total fat 15-30%
  - saturated less than 10%
  - polyunsaturated 6-10%
- total carbohydrates 55-75%
  - free sugars less than 10%
- proteins 10-15%
- dietary fiber 27-40 g
- fruits and vegetable more than 400 g



Bryndzové halušky (potato dumplings with sheep's-milk cheese) is a traditional food of shepherds in Slovakia.

<https://en.wikipedia.org/wiki/Food>

# Food and energy intake

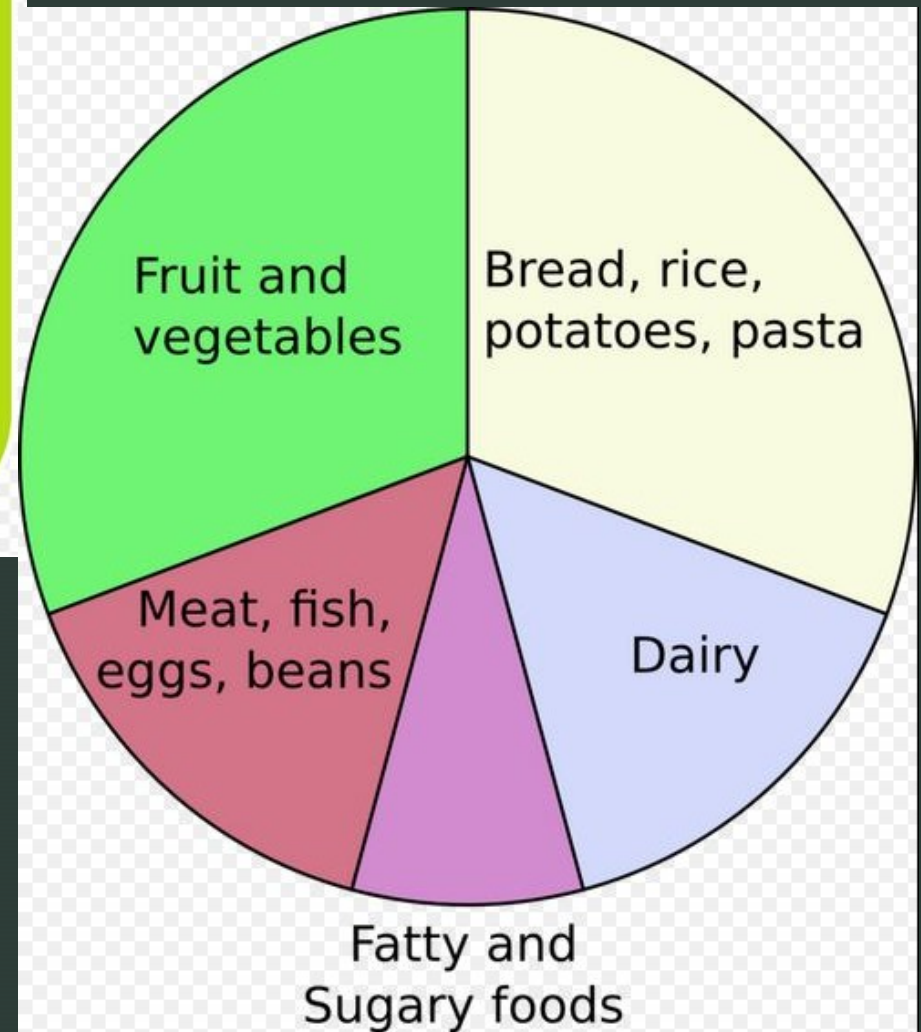


- **Micronutrients**
  - A, C, D, E, beta-carotene
  - minerals
- **Alcohol**
- limit of daily intake max. 30 g = 300 ml of wine
- **Preparation of food**
- **Intake frequency**
- **Culture of dinning**



[https://en.wikipedia.org/wiki/List\\_of\\_nutrition\\_guides](https://en.wikipedia.org/wiki/List_of_nutrition_guides)

## My plate



| Nutrients             | Deficiency                                     | Excess                                                      |
|-----------------------|------------------------------------------------|-------------------------------------------------------------|
| <b>Macronutrients</b> |                                                |                                                             |
| Calories              | Starvation, marasmus                           | Obesity, diabetes mellitus, cardiovascular disease          |
| Simple carbohydrates  | None                                           | Obesity, diabetes mellitus, cardiovascular disease          |
| Complex carbohydrates | None                                           | Obesity, cardiovascular disease (high glycemic index foods) |
| Protein               | Kwashiorkor                                    | <u>Rabbit starvation</u>                                    |
| Saturated fat         | Low testosterone levels, vitamin deficiencies. | Obesity, cardiovascular disease                             |
| Trans fat             | None                                           | Obesity, cardiovascular disease                             |
| Unsaturated fat       | Fat-soluble vitamin deficiency                 | Obesity, cardiovascular disease                             |



| Micronutrients          |                                   |                                                                                     |
|-------------------------|-----------------------------------|-------------------------------------------------------------------------------------|
| Vitamin A               | Xerophthalmia and night blindness | Hypervitaminosis A (cirrhosis, hair loss)                                           |
| Vitamin B <sub>1</sub>  | Beri-Beri                         | ?                                                                                   |
| Vitamin B <sub>2</sub>  | Skin and corneal lesions          | ?                                                                                   |
| Niacin                  | Pellagra                          | Dyspepsia, cardiac arrhythmias, birth defects                                       |
| Biotin                  | Biotin deficiency                 | Reproductive and teratogenic effects                                                |
| Vitamin B <sub>12</sub> | Pernicious anemia                 | ?                                                                                   |
| Vitamin C               | Scurvy                            | Diarrhea causing dehydration                                                        |
| Vitamin D               | Rickets, Hypovitaminosis D        | Hypervitaminosis D (dehydration, vomiting, constipation)                            |
| Vitamin E               | Neurological disease              | Hypervitaminosis E (anticoagulant: excessive bleeding)                              |
| Vitamin K               | Hemorrhage                        | Liver damage                                                                        |
| Omega-3 fats            | Cardiovascular Disease            | Bleeding, Hemorrhages, Hemorrhagic stroke, reduced glycemic control among diabetics |
| Omega-6 fats            | None                              | Cardiovascular Disease, Cancer                                                      |
| Cholesterol             | None                              | Cardiovascular Disease                                                              |

| Macrominerals  |                                                                           |                                                                                                                  |
|----------------|---------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| Calcium        | Osteoporosis, tetany, carpopedal spasm, laryngospasm, cardiac arrhythmias | Fatigue, depression, confusion, nausea, vomiting, constipation, pancreatitis, increased urination, kidney stones |
| Magnesium      | Hypertension                                                              | Weakness, nausea, vomiting, impaired breathing, and hypotension                                                  |
| Potassium      | Hypokalemia, cardiac arrhythmias                                          | Hyperkalemia, palpitations                                                                                       |
| Sodium         | Hyponatremia                                                              | Hypernatremia, hypertension                                                                                      |
| Trace minerals |                                                                           |                                                                                                                  |
| Iron           | Anemia                                                                    | Cirrhosis, Hereditary hemochromatosis, heart disease                                                             |
| Iodine         | Goiter, hypothyroidism                                                    | Iodine toxicity (goiter, hypothyroidism)                                                                         |



## Vitamin deficiency and overdose

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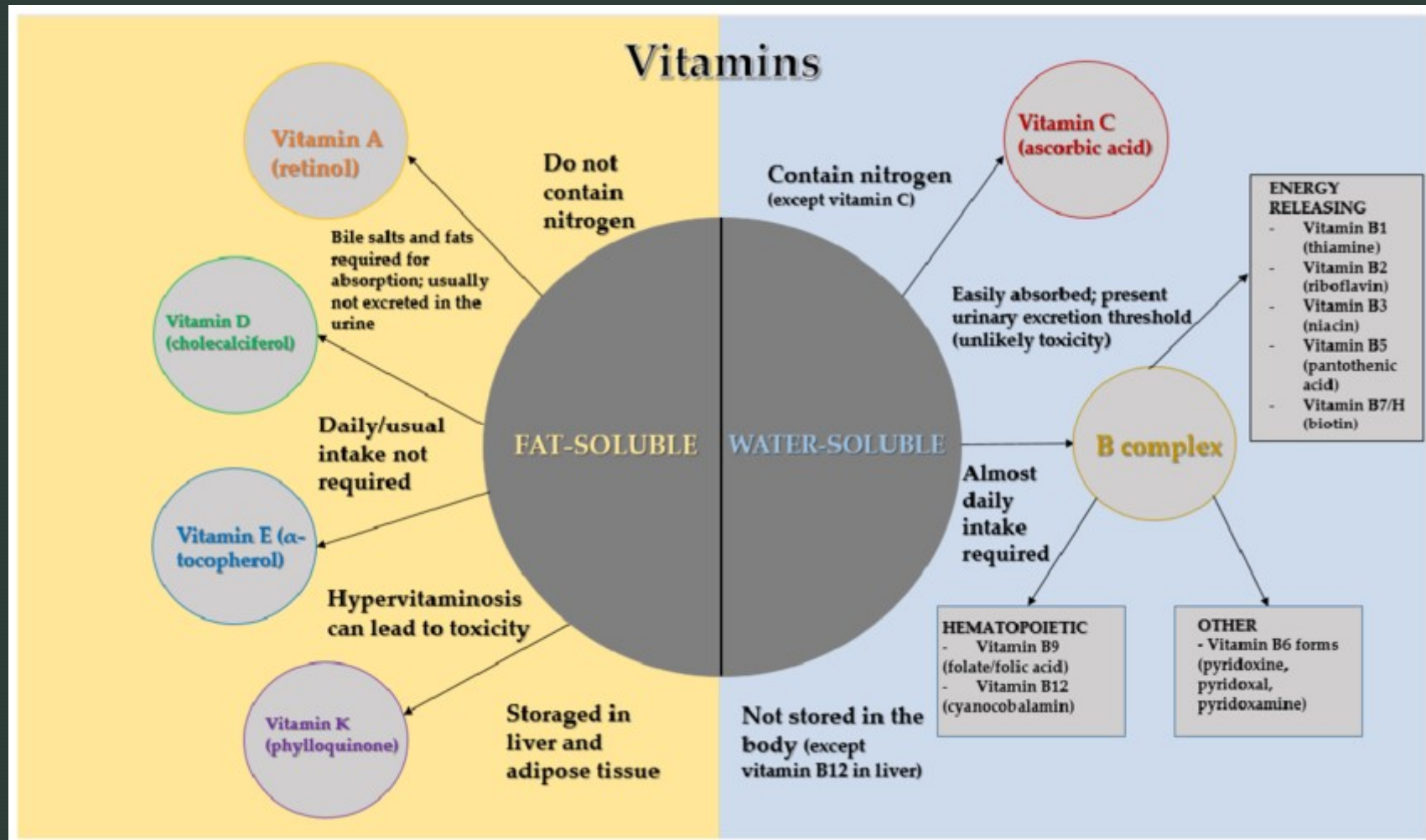
# VITAMINS

| VITAMIN                 | WHAT WE USE IT FOR                                                            | GOOD SOURCES                                                     |
|-------------------------|-------------------------------------------------------------------------------|------------------------------------------------------------------|
| <b>A</b>                | For healthy vision, skin, bones, teeth & reproduction                         | Liver, Eggs, Fish, Milk, Carrots, Sweet Potato, Pumpkin, Spinach |
| <b>B1</b><br>THIAMIN    | Helps convert food into energy and is critical for nerve function             | Pork, Soy, Watermelon, Tomato, Spinach                           |
| <b>B2</b><br>RIBOFLAVIN | Helps convert food into energy and supports healthy skin, hair, blood & brain | Dairy, Meat, Green Leafy Veggies, Enriched Wheat, Oysters        |
| <b>B3</b><br>NIACIN     | Helps convert food into energy and is essential for healthy nervous system    | Beef, Chicken, Shrimp, Avocado, Peanuts, Tomato, Spinach         |
| <b>B6</b><br>PYRIDOXINE | Helps make red blood cells and improves sleep, appetite & mood                | Chicken, Tofu, Banana, Watermelon, Fish, Legumes                 |
| <b>B7</b><br>BIOTIN     | Helps convert food to energy & break down glucose                             | Whole Grains, Eggs, Almonds, Soybeans, Fish                      |
| <b>B9</b><br>FOLATE     | Vital for new cell creation and DNA synthesis                                 | Legumes, Spinach, Leafy Greens, Chickpeas, Tomato, Asparagus     |
| <b>B12</b>              | Breaks down fatty acids & amino acids, helps make red blood cells             | Dairy, Beef, Pork, Poultry, Fish, Eggs                           |
| <b>C</b>                | Acts as an antioxidant, helps make new cells, & improves immune system        | Fruit & Fruit Juices, Pepper, Broccoli, Tomato, Spinach          |
| <b>D</b>                | Strengthens and helps form bones & teeth via calcium & phosphorus             | Egg Yolk, Fatty Fish, Liver, Sunlight                            |
| <b>E</b>                | Acts as an antioxidant, helps stabilize cell membranes                        | Nuts, Avocado, Tofu, Whole Grains, Seeds                         |
| <b>K</b>                | Essential for blood clotting and helping to regulate blood calcium            | Broccoli, Brussels Sprouts, Liver, Leafy Greens                  |

# Vitamins

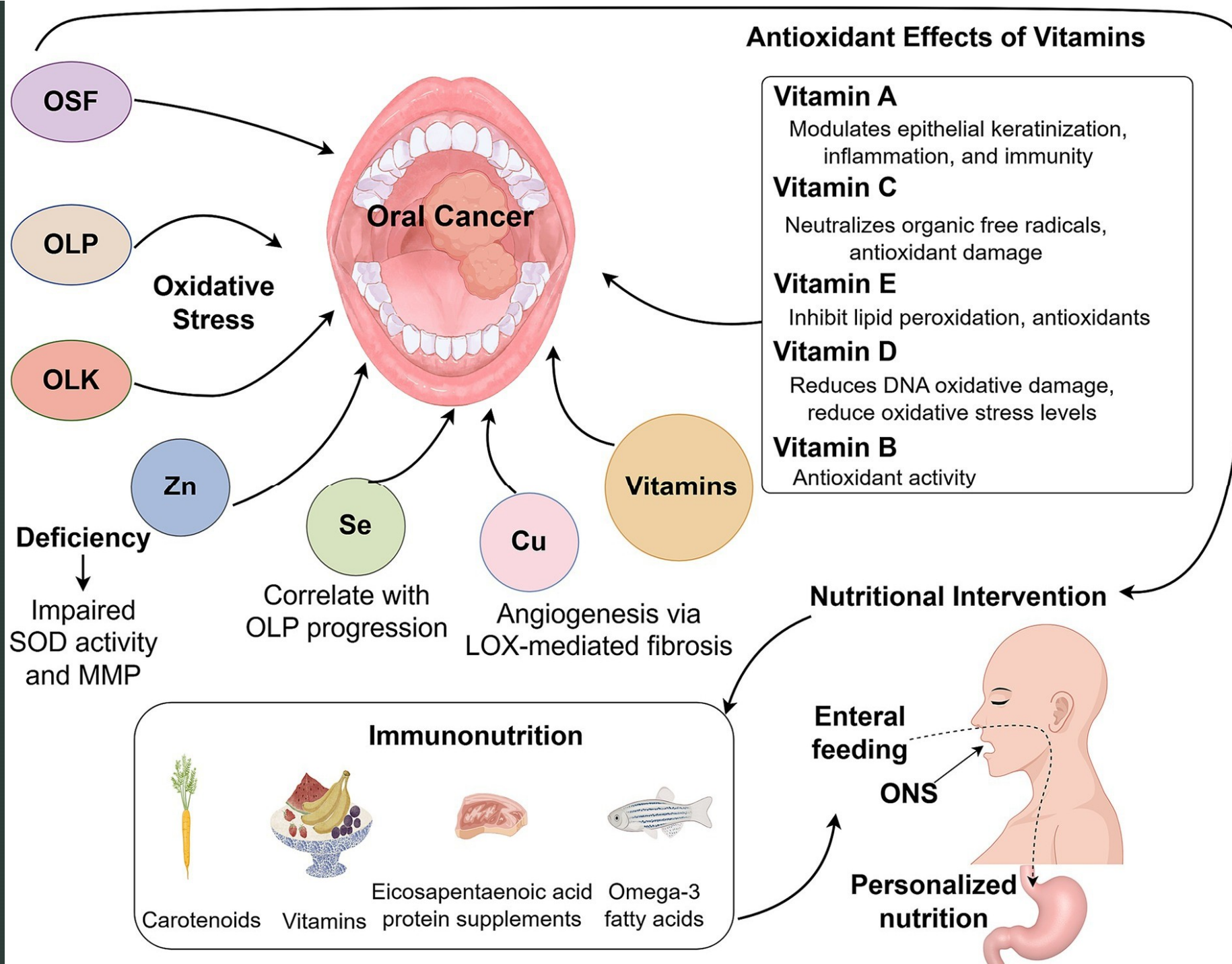
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| VITAMIN                                                           | WHAT IT DOES                                                                                                                                                                                                                | WHERE IS IT FOUND                                                                                                                                                                                                                                                                                                                    | DAILY VALUE* |
|-------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Vitamin A</b>                                                  | <ul style="list-style-type: none"> <li>• Growth and development</li> <li>• Immune function</li> <li>• Reproduction</li> <li>• Red blood cell formation</li> <li>• Skin and bone formation</li> <li>• Vision</li> </ul>      | <ul style="list-style-type: none"> <li>• Cantaloupe</li> <li>• Carrots</li> <li>• Dairy products</li> <li>• Eggs</li> <li>• Fortified cereals</li> <li>• Green leafy vegetables (e.g., spinach and broccoli)</li> <li>• Pumpkin</li> <li>• Red peppers</li> <li>• Sweet potatoes</li> </ul>                                          | 5,000 IU     |
| <b>Vitamin B<sub>6</sub></b>                                      | <ul style="list-style-type: none"> <li>• Immune function</li> <li>• Nervous system function</li> <li>• Protein, carbohydrate, and fat metabolism</li> <li>• Red blood cell formation</li> </ul>                             | <ul style="list-style-type: none"> <li>• Chickpeas</li> <li>• Fruits (other than citrus)</li> <li>• Potatoes</li> <li>• Salmon</li> <li>• Tuna</li> </ul>                                                                                                                                                                            | 2 mg         |
| <b>Vitamin B<sub>12</sub></b>                                     | <ul style="list-style-type: none"> <li>• Conversion of food into energy</li> <li>• Nervous system function</li> <li>• Red blood cell formation</li> </ul>                                                                   | <ul style="list-style-type: none"> <li>• Dairy products</li> <li>• Eggs</li> <li>• Fortified cereals</li> <li>• Meats</li> <li>• Poultry</li> <li>• Seafood (e.g., clams, trout, salmon, haddock, tuna)</li> </ul>                                                                                                                   | 6 mcg        |
| <b>Vitamin C</b>                                                  | <ul style="list-style-type: none"> <li>• Antioxidant</li> <li>• Collagen and connective tissue formation</li> <li>• Immune function</li> <li>• Wound healing</li> </ul>                                                     | <ul style="list-style-type: none"> <li>• Broccoli</li> <li>• Brussels sprouts</li> <li>• Cantaloupe</li> <li>• Citrus fruits and juices (e.g., oranges and grapefruit)</li> <li>• Kiwifruit</li> <li>• Peppers</li> <li>• Strawberries</li> <li>• Tomatoes and tomato juice</li> </ul>                                               | 60 mg        |
| <b>Vitamin D</b><br><i>Nutrient of concern for most Americans</i> | <ul style="list-style-type: none"> <li>• Blood pressure regulation</li> <li>• Bone growth</li> <li>• Calcium balance</li> <li>• Hormone production</li> <li>• Immune function</li> <li>• Nervous system function</li> </ul> | <ul style="list-style-type: none"> <li>• Eggs</li> <li>• Fish (e.g., herring, mackerel, salmon, trout, and tuna)</li> <li>• Fish liver oil</li> <li>• Fortified cereals</li> <li>• Fortified dairy products</li> <li>• Fortified margarine</li> <li>• Fortified orange juice</li> <li>• Fortified soy beverages (soymilk)</li> </ul> | 400 IU       |
| <b>Vitamin E</b>                                                  | <ul style="list-style-type: none"> <li>• Antioxidant</li> <li>• Formation of blood vessels</li> <li>• Immune function</li> </ul>                                                                                            | <ul style="list-style-type: none"> <li>• Fortified cereals and juices</li> <li>• Green vegetables (e.g., spinach and broccoli)</li> <li>• Nuts and seeds</li> <li>• Peanuts and peanut butter</li> <li>• Vegetable oils</li> </ul>                                                                                                   | 30 IU        |
| <b>Vitamin K</b>                                                  | <ul style="list-style-type: none"> <li>• Blood clotting</li> <li>• Strong bones</li> </ul>                                                                                                                                  | <ul style="list-style-type: none"> <li>• Green vegetables (e.g., broccoli, kale, spinach, turnip greens, collards, Swiss chard, mustard greens)</li> </ul>                                                                                                                                                                           | 80 mcg       |

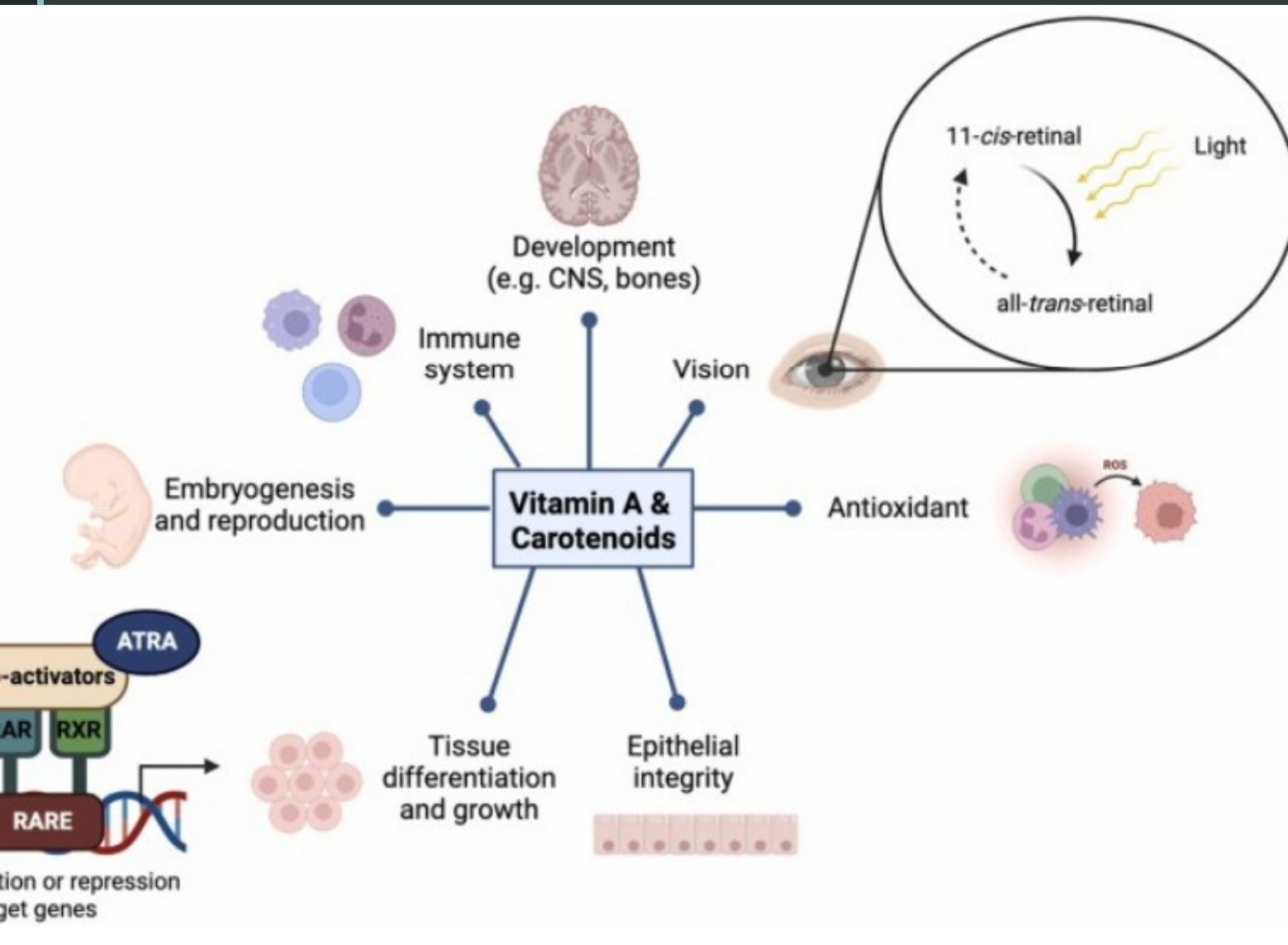


# General characteristics of selected vitamin deficiencies

| Deficiency                | Systemic effects                                                  | Oral effects                                       |
|---------------------------|-------------------------------------------------------------------|----------------------------------------------------|
| Vitamin A                 | Night-blindness, xerophthalmia                                    | Unconformed contribution to leukoplakia and cancer |
| Thiamin (B1)              | Neuritis, cardiac failure                                         | None                                               |
| Riboflavin (B2)           | Dermatitis                                                        | Angular <b>stomatitis</b> and <b>glossitis</b>     |
| Nicotinamide (Niacin, B3) | Dermatitis, CNS disease (dementia), diarrhea                      | <b>Glossitis, gingivitis, stomatitis</b>           |
| Cyanocobalamin (B12)      | Pernicious anemia, Wernicke-Korsakoff syndrome                    | <b>Glossitis, aphtae</b>                           |
| Folic acid (B9)           | Macrocytic anemia                                                 | <b>Glossitis, aphtae</b>                           |
| Ascorbic acid (C)         | Scurvy (purpura, delayed wound healing, bone lesions in children) | <b>Gingival swelling and bleeding</b>              |
| Vitamin D                 | Ricketts                                                          | Hypocalcification of teeth (severe rickets only)   |



# Vitamin A deficiency



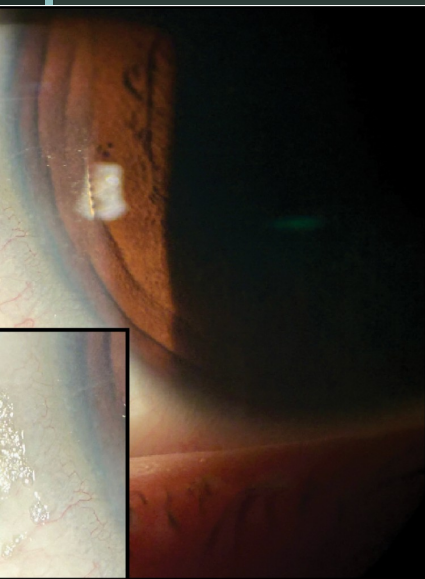
[Structural, functional, nutritional and clinical aspects of vitamin A: A review - ScienceDirect](#)



Follicular  
Hyperkeratosis

# Vitamin A deficiency

- Fat soluble vitamin
- Deficiency -> ↑children and maternal mortality
  - Increased needs during growth period
  - Typical in infants and pre-school aged children; fats malabsorption
- Incidence – 1-2.5 millions/year
- Systemic manifestations
  - Night blindness, xerophthalmia, keratomalacia, Bitot spots, follicular hyperkeratosis, prone to infections, nail fragility



Bitot Spots

# Oral manifestation of vitamin A deficiency

- Pathomechanism
  - Columnar epithelium -> squamous and keratinised in rats (no evidence in humans)
- Manifestation
  - Epithelium -> keratotic changes, hyperkeratinisation
  - Dentin, enamel -> enamel hypoplasia (even amelogenesis imperfecta), ↑caries, periodontitis
  - Prone to fungal infections
  - ? Prone to cancer

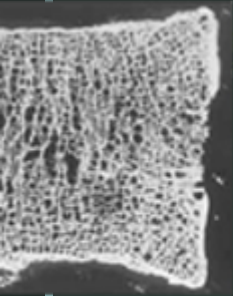


Marked hyperkeratosis – the lesion cannot be scraped off

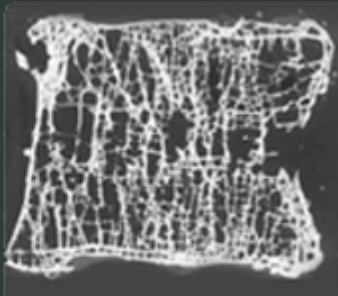
# Vitamin D deficiency

- Two forms – ergocalciferol (D2) and cholecalciferol (D3)
  - D3 formed by UV (skin exposure) -> liver -> kidney
- Effects
  - $Ca^{2+}$  and  $PO_4^{3-}$  regulation (blood, bones)
    - Intestinal  $Ca^{2+}$  absorption, bones remodelling
  - Immunotolerance -> dendritic cells ->  $\uparrow T_{reg}$  cells
  - Tumour-suppressor, anti-inflammatory

# Oral manifestation of vitamin D deficiency



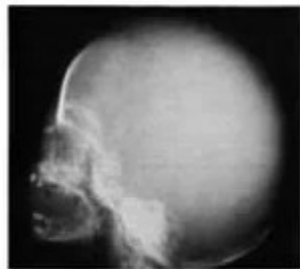
Normal Bone



Osteoporotic Bone

[Vitamin D deficiency - Wikipedia](#)

## CRANIOTABES



Rickets: a bone softening disease  
radiologic signs |  
PPTX

• Rachitic Rosary:



\*some sources link vitamins A and D as an acquired forms of amelogenesis imperfecta, this is controversial highly

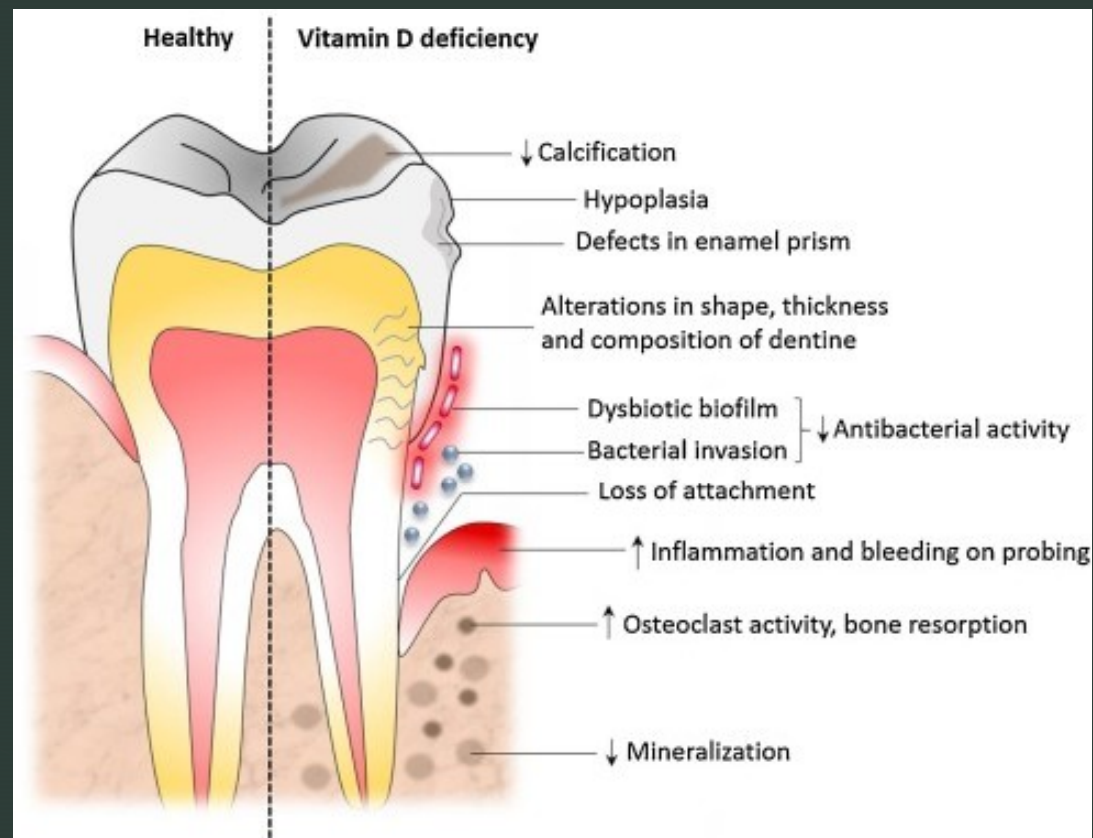


# Oral manifestation of vitamin D deficiency

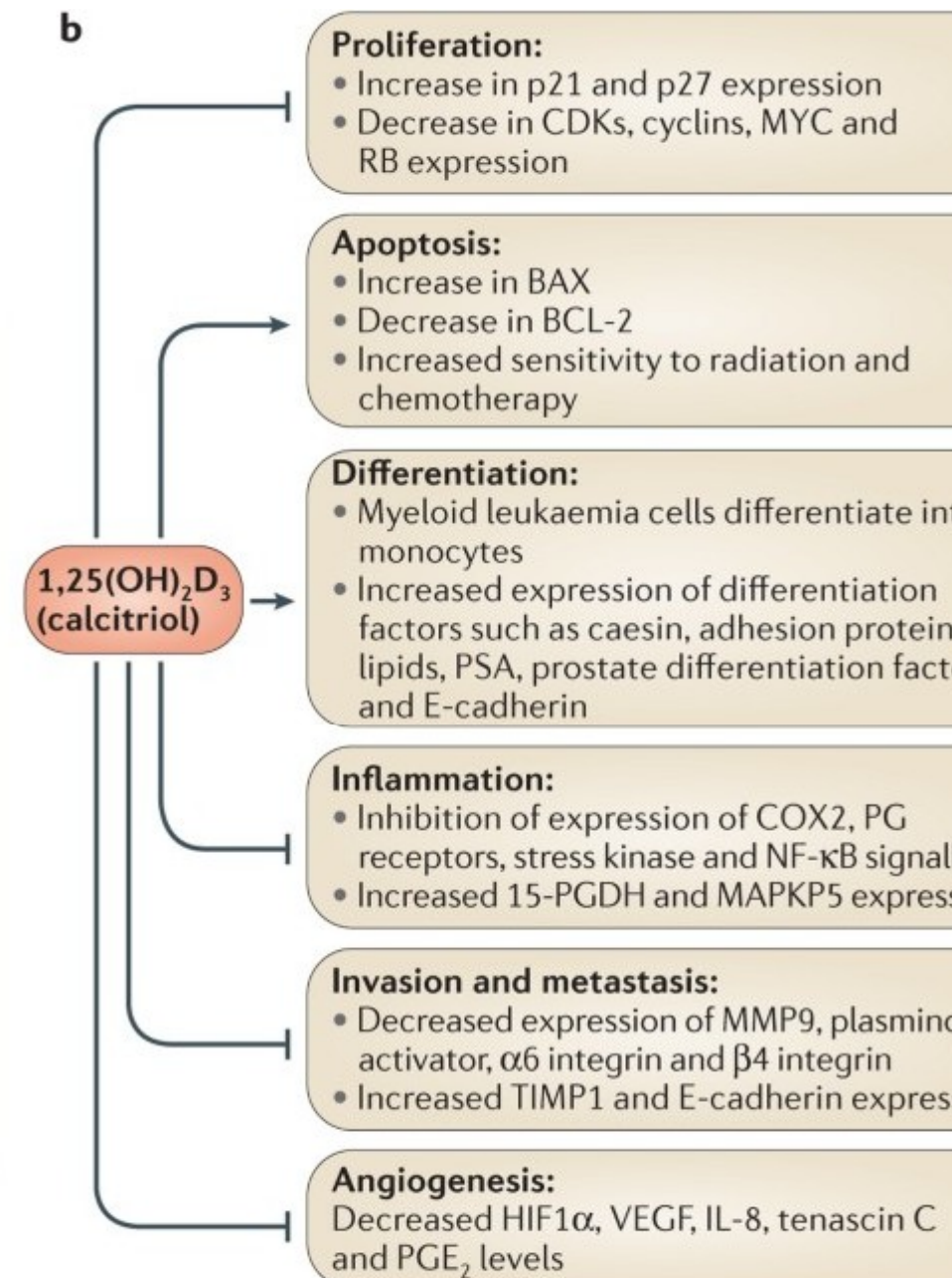
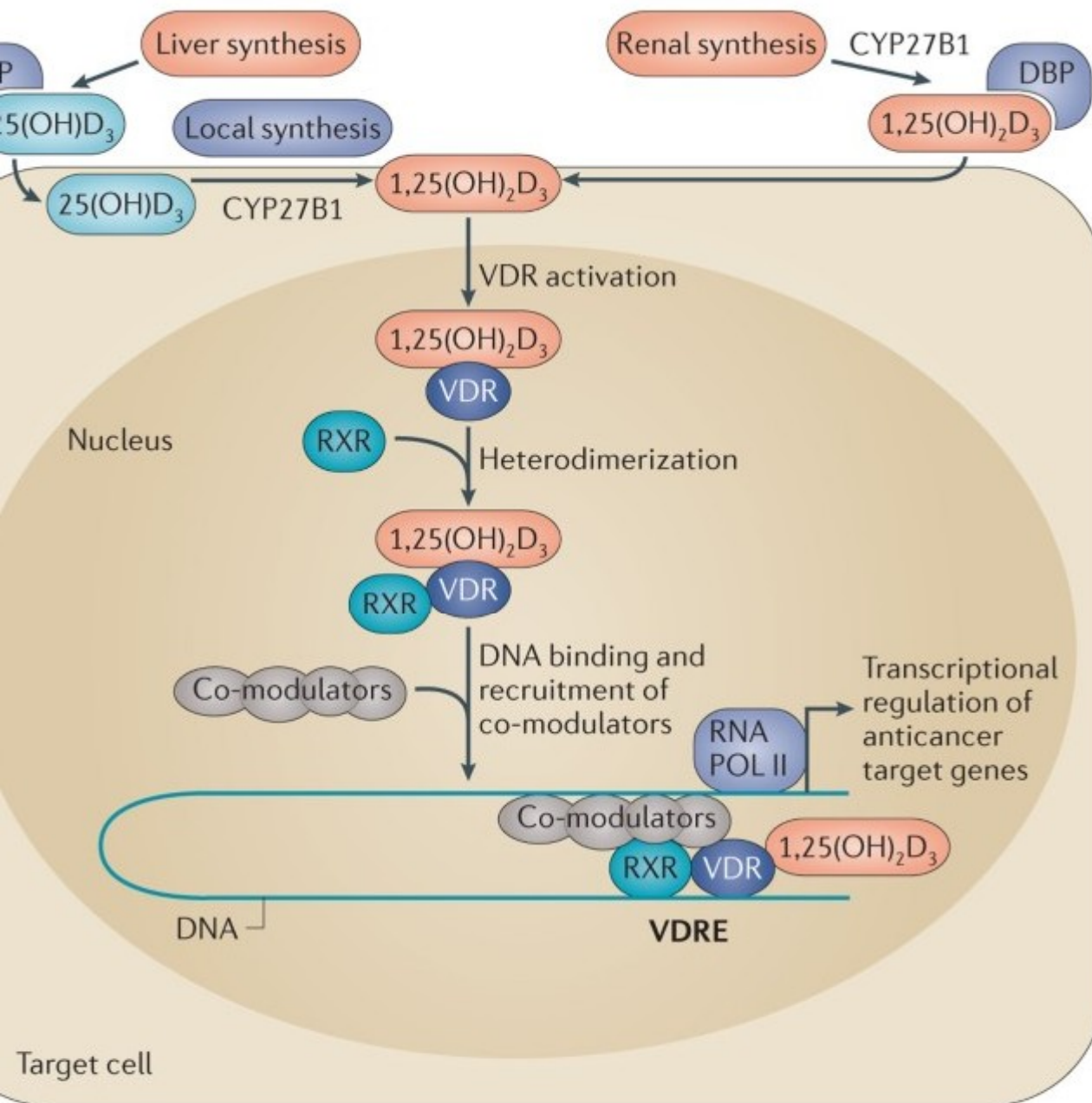
- Manifestation
  - Enamel hypoplasia, hypomineralisation
  - Dentin defects
  - Ectodermal dysplasia
  - Jawbone resorption
  - Increased caries incidence



Dentin and enamel hypoplasia



Summary effects of vitamin D effect in oral cavity



# Vitamin E deficiency

- Risk groups for deficiency
  - Preterm infants, pregnant women, metabolic diseases
- Main role
  - Membranous antioxidant, anti-inflammatory
- Manifestation
  - Neurologic manifestation, immune system disorders, haemolytic anaemia
  - NO ORAL MANIFESTATION
    - *(alleviate mucositis due to oncology treatment)*



Mucositis and xerostomia in patient treated for oropharyngeal cancer

# Vitamin K deficiency

- Risk groups for deficiency
  - Infants, home births, rejection of vitamin K prophylaxis, intestine diseases
- Main role
  - Coagulation cascade -> Factors II, VII, IX and XI; anticoagulant proteins C and S
  - $\gamma$ -carboxylation ->  $Ca^{2+}$  binding -> phospholipid membranes interaction
- Manifestation
  - Bleeding – mucosal, submucosal (may be fatal in some organs)



# Water soluble vitamins – B group

- Members
  - B1 (thiamine), B2 (riboflavin), B3 (niacin), B5 (pantothenic acid), B6 (pyridoxine), B7 (biotin/vitamin H), B9 (folate), B12 ((cyano)cobalamin)
- Complete avitaminosis rare
  - Endangered groups – alcoholics, malabsorption (e.g. Crohn's disease), imbalanced diet vegans
- Roles
  - Energy production, cell metabolism, brain and neural function, red blood cells formation, cytotoxic immunity

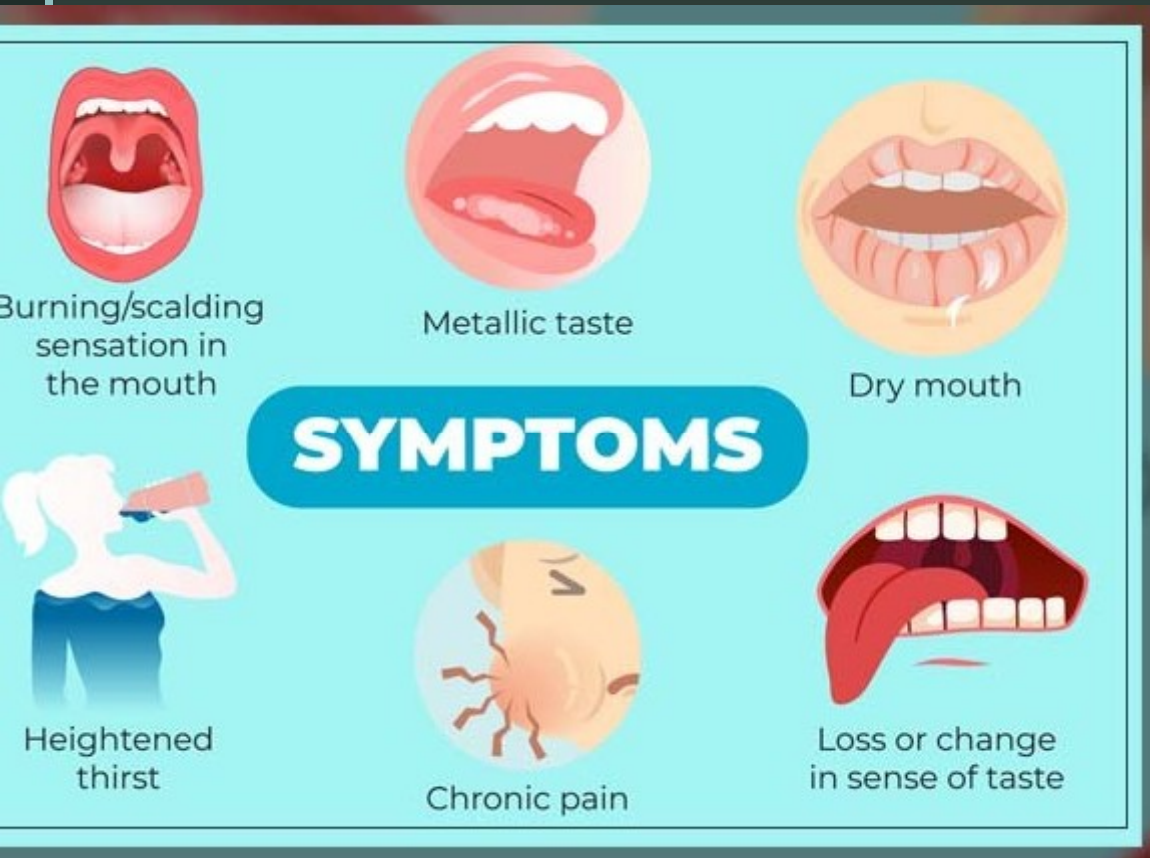
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## Summary Table: B Vitamins Overview

| Vitamin | Common Name         | Primary Benefit            | RDI (Adult)                 |
|---------|---------------------|----------------------------|-----------------------------|
| B1      | Thiamine            | Energy, nerve function     | 1.1–1.2 mg                  |
| B2      | Riboflavin          | Energy, skin, eyes         | 1.1–1.3 mg                  |
| B3      | Niacin              | Cholesterol, metabolism    | 14–16 mg NE                 |
| B5      | Pantothenic Acid    | Hormone synthesis          | 5 mg                        |
| B6      | Pyridoxine          | Brain, immunity            | 1.3–1.7 mg                  |
| B7      | Biotin              | Skin, nails, metabolism    | 30 mcg                      |
| B8      | Inositol            | Mood, insulin sensitivity  | 500–2,000 mg (supplemental) |
| B9      | Folate              | DNA, pregnancy             | 400–600 mcg DFE             |
| B10     | PABA                | Skin, hair (not essential) | 30–100 mg (supplemental)    |
| B11     | (Variable/obsolete) | No established benefit     | –                           |
| B12     | Cobalamin           | Nerves, red blood cells    | 2.4 mcg                     |
| B13     | Orotic Acid         | RNA/DNA synthesis          | 500–1,000 mg (supplemental) |

# Vitamin B1

- Function
  - Energy production, nerve impulses transmission, myelin sheath formation and maintenance
- Manifestation
  - Tingling, paraesthesia
  - Beri-beri: Wernicke-Korsakoff syndrome (Wernicke encephalopathy – acute, Korsakoff psychosis - chronic), wet form, GIT form, infant form
- Oral symptoms
  - „Burning mouth“ – mouth sores, hyperesthesia



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://gabapsychiatrist.com/wp-content/uploads/2024/07/Psychiatric-symptoms-of-Vitamin-B1-deficiency\_portrait.webp



**GABA**  
TELEPSYCHIATRY

## PSYCHIATRIC SYMPTOMS OF VITAMIN B1 DEFICIENCY



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Wernicke-Korsakoff syndrome (alcohol-associated neurological disorder)

### COAT RACK

Wernicke's encephalopathy (acute phase) clinical features:

- C onfusion
- O phthalmoplegia
- A taxia
- T hiamine is an important aspect of Tx

Korsakoff's psychosis (chronic phase) characteristic findings:

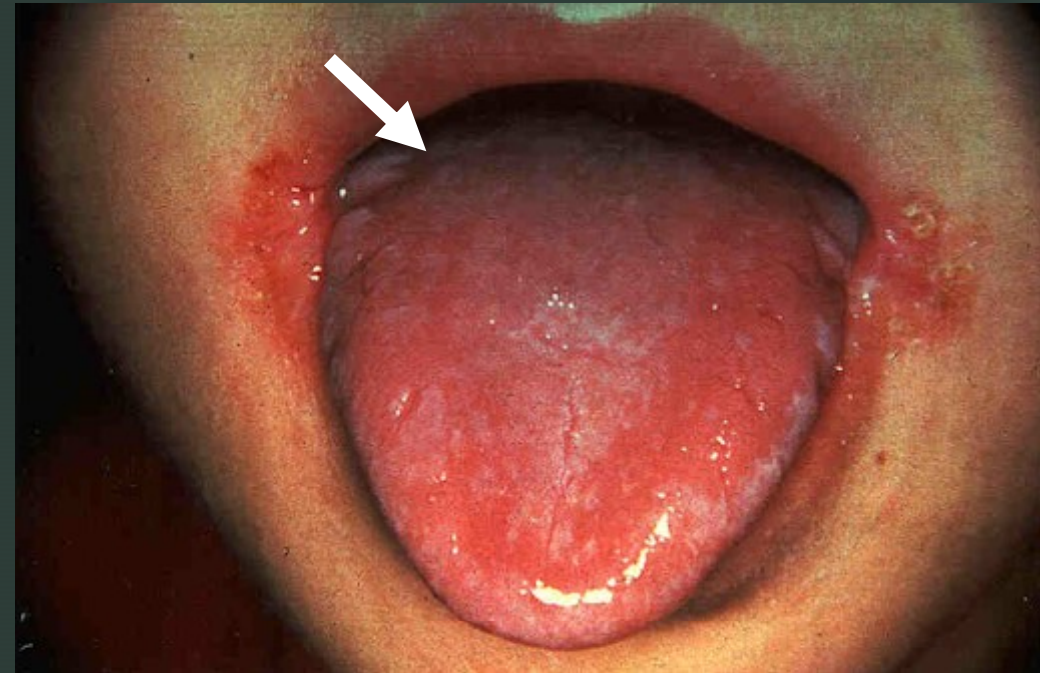
- Retrograde amnesia (recall of some old memories)
- A nterograde amnesia (ability to form new memories)
- C onfabulation
- K orsakoff's psychosis



[rnpedia.com/mnemonics](http://rnpedia.com/mnemonics)

# Vitamin B2 (riboflavin) deficiency

- Role
  - Energy metabolism, cell respiration, antibody production, growth and development
- General manifestations
  - Recurrent aphtous stomatitis
  - Glossitis
  - Angular cheilitis
- *NOTE – symptoms from B1 and B2 deficiency may overlap*



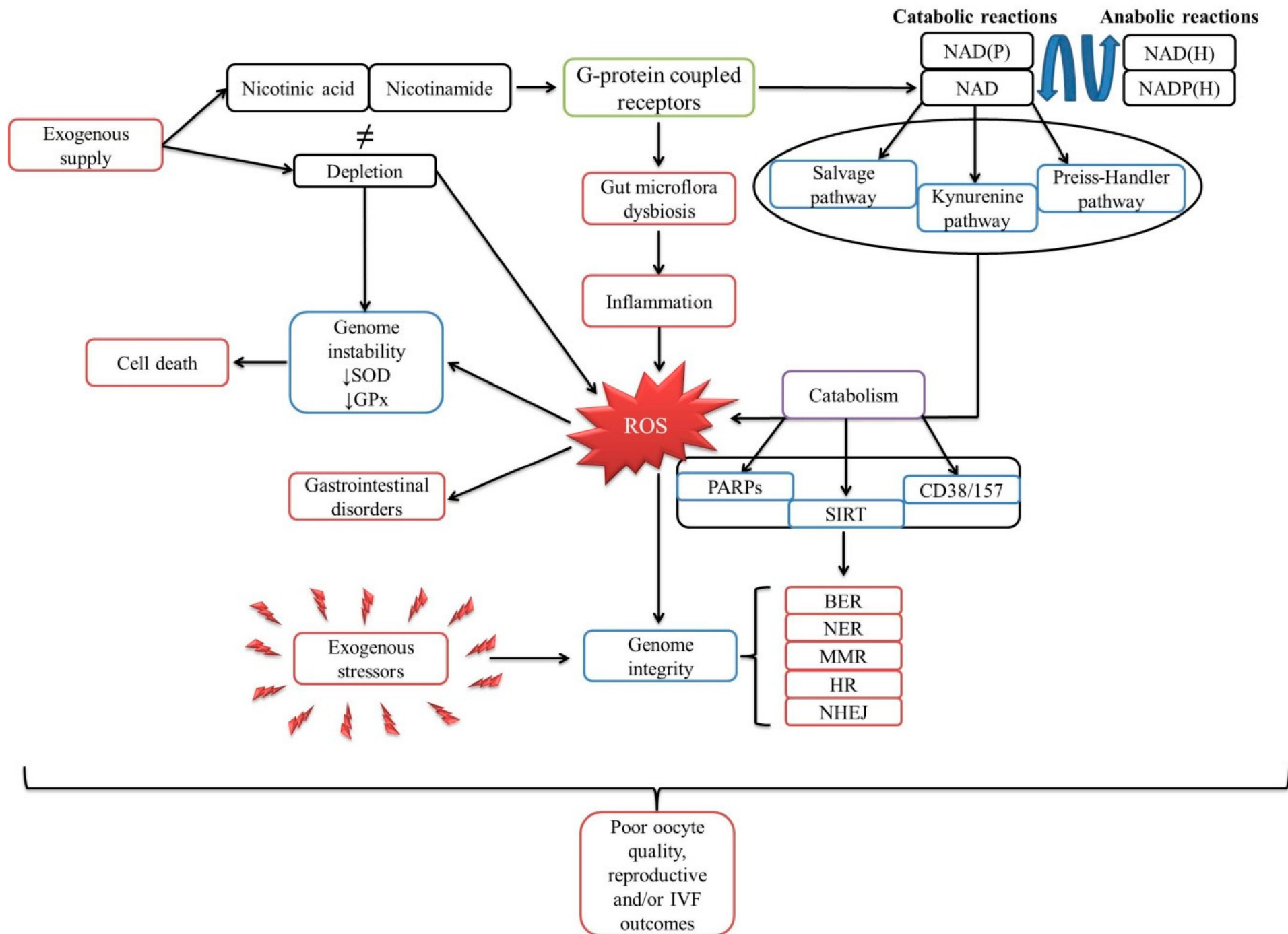
Upper left - Angular cheilitis  
Upper right – glossitis (tongue inflammation)  
Lower right – sore eyes

<https://cdn.ncbi.nlm.nih.gov/pmc/blobs/51cd/11049216/da2643874cba/dentistry-12-00109-g006.jpg>

<https://img.brainkart.com/imagebk35/fFX1e3M.jpg>

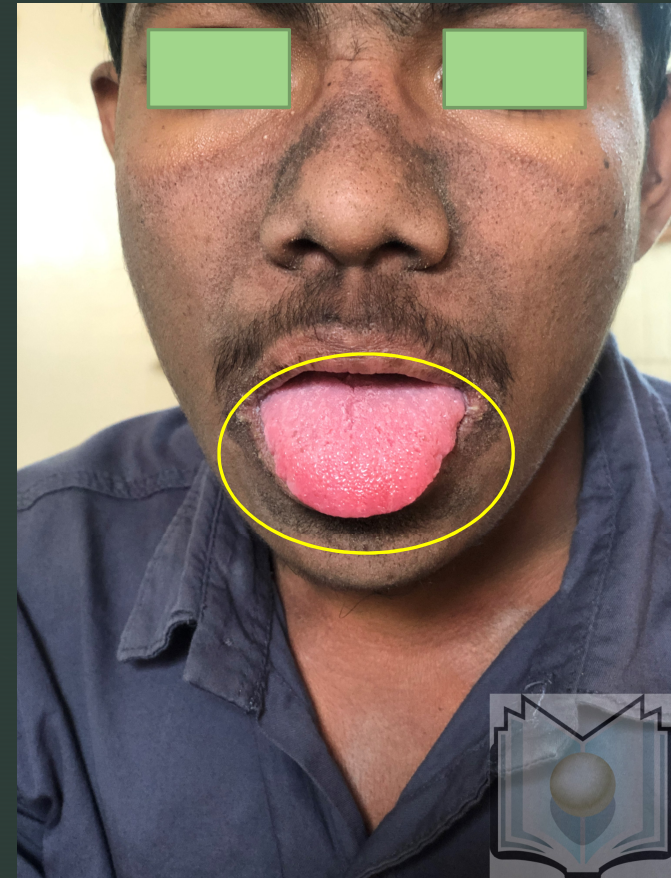
# Vitamin B3 deficiency

- Role
  - NAD, NADP
  - Lipoproteins and cholesterol metabolism - ↓LDL, ↑HDL
  - Neural and brain function
  - Apoptosis, DNA reparation
  - Gene expression, fertility...
- Manifestation
  - Pellagra – dermatitis, diarrhoea, dementia
- Oral manifestation
  - Recurrent aphthous stomatitis, glossitis, dry mouth
  - Foul breath -> bacterial overgrowth -> caries (?)





Pellagra  
- „gloves, socks, necklace“ style of lesions



Pale tongue

# Vitamin B5 (pantothenic acid) and vitamin B6 (pyridoxine)

- Vitamin B5
  - Role
    - Energy metabolism, cholesterol and hormones synthesis, coenzyme A synthesis
    - Deficiency is rare
  - Manifestation
    - Headache, nausea, muscle cramps, paraesthesia
    - Irritability, fatigue, apathy
    - ORAL – xerosis (dry mucosa), cheilitis
- Vitamin B6
  - Role
    - Haemoglobin synthesis, amino acid metabolism, protein, neurotransmitters, sphingolipids synthesis, glucose metabolism
  - Manifestation (ORAL)
    - Angular cheilitis, glossitis
    - Recurrent aphthous stomatitis
    - Halitosis
    - Fungal infections (decreased immunity)
    - Pale mucosa (possible anaemia)

## SOURCES



**SUNFLOWER SEEDS**  
1,34mg(100g)



**GARLIC**  
1,23mg(100g)



**SALMON**  
0,8mg(100g)



**BEANS**  
0,9mg(100g)



**HAZELNUT**  
0,7mg(100g)



**SESAME**  
0,79mg(100g)



**WHEAT**  
0,6mg(100g)



**BELL PEPPER**  
0,52mg(100g)

# PYRIDOXINE

# B6

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## DAILY NORM

  **2 MG**

**B6** + **B2** + **Zn**

## BENEFICIAL FEATURES



**REDUCES TOXICOSIS  
DURING PREGNANCY**



**PREVENTS  
SKIN DISORDERS**



**REDUCES  
NERVOUS  
DISORDERS**



**REDUCES NIGHT  
MUSCLE SPASMS**

## DEFICIENCY



**LOSS OF APPETITE**



**DRY SKIN  
AROUND THE EYES**



**FATIGUE**



**THE APPEARANCE  
OF KIDNEY STONES**



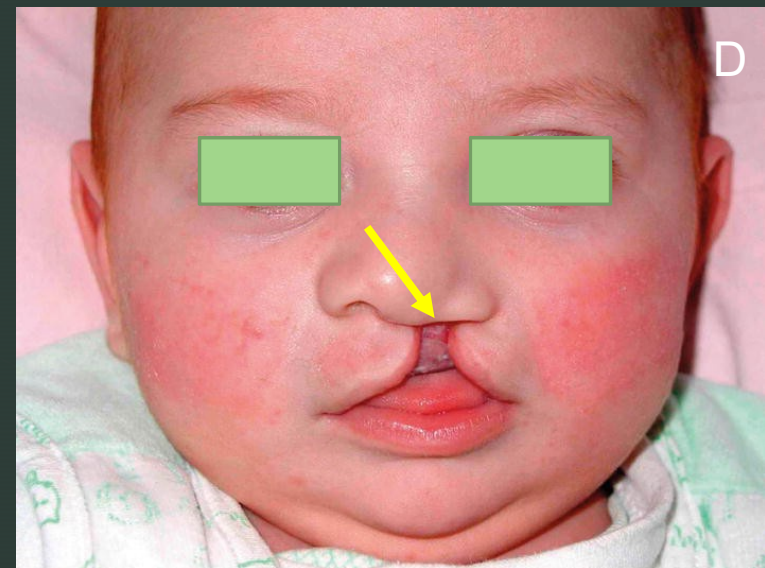
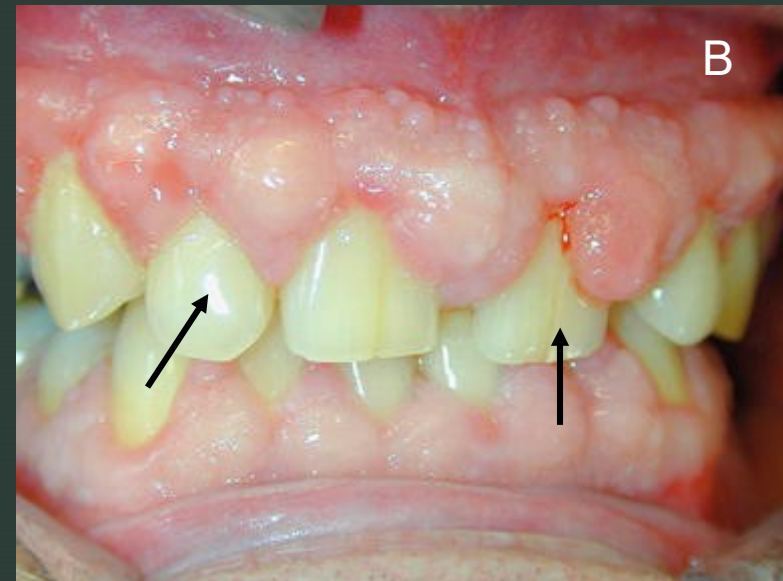
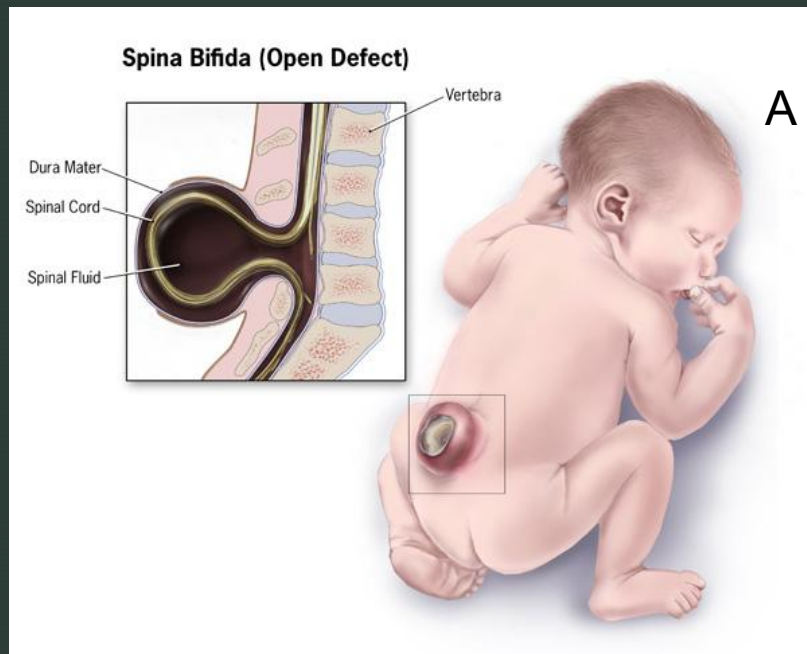
**SORES IN THE  
CORNERS  
OF THE MOUTH**



**FOCAL HAIR LOSS**

# Vitamin B9 deficiency

- Role
  - DNA synthesis, tissue growth, cells function, neural tube development
- Manifestation
  - Megaloblastic anaemia, spina bifida occulta
- Oral symptoms
  - Gingivitis, angular cheilitis, glossitis
  - Cleft lip (unilateral mainly)

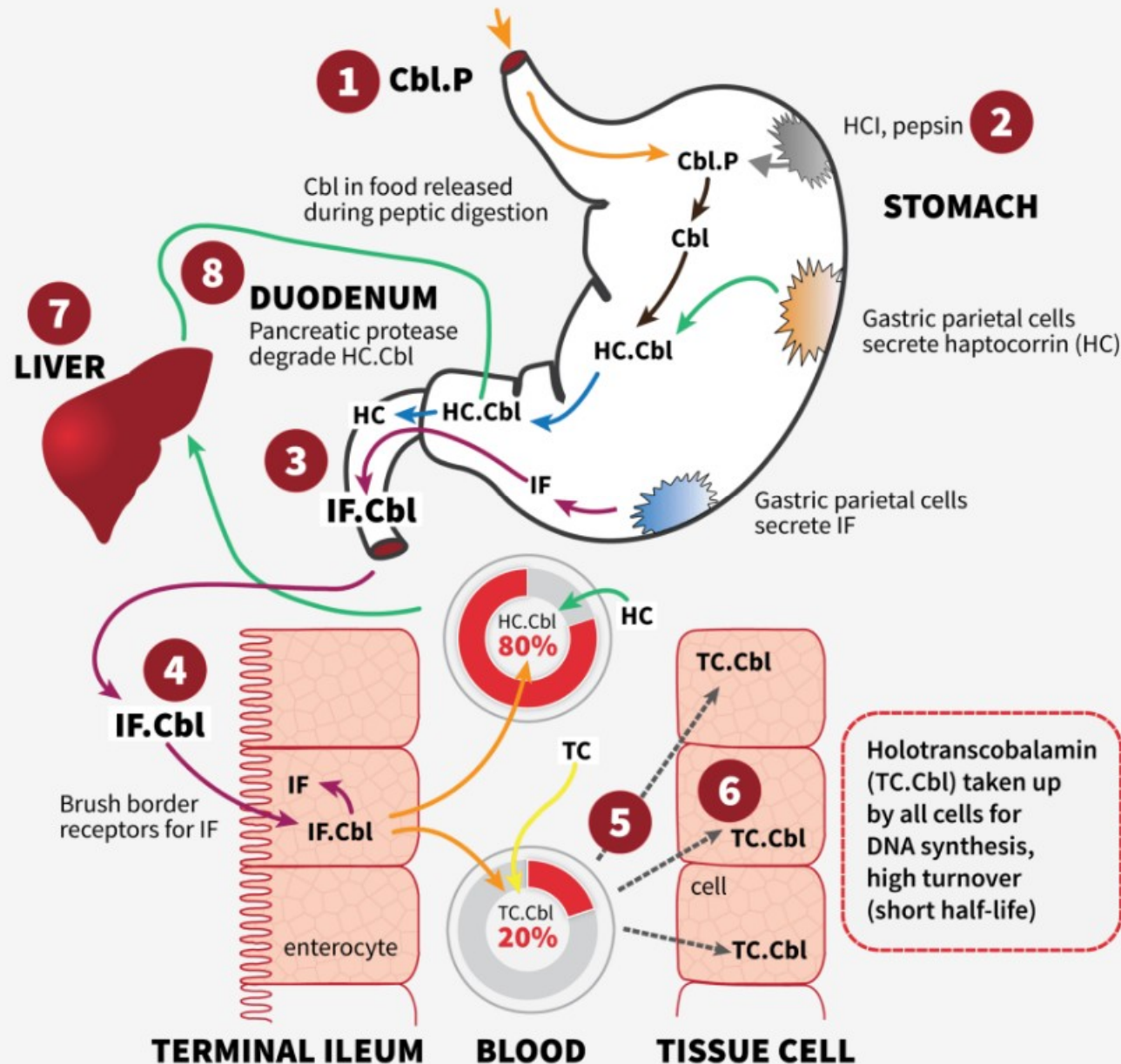


A – spina bifida; B – gingivitis (swollen and bleeding gums)  
C – recurrent aphthae, D – unilateral lip cleft

# Vitamin B12 deficiency

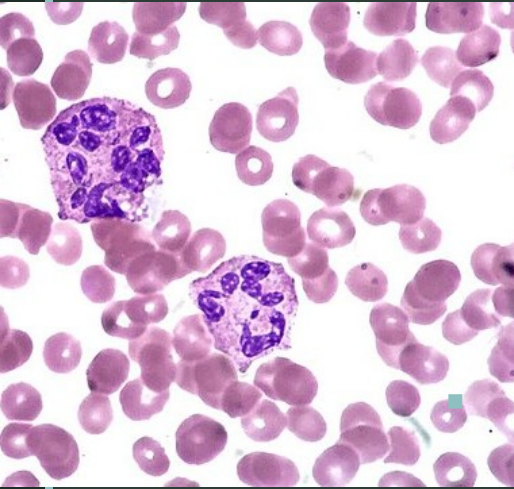
- Role
  - Nerve cell function, mood-regulating neurotransmitters balance
  - DNA replication, AA and FA metabolism
  - Myelin synthesis
  - ↓homocysteine level -> ↓cardiovascular risk
- Manifestation
  - Pernicious anaemia
    - Disrupted DNA synthesis -> less frequent and faulty divisions -> megaloblastic anaemia (pernicious anemia)
  - Neural and cognitive defects, psychosis possible
    - Impaired myelin synthesis, neuropathy, fatigue, paresthesia, ataxia
  - Fetal development
    - Miscariage, neural tube defects

# VITAMIN B12 ABSORPTION



Vitamin  
B12  
Absorption:  
Possible  
Failure  
Sites · PA  
Relief

# Oral manifestations of vitamin B12 deficiency



## Anaemia

- Mucosal pallor
- Anaemic gingiva
  - Poor oxygen delivery suspected
- Dry mouth
- Glossitis („strawberry tongue“)
- Taste perception alteration



[Hypersegmented neutrophil – Wikipedia](#)

<https://cached.imagescaler.hbpl.co.uk/resize/scaleWidth/815/cached.offlinehbpl.hbpl.co.uk/news/PGH/Strawberry-Tongue-20140313031106894.png>

Exfoliative  
glossitis



# Vitamin C deficiency

- Role
  - Collagen synthesis
    - Collagen hydroxylation -> important for tissue repair, wound healing
  - Carnitine & norepinephrine biosynthesis, tyrosine metabolism
  - Peptide hormones amidation
  - Antioxidant (vitamin E synergy)
  - Cell signalling, epigenetics
  - Bacterial infections prevention

# Vitamin C deficiency manifestation (scurvy) – oral cavity

- Gingival hypertrophy
  - Inability to produce procollagen -> tissue and vessels fragility -> prone to bleeding and inflammation -> overgrowth (cytokines stimulation)
- Deep dental pockets
- Bruising easily -> possible petechiae
- Delayed wound healing
- (?) Oral infections containment impaired



Ascorbic  
acid therapy



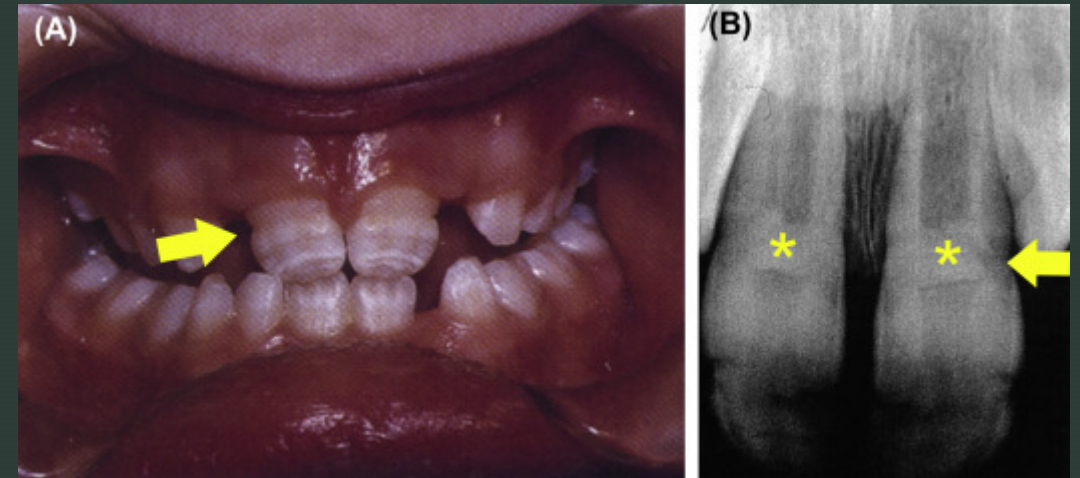
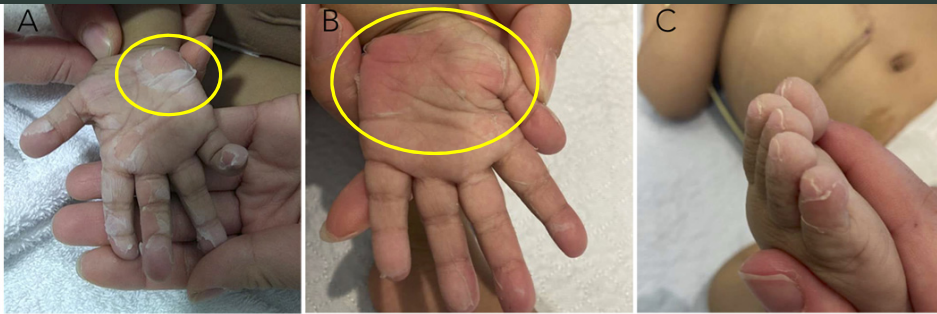




[Scorbutic tongue \(cropped\) - Scurvy - Wikipedia](#)

# Vitamins overdose (rare)

| Vitamin | Acute                                                                                                                                                  | Chronic                                                                                                                          |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| A       | Headache, loss of consciousness<br>Nausea, vomiting<br>Irritability<br>Fever, <b>skin rash</b>                                                         | <b>Dry patchy skin</b><br><b>Dry cracking lips</b><br>Brittle nails<br>Hair loss<br>Movement stiffness (bones alteration)        |
| D       | <b>Tremor (extremities)</b><br>Dehydration<br><b>Subcutaneous bleeding</b><br>Congenital bone defects (pregnancy)                                      | Pancreatic cancer risk<br>Cardiovascular morbidity<br>Fractures<br><b>Enamel hypoplasia</b><br><b>Dentine pulp calcification</b> |
| E       | Increased bleeding, impaired immunity, delayed wound healing<br>Hypertension, angina pectoris, atherosclerosis<br>Fatigue, intestinal cramps, diarrhea |                                                                                                                                  |
| K       | Hemolytic anemia (vit. K3 only)                                                                                                                        |                                                                                                                                  |
| C       | Nerves excitability<br>Skin rash, itching                                                                                                              |                                                                                                                                  |
| B group | Various neural symptomatology mostly                                                                                                                   |                                                                                                                                  |



Hypervitaminosis D

## Vitamin C Toxicity

Maximum limit of vitamin C intake - 2000 mg/day

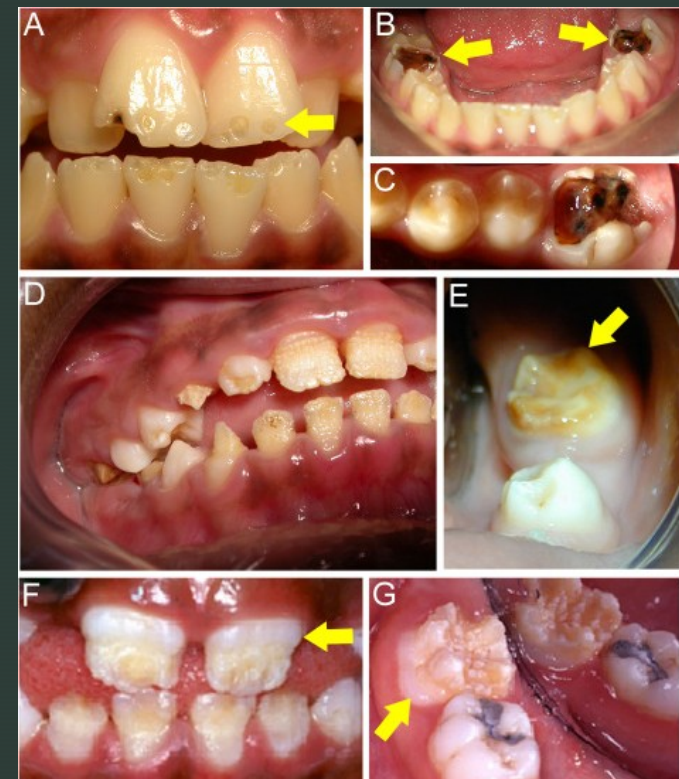
**iCliniq**  
The Virtual Hospital

### Symptoms of Vitamin C Toxicity

- Diarrhea
- Abdominal cramps
- Nausea and vomiting
- Headache
- Insomnia
- Fever

### Severe toxicity causes

- Bone fractures
- Kidney stones
- Bleeding through the nose
- Muscle pain
- Seizures



3.amazonaws.com/images.icliniq.com/infographics/Vitamin+C+Toxicity+%282%29.jpg  
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# A burning question appears...

Vitamin K3 overdose may be manifested with jaundice?

TRUE

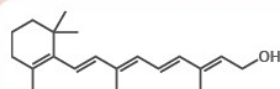
FALSE

Haemolytic anaemia  
leads to serum bilirubin  
elevation  
(liver capacity reached)

# THE CHEMICAL STRUCTURES OF VITAMINS

Vitamins are the essential nutrients that our body needs in small amounts. More specifically, an organic compound is defined as a vitamin when it is required by an organism, but not synthesised by that organism in the required amounts (or at all). There are thirteen recognised vitamins.

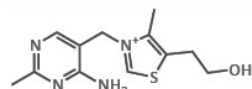
## VITAMIN A



**RETINOL**  
*active form in mammalian tissues*

Important for eyesight. Also strengthens immune system and keeps skin and linings of parts of the body healthy.

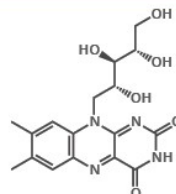
## VITAMIN B1



**THIAMIN**  
*can also occur in pyrophosphate ester form*

Used to keep nerves & muscle tissue healthy. Also important for processing of carbohydrates and some proteins.

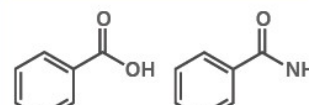
## VITAMIN B2



**RIBOFLAVIN**  
*excess turns urine bright yellow*

Important for body growth, red blood cell production, and keeping the eyes healthy. Also helps processing of carbohydrates.

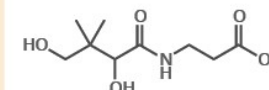
## VITAMIN B3



**NICOTINIC ACID**   **NICOTINEAMIDE**  
*niacin is collective name for these compounds*

Helps with digestion and digestive system health. Also helps with the processing of carbohydrates.

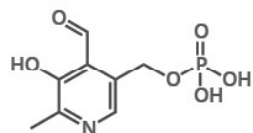
## VITAMIN B5



**PANTOTHENIC ACID**  
*also occurs in pyrophosphate ester form*

Important for manufacturing red blood cells and maintaining a healthy digestive system. Also helps process carbohydrates.

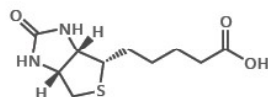
## VITAMIN B6



**PYRIDOXAL PHOSPHATE**  
*active form in mammalian tissues*

Helps make some brain chemicals; needed for normal brain function. Also helps make red blood cells and immune system cells.

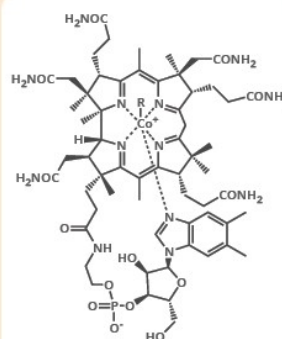
## VITAMIN B7



**BIOTIN**  
*produced by intestinal bacteria*

Needed for metabolism of various compounds. Often recommended for strengthening hair, but evidence is variable.

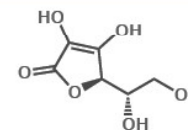
## VITAMIN B12



**COBALAMIN**  
*usually contains CN as the R group*

Important for the nervous system, for making red blood cells, and helps in the production of DNA and RNA.

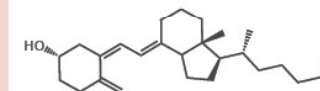
## VITAMIN C



**ASCORBIC ACID**  
*deficiency can cause scurvy*

Important for a healthy immune system; helps produce collagen, used to make skin and other tissues. Also helps wound healing.

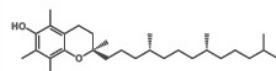
## VITAMIN D



**CHOLECALCIFEROL**  
*natural form; different form used in supplements*

Important for bone health and maintaining the immune system function. May also have a preventative role in cancers.

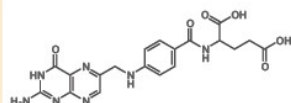
## VITAMIN E



**ALPHA-TOCOPHEROL**  
*group includes tocopherols & tocotrienols*

An antioxidant that helps prevent damage to cells and may have a preventative role in cancer. Also helps make red blood cells.

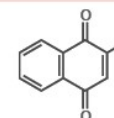
## VITAMIN B9



**FOLIC ACID**  
*found as tetrahydrofolate in food*

Important for brain function & mental health. Aids production of DNA & RNA. Important when tissues are growing quickly.

## VITAMIN K



**MENADIOL**  
*all K vitamins are menadiol or derivatives*

Helps blood clot properly, & plays a key role in bone health. Newborns receive vitamin K injections to prevent bleeding.

## Key

Vitamins can be divided broadly into two classes.

**WATER-SOLUBLE VITAMINS**  
These vitamins are not stored in the body. As such, generally, they are required more frequently than the fat-soluble vitamins.

**FAT-SOLUBLE VITAMINS**  
These vitamins are stored in the liver and fatty tissues until required. As such, they can be harmful if too much is taken in.





## Trace elements disorders

| RDIs - Nutrients        |                                   |                                  |                                           |                               |                                       |
|-------------------------|-----------------------------------|----------------------------------|-------------------------------------------|-------------------------------|---------------------------------------|
| Nutrient                | Unit of measure                   | Adults and Children<br>≥ 4 years | <sup>1</sup> Infants through 12<br>months | Children 1 through 3<br>years | Pregnant women<br>and lactating women |
| Vitamin A               | Micrograms RAE <sup>2</sup> (mcg) | 900                              | 500                                       | 300                           | 1,300                                 |
| Vitamin C               | Milligrams (mg)                   | 90                               | 50                                        | 15                            | 120                                   |
| Calcium                 | Milligrams (mg)                   | 1,300                            | 260                                       | 700                           | 1,300                                 |
| Iron                    | Milligrams (mg)                   | 18                               | 11                                        | 7                             | 27                                    |
| Vitamin D               | Micrograms (mcg) <sup>3</sup>     | 20                               | 10                                        | 15                            | 15                                    |
| Vitamin E               | Milligrams (mg) <sup>4</sup>      | 15                               | 5                                         | 6                             | 19                                    |
| Vitamin K               | Micrograms (mcg)                  | 120                              | 2.5                                       | 30                            | 90                                    |
| Thiamin                 | Milligrams (mg)                   | 1.2                              | 0.3                                       | 0.5                           | 1.4                                   |
| Riboflavin              | Milligrams (mg)                   | 1.3                              | 0.4                                       | 0.5                           | 1.6                                   |
| Niacin                  | Milligrams NE <sup>5</sup> (mg)   | 16                               | 4                                         | 6                             | 18                                    |
| Vitamin B <sub>6</sub>  | Milligrams (mg)                   | 1.7                              | 0.3                                       | 0.5                           | 2                                     |
| Folate <sup>6</sup>     | Micrograms DFE <sup>7</sup> (mcg) | 400                              | 80                                        | 150                           | 600                                   |
| Vitamin B <sub>12</sub> | Micrograms (mcg)                  | 2.4                              | 0.5                                       | 0.9                           | 2.8                                   |
| Biotin                  | Micrograms (mcg)                  | 30                               | 6                                         | 8                             | 35                                    |
| Pantothenic acid        | Milligrams (mg)                   | 5                                | 1.8                                       | 2                             | 7                                     |
| Phosphorus              | Milligrams (mg)                   | 1,250                            | 275                                       | 460                           | 1,250                                 |
| Iodine                  | Micrograms (mcg)                  | 150                              | 130                                       | 90                            | 290                                   |
| Magnesium               | Milligrams (mg)                   | 420                              | 75                                        | 80                            | 400                                   |
| Zinc                    | Milligrams (mg)                   | 11                               | 3                                         | 3                             | 13                                    |
| Selenium                | Micrograms (mcg)                  | 55                               | 20                                        | 20                            | 70                                    |
| Copper                  | Milligrams (mg)                   | 0.9                              | 0.2                                       | 0.3                           | 1.3                                   |
| Manganese               | Milligrams (mg)                   | 2.3                              | 0.6                                       | 1.2                           | 2.6                                   |
| Chromium                | Micrograms (mcg)                  | 35                               | 5.5                                       | 11                            | 45                                    |
| Molybdenum              | Micrograms (mcg)                  | 45                               | 3                                         | 17                            | 50                                    |
| Chloride                | Milligrams (mg)                   | 2,300                            | 570                                       | 1,500                         | 2,300                                 |
| Potassium               | Milligrams (mg)                   | 4,700                            | 700                                       | 3,000                         | 5,100                                 |
| Choline                 | Milligrams (mg)                   | 550                              | 150                                       | 200                           | 550                                   |

# Iron

- Role
  - Part of proteins and enzymes
    - Haemoglobin, myoglobin
    - Cytochrome a-c, p450; cytochrome c reductase, catalases, peroxidases, xanthine oxidases, tryptophan pyrrolase, succinate dehydrogenase, glucose-6-phosphate dehydrogenase, and choline dehydrogenase, lipoxygenases..
  - Energy metabolism
  - DNA, RNA, collagen, antibody synthesis

# Oral manifestation of iron deficiency

1. Iron deficiency anaemia (microcytic hypochromic)
  - Pathomechanism – poor oxygen delivery, unable to contain infections -> subclinical chronic inflammation
    - Angular cheilitis
    - Atrophic glossitis
    - Mucosal atrophy, candida infections
    - Mucosal pallor
    - Stomatitis
    - Plummer-Vinson syndrome (Paterson-Kelly sy./sideropenic dysphagia)



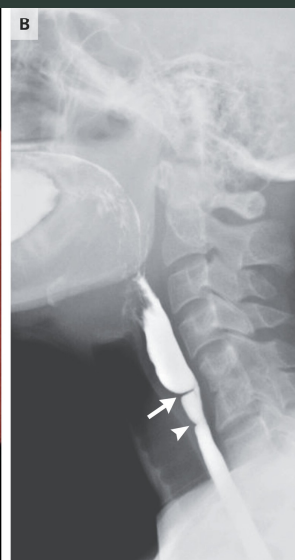
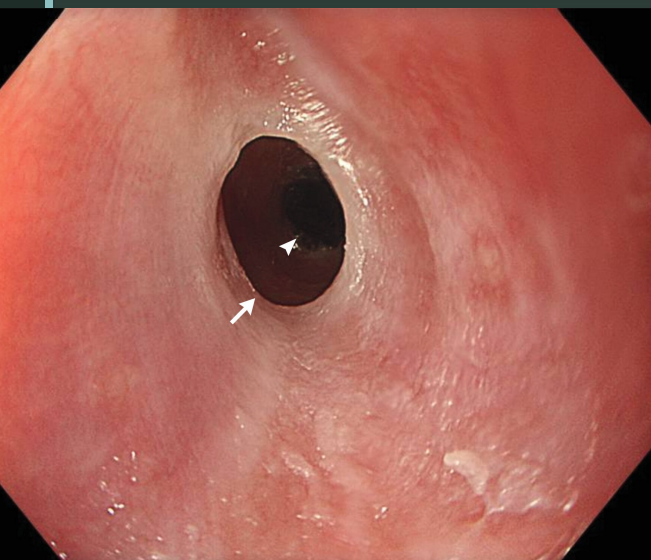
Angular cheilitis



Mucosal pallor



Median rhomboid glossitis



### Plummer-Vinson syndrome

- Triad – dysphagia, iron deficiency anaemia, oesophageal webs, angular stomatitis, atrophic glossitis
- Women slightly more affected
- Autoimmune part contribution
- Possible malignant transformation – squamous cell carcinoma of oesophagus

<https://www.ccjm.org/content/ccjom/85/8/581/F1.large.jpg>

[https://media.springernature.com/lw685/springer-static/image/chp%3A10.1007%2F978-3-319-55387-0\\_4/MediaObjects/394201\\_1\\_En\\_4\\_Fig2\\_HTML.jpg](https://media.springernature.com/lw685/springer-static/image/chp%3A10.1007%2F978-3-319-55387-0_4/MediaObjects/394201_1_En_4_Fig2_HTML.jpg)

<https://www.researchgate.net/publication/51632598/figure/fig1/AS:202503011475475@1425291888626/The-appearance-of-median-rhomboid-glossitis-MRG.png>

[https://www.nejm.org/cms/10.1056/NEJMicm2309721/asset/2bca29b1-3e0b-44bd-be1b-843072096cab/assets/images/large/nejmicm2309721\\_f1.jpg](https://www.nejm.org/cms/10.1056/NEJMicm2309721/asset/2bca29b1-3e0b-44bd-be1b-843072096cab/assets/images/large/nejmicm2309721_f1.jpg)

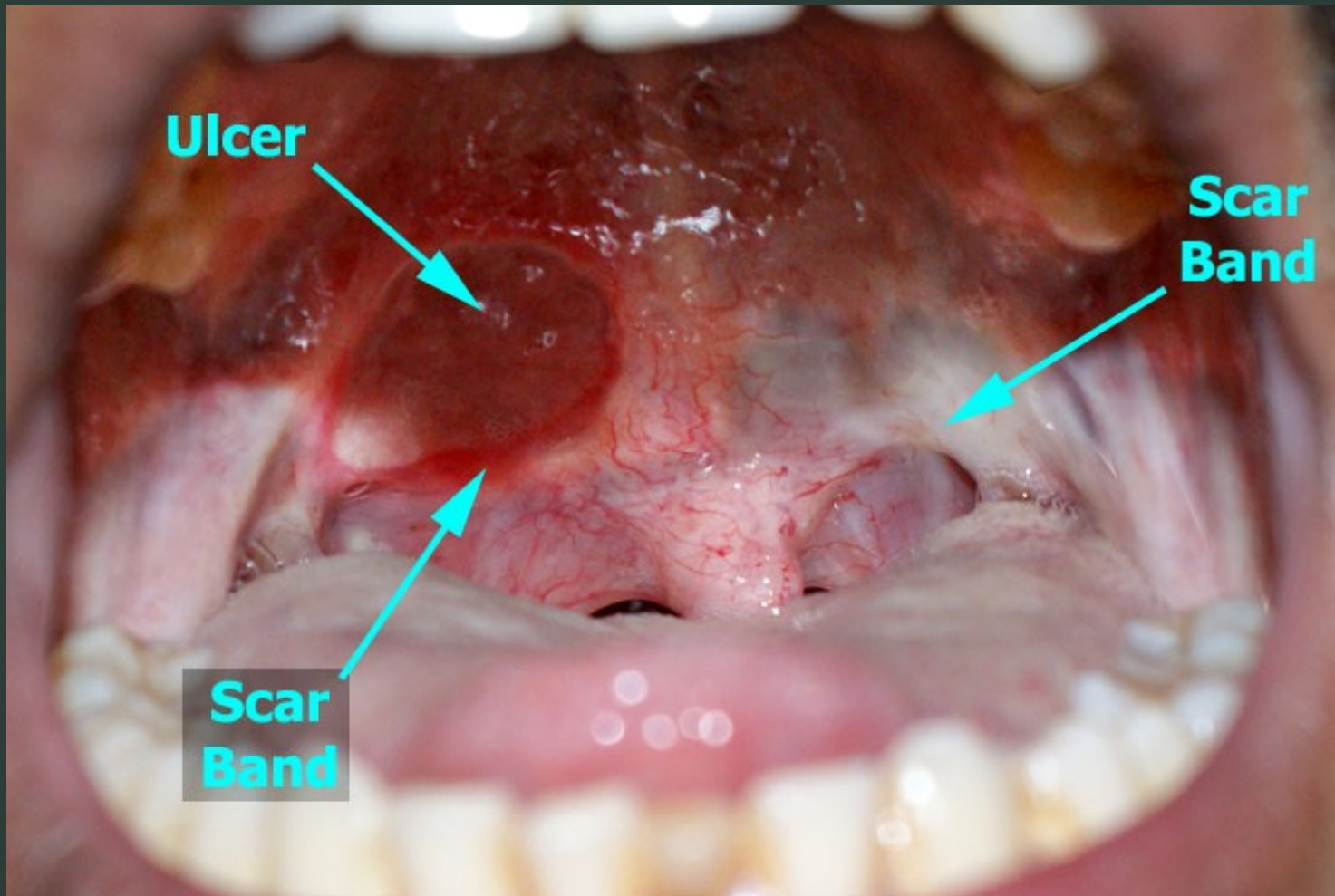
# Oral manifestations of iron deficiency

## 2. Premalignant lesions

- $\downarrow$ serum  $\text{Fe}^{2+}$ ,  $\uparrow$  $\text{Fe}^{2+}$ -binding capacity
- Promotion of oral submucous fibrosis (1% risk)
- Pathomechanism – poor oxygen delivery, constant inflammation, additional stimulation of cell division (e.g. arecoline from areca nuts)
  - Similar mechanism estimated during smoking – carcinogens, ROS

## 3. Tumour progression

- Similar mechanisms suspected



Oral submucous fibrosis

# Copper

- Role – important part of various enzymes
  - Cytochrome c oxidase – energy production
  - Superoxide dismutase – antioxidant defence (superoxide to hydrogen peroxide)
  - Lysyl oxidase – collagen and elastin production
  - Ceruloplasmin – Fe oxidation -> haemoglobin synthesis
  - Tyrosinase – melanin production
  - Phospholipid synthesis -> myelin production
  - Thyroxin production
  - Free copper – oxidative stress

## General symptoms of copper deficiency

1. Anemia (micro- up to macrocytic) and neutropenia
2. Myelopathy, peripheral neuropathy and optic neuropathy

# Oral manifestation of copper deficiency

1. Anaemia and defective keratinisation
2. Frequent inflammation and prolonged healing, protracted infections
  - Neutropenia observed, granulocytes maturation disorders
3. Osteoporosis (mostly jawbone and skull)
  - Lysyl oxidase and ascorbate oxidase impaired -> improper bone matrix synthesis

# Oral manifestation of copper overdose

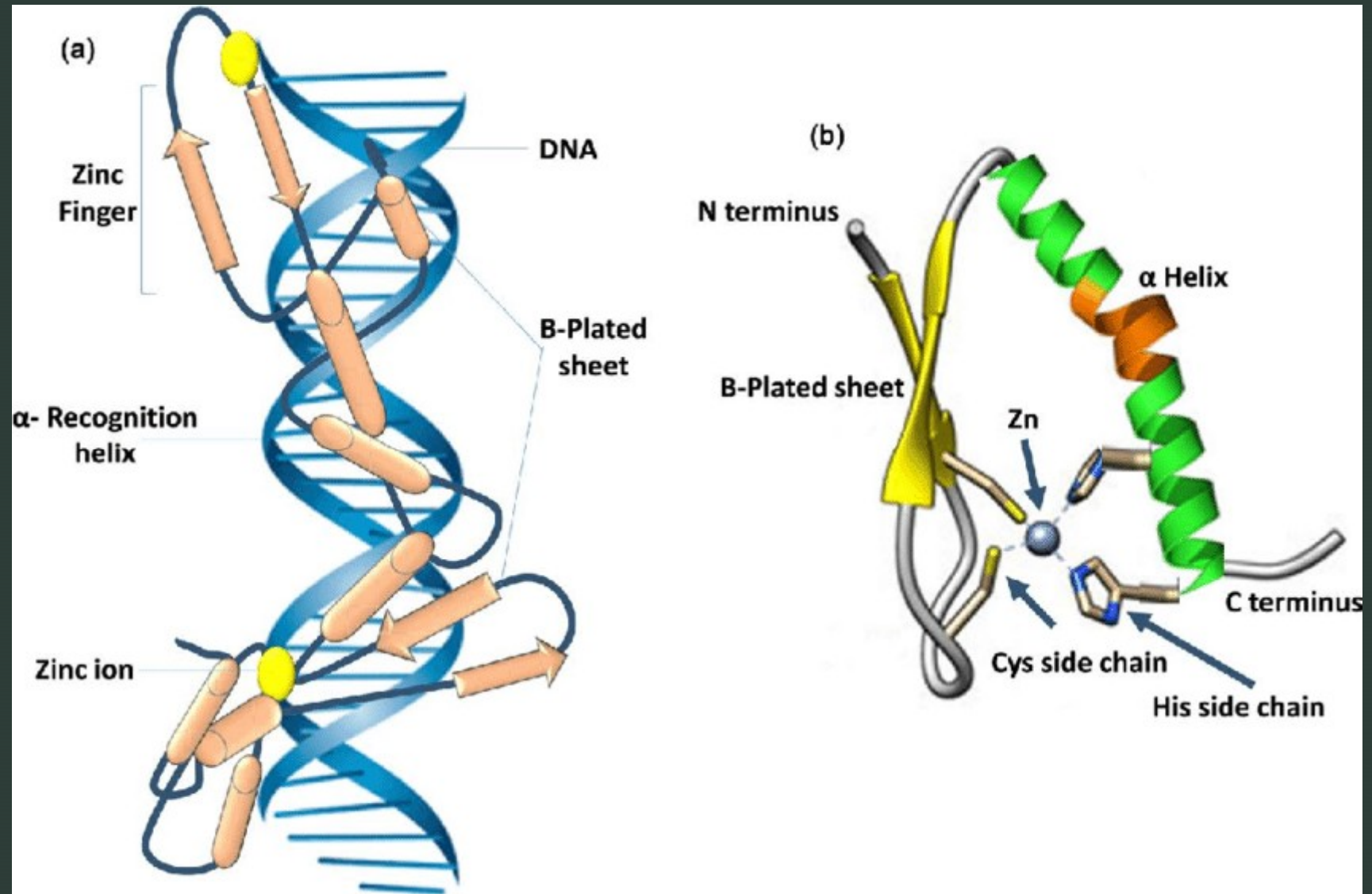
4. Premalignant and malignant lesions
  - Oral leucoplakia, oral submucous fibrosis
  - Increased risk of squamous cell carcinoma
  - Prominent in India and consumers of areca nuts
    - Serum copper levels were significantly higher compared to non-consumers
    - Salivary concentration seems to be decisive
5. (?) Cariogenic properties



Acute intoxication by copper sulfate (pond algacide) – intake for 2 days (to treat „black tongue“, advised by friends), discoloration for 2 months due to copper + poor hygiene  
Treatment – 1 month prednisone, 1 week fluconazole (BOTH INEFFECTIVE); chelation (EFFECTIVE)

# Zinc

- Role
  - Catalytic activity of enzymes
  - Immune function, wound healing
  - Zinc fingers -> protein synthesis, DNA synthesis, cell division, apoptosis..
  - Taste and smell perception
  - Growth and development of an organism
  - Antioxidant defence
  - Antimicrobial properties



# Oral manifestations of zinc deficiency

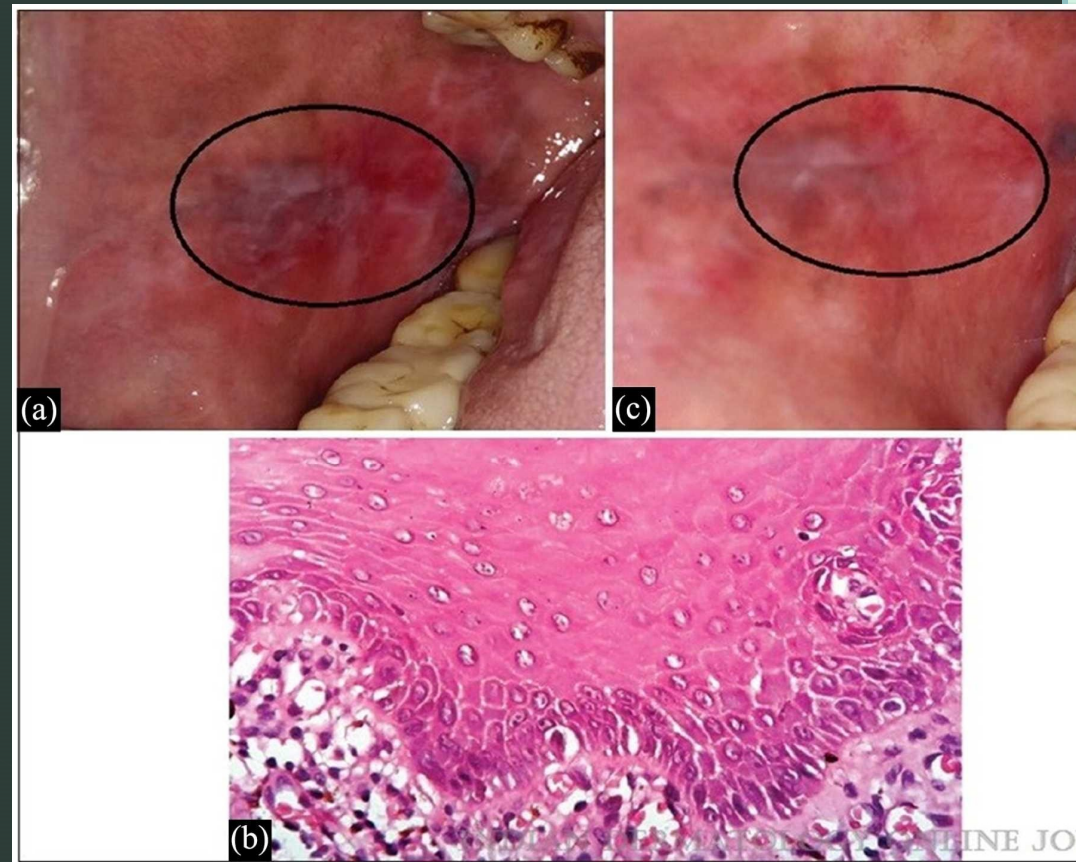
1. Cariogenicity (disputed)
  - Plaque control, malodour control, calculus formation cessation
2. Taste disturbances
  - Impaired perception and neural transmission
3. Parakeratosis and loss of filiform papillae
4. Premalignant and malignant lesions
  - Oral leucoplakia and squamous cell carcinoma
  - Lack of zinc cannot counter free copper action

# Oral manifestations of zinc deficiency and overdose

1. Superoxide dismutase (Cu-Zn)
  - Anti-carcinogenic properties -> impaired in zinc deficiency
2. Impaired inactivation of copper-related enzymes
  - $\uparrow$ lysyl oxidase ->  $\uparrow$ collagen cross-links -> malignant transformation factor
  - Zinc counters mucosal copper absorption (physiologically protective)
1. (OVERDOSE) - Oral submucous fibrosis
  - Serum zinc increased with drop of iron concentration
  - Carcinogenesis disputed



Acrodermatitis enteropathica  
(zinc deficiency, congenital, autosomal  
recessive)



Lichen planus improvement – a) before  
zinc supplementation, b) after, with  
reduction of erosive patterns (c)

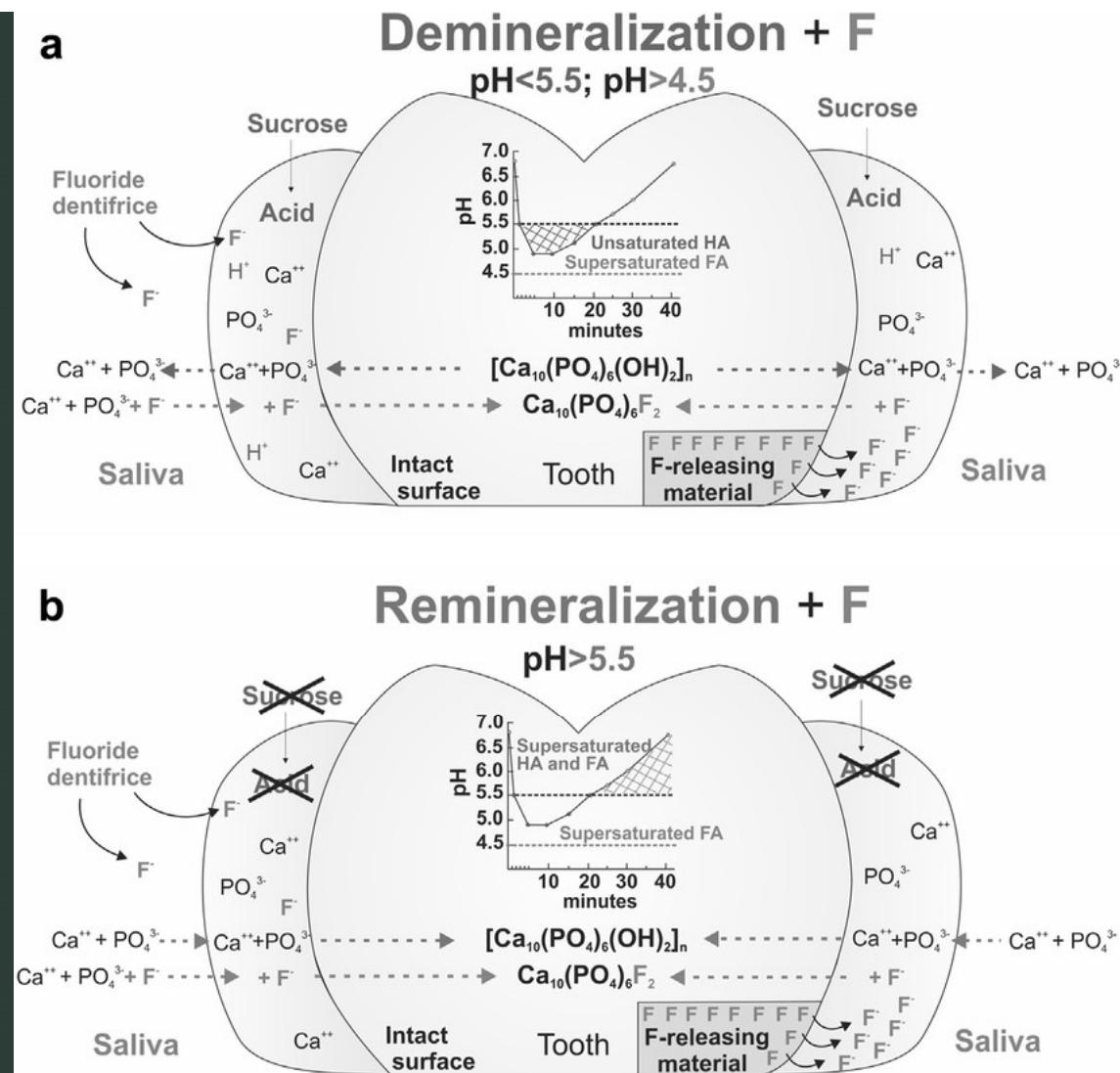
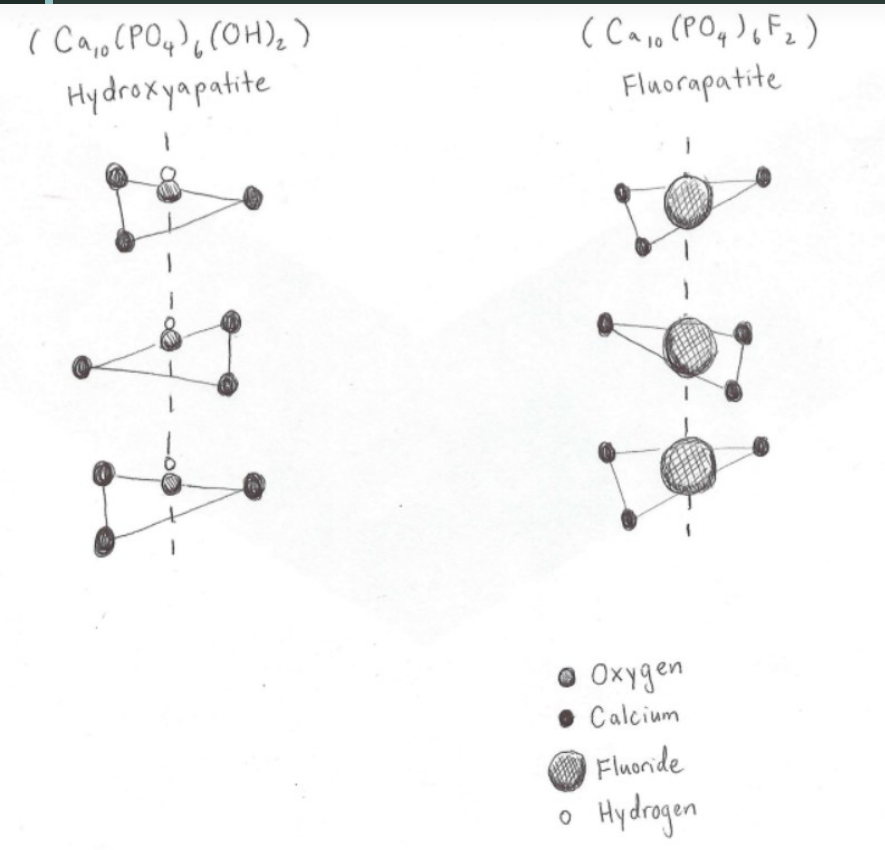
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<https://html.scrip.org/file/1111758-rld21.jpeg?20240724104417>

# *Cobalt, chromium, molybdenum, selenium*

- Cobalt deficiency -> see vitamin B12
- Cobalt, chromium, nickel exposure -> lichen planus, lichenoid reaction
- Chromium deficiency -> hyperglycaemic effect
  - Intensifies diabetic syndrome manifestation
- Selenium deficiency -> possible premalignant and malignant transformation
  - ↓glutathione peroxidase levels
- Vanadium, boron, molybdenum -> possibly cariostatic (inconclusive)

# Fluorine

- Role
  - Most negatively charged element -> most reactive
  - Fluorapatite formation -> acid resistant
    - Fluorohydroxyapatite has both some OH-groups and some substituted by fluorine
    - Prevention in childhood has protective effects also on permanent dentition
  - Prevention of cariogenic bacteria growth
  - Promoting remineralisation -> countering bacterial acid effect
  - Osteoblastic activity promotion
    - Synergy with calcium



Fluorapatite – OH-groups fully substituted by fluorine

Ca-hydroxyapatite loss compensated with fluorapatite creation (enhanced then with Ca-hydroxyapatite recreation during pH compensation)

# Oral manifestation of fluorine deficiency and overdose

- Deficiency
  - Poor remineralisation of teeth
  - Increased caries occurrence
  - -> ↑enamel damage by bacterial acids
  - ↑plaque formation -> ↑cariogenic bacterial behaviour
- Overdose (fluorosis)
  - Brown stains and marks -> cosmetic
  - No increased caries risk
  - Severe may lead to permanent tooth damage



Severe fluorosis with mottled enamel – region with high natural occurrence of fluorine

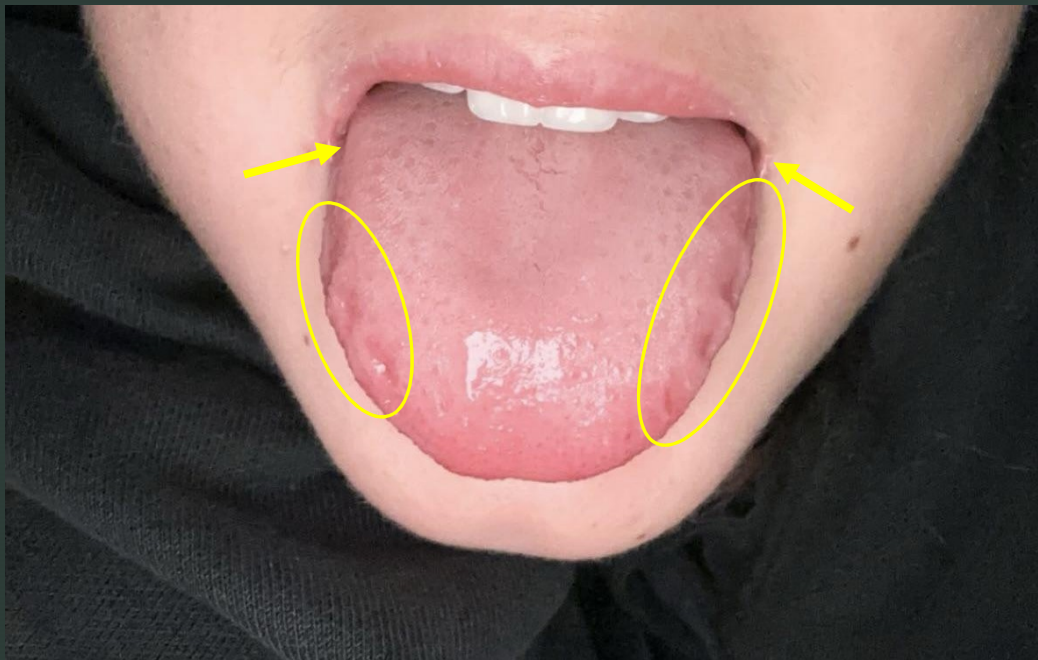
# *Iodine*

- Role
  - Thyroid hormone synthesis
  - Immunological function and antioxidant defence
- - Mostly in primitive life forms
  - High concentration in thymus
  - Salivary glands prevent peroxidation by  $Na^+/I^-$  symporter

# Oral manifestations of iodine deficiency and overdose

- Deficiency
  - Hypothyroidism -> deposition of glycosaminoglycans
    - Lips thickening
    - Macroglossia
  - Delayed teeth eruption
- Overdose
  - Bleeding ulcerations (GIT)
  - Hyperthyroidism – brown pigmentation – buccal mucosa, gingiva, palate, tongue
    - ↑melanin production (unknown means)

<https://pocketdentistry.com/hyperthyroidism/>  
<https://i.redd.it/7a8s2k7loo6c1.jpeg>



Low thyroid function – „tooth“ prints on tongue and no space between tongue and lips (Hashimoto's thyroiditis on the picture)



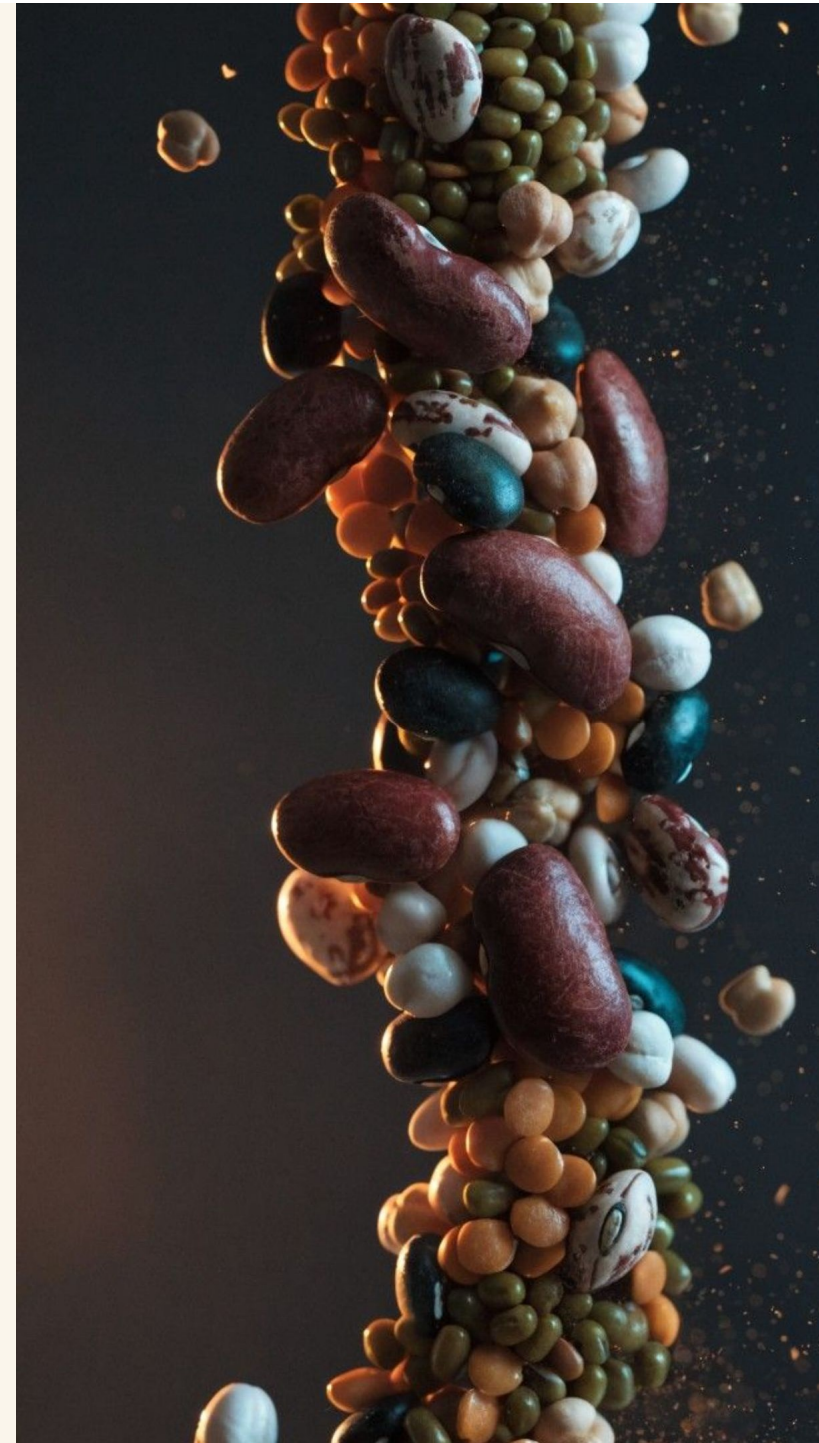
Hyperthyroidism – pitted enamel, gingival staining and tooth surface loss

# Cariogenic versus cariostatic elements

| Element     | Mechanism of action                                      | Element   | Mechanism of action                                                                       |
|-------------|----------------------------------------------------------|-----------|-------------------------------------------------------------------------------------------|
| Fluorine    | ↑enamel resistance<br>Incipient lesions remineralisation | Selenium  | (?) Dentin structure changes in mandibular condyles                                       |
| Molybdaenum | (?) similar/synergy to fluorine (Hungary, New Zealand)   | Cadmium   | (?) Countering fluorine action                                                            |
| Vanadium    | (?) limited proofs in hamsters, limited evidence in men  | Lead      | $Ca^{2+}$ and $PO_4^{3-}$ ions substitution<br>Hypercalcemia, hyperphosphatemia induction |
| Strontium   | ↑content in younger teeth                                | Manganese | ↑caries incidence in Mn-rich areas<br>↑young boys affected more                           |
| Lithium     | (?) indirect, unclear                                    | Copper    | (?) unclear                                                                               |
|             |                                                          | Zinc      | (?) controversial                                                                         |

# Antinutrients: The Hidden Barriers to Nutrient Absorption

PATHOPHYSIOLOGY · DENTAL MEDICINE



## Defining the Antinutrient Landscape



Antinutrients are naturally occurring compounds in plants — particularly grains, legumes, and nuts — that evolved as **chemical defense mechanisms** against herbivores and pests.

# Antiproteins: The Digestive Blockers

## Lectins

Bind to intestinal mucosa, disrupting absorption of amino acids and fats. Can cause direct damage to the gut epithelial lining.

## Protease Inhibitors

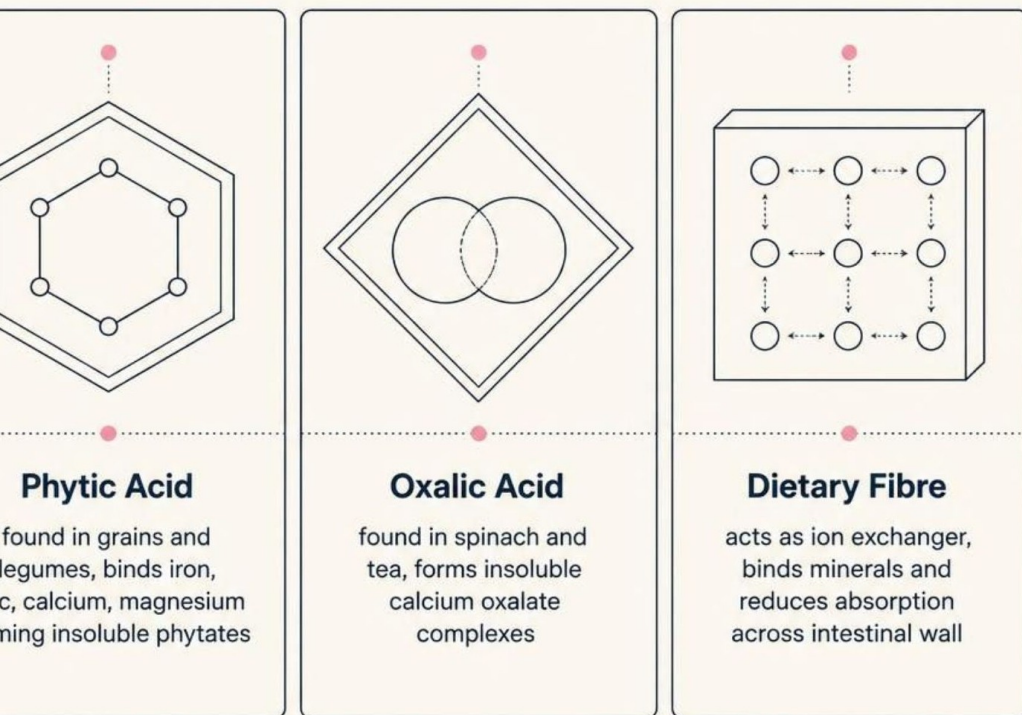
Inhibit key enzymes — trypsin and pepsin — preventing adequate protein hydrolysis and reducing amino acid bioavailability.

## Clinical Consequence

Reduced protein bioavailability, impaired mucosal integrity, and potential systemic effects on tissue repair and immunity.



# Antiminerals: The Mineral Sequestrators



## Why This Matters Clinically

Antiminerals form **insoluble complexes** that the intestinal wall cannot absorb — even when dietary intake appears adequate.

- Phytic acid is the most prevalent — a major concern in plant-based diets
- Oxalate-calcium binding contributes to kidney stone formation
- High-fibre diets may paradoxically reduce mineral status

# Antivitamins: The Metabolic Saboteurs



## Thiaminases

Found in raw fish and certain shellfish. Split thiamine (B1) at the methylene linkage, causing deficiency — notably **Beri-Beri**.



## Avidin

Found in raw egg whites. Forms extremely stable, unabsorbable complexes with **biotin**, leading to deficiency with prolonged raw egg consumption.



## Ascorbic Acid Oxidase

A copper-containing enzyme that **degrades Vitamin C** during food processing and storage, reducing its bioavailability.

# Drug–Nutrient Interactions: The Clinical Context



Beyond food, **commonly prescribed medications** can induce clinically significant micronutrient depletion — a key consideration in long-term patient management.

## PPIs & Antacids

Raise gastric pH, impairing absorption of **B12, iron, and calcium**

## Metformin

Associated with **B12 and folate depletion** via altered intestinal motility

## Diuretics

Loop and thiazide diuretics increase urinary excretion of **calcium, magnesium, and zinc**



# Oral Manifestations of Nutrient Deficiency



## Iron / B12 / Folate

Recurrent aphthous stomatitis, atrophic glossitis, and gingival inflammation — often the **first clinical sign** of deficiency.



## Vitamin C

Scurvy-like presentation: swollen, bleeding gingiva, impaired wound healing, and perifollicular haemorrhage.



## Vitamin A / D

Enamel hypoplasia, delayed tooth eruption, and compromised dentine mineralisation during development.

# Trace Elements and Dental Health

## Elements That Protect

### Fluoride

Incorporates into hydroxyapatite forming fluoroapatite — more acid-resistant

### Phosphorus

Essential for enamel mineralisation and remineralisation cycles

## Elements That Harm

### Selenium & Lead

Linked to increased caries prevalence and disrupted enamel formation

### Magnesium (excess)

High levels may destabilise crystal lattice, increasing susceptibility

❏ Enamel's high surface area allows adsorption of foreign ions — making trace element balance critical for tooth integrity.

# Mitigating Antinutrient Effects



## Processing

Soaking, sprouting, fermentation reduce phytates and lectins

## Heat

Boiling and cooking degrade lectins and thiaminases

## Dietary Pairing

Combine iron-rich foods with vitamin C to improve absorption

Simple food preparation techniques can dramatically improve micronutrient bioavailability — an important counselling point for patients with marginal nutrient status.

# Clinical Vigilance in Dental Medicine

## 1 Recognise the Oral–Systemic Link

Systemic nutrient status directly governs oral tissue health, immune response, and wound healing capacity.

## 2 Screen for Drug-Induced Depletions

Patients on long-term PPIs, metformin, or diuretics are at elevated risk — consider targeted supplementation.

## 3 Advocate for Dietary Optimisation

Educate patients on food preparation methods and dietary combinations that maximise micronutrient bioavailability.





Malnutrition, imbalanced diet

# Disorders of nutrients

# Protein-energy malnutrition (PEM)

- Definition
  - One or more macronutrients are insufficiently supplemented by the diet
  - Can be selective (e.g. just proteins) or total
  - Lack of one nutrient may be connected with excess of another (e.g. kwashiorkor - ↓proteins, ↑sugars and fats)

# Systemic manifestations of PEM

- Decrease in body weight (even up to 60 – 80 % of normal weight)
- Reduced metabolic rate, bradycardia
- Thin, dry skin, wrinkles, loss of pigmentation (?), delayed wound healing
- Prone to infections
- Delayed psychomotor development, impaired cognitive functions, apathy, lethargy
- Hypothermia or feeling constantly cold
- Oral health issues

## KWASHIORKOR VS MARASMUS

- In preschool children (1-5 years of age)
- Due to low protein intake
- Mild growth retardation
- Mild reduction in body weight
- Protruding abdomen and subcutaneous fat reserved
- Ribs not very prominent
- Poor appetite
- Enlarged fatty liver
- Oedema present
- Moonfacies
- Sparse hair
- Flaky paint-like skin
- Lethargic
- Requires adequate amount of protein



Kwashiorkor

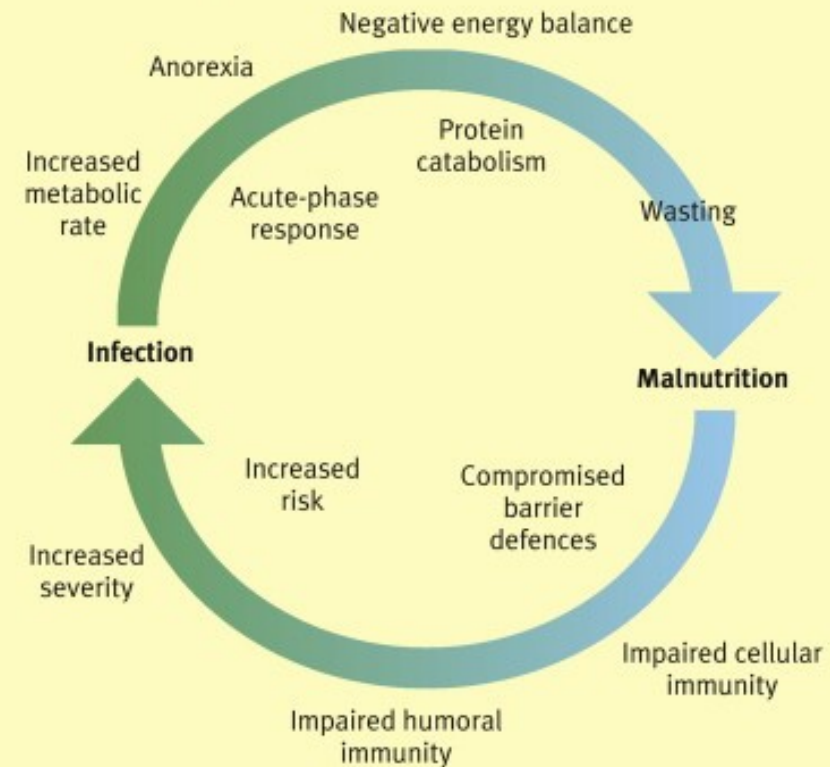
- In weakened infants (<1 year old)
- Due to low calorie intake
- Severe growth retardation
- Severe reduction in body weight
- Shrunken abdomen and subcutaneous fat not preserved
- Prominent ribs
- Voracious feeder
- No fatty liver
- Oedema not present
- An old man like face
- No hair changes noted
- Dry and wrinkled skin
- Alert but irritable
- Requires adequate amount of protein, fat and carbohydrate



Marasmus



## The vicious cycle of infection and malnutrition



## Kwashiorkor

Low dietary  
protein

↓ ferritin

↓ protein

↓ Hb and  
Anemia

Hypoalbuminemia

Impaired  
β-lipoprotein

↓ oncotic  
pressure

Fatty liver

Edema

Marasmic-kwashiorkor

## Marasmus

Low dietary  
energy/calories

↓ glycogen  
storage

↑ Glucose

Tryglycerides

Fatty acid

Protein  
catabolism

Muscle wasting

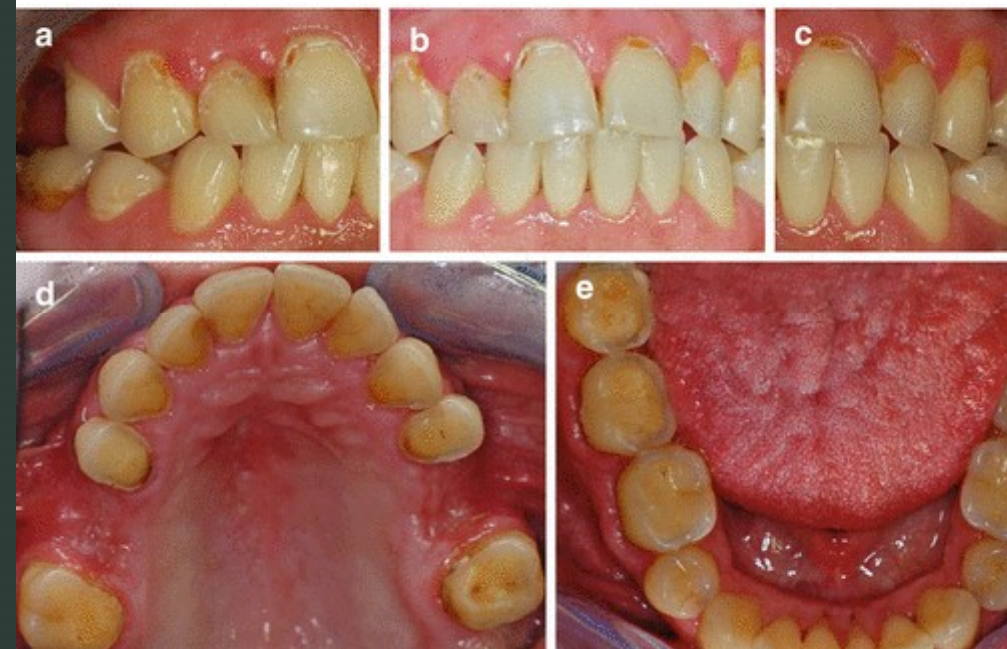
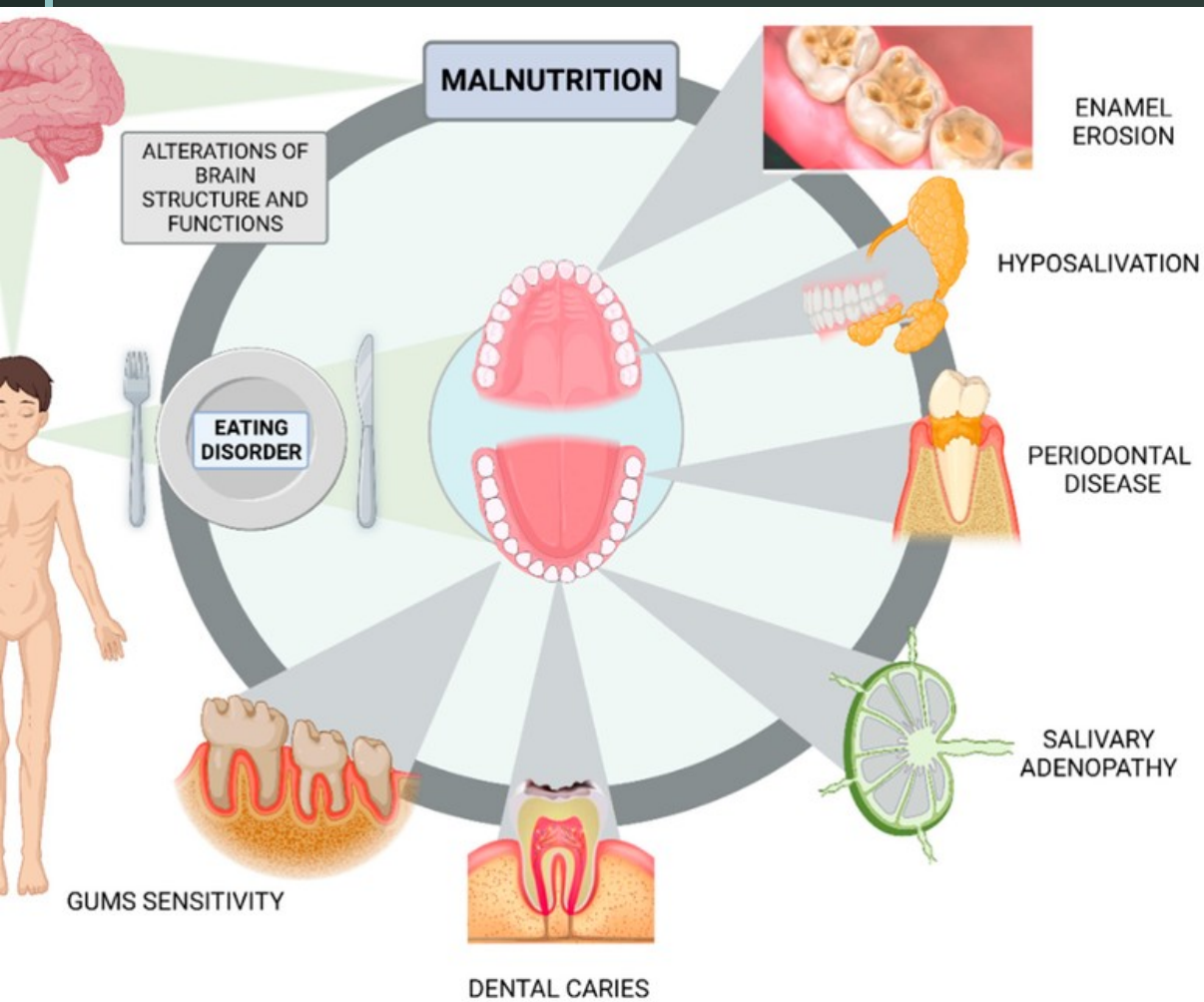


# Oral health manifestations of PEM

1. Tooth defects
2. Salivary gland hypofunction
3. Increased risk of oral diseases
4. Oral tissue inflammation

# Oral health manifestations of PEM – Tooth defects

- Delayed eruption of teeth
- Enamel hypoplasia
  - ↓vitamin A and vitamin D -> improper enamel formation
  - ↓proteins -> insufficient organic matrix -> ↓remineralisation, ↑demineralisation
  - ↓vitamin D -> hypocalcaemia
- Teeth may be smaller
- Tooth loss possible



Enamel erosion – „chalky“ teeth

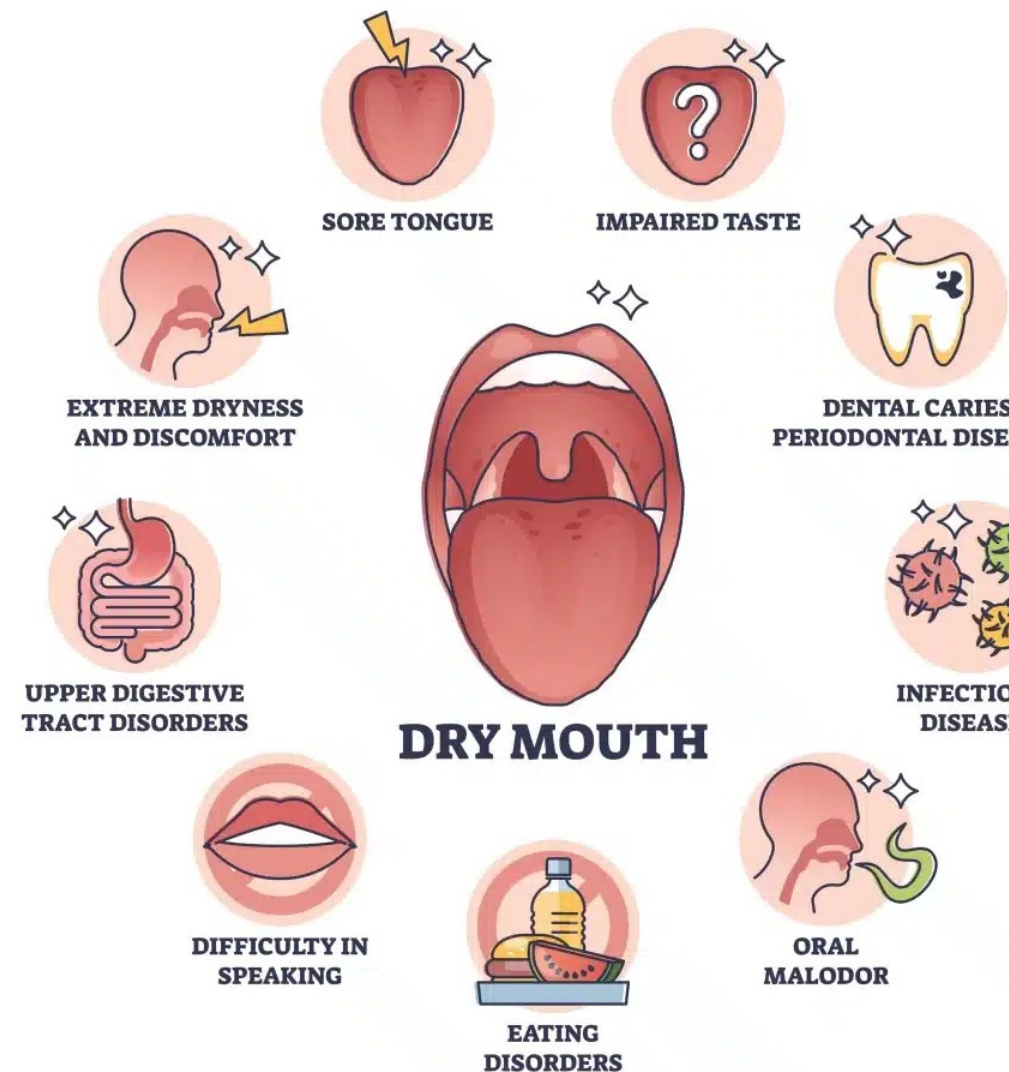
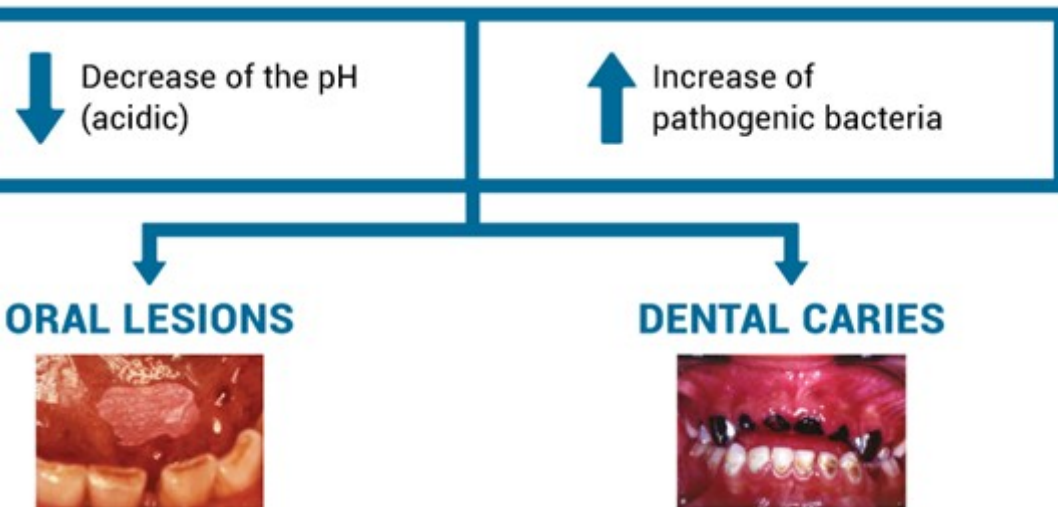
## Oral health manifestations of PEM – Salivary glands hypofunction

- Salivary production is energetically demanding
- ↓salivary flow -> xerostomia
- ↓proteins content -> ↓buffering capacity, ↓antimicrobial properties
- Salivary glands degeneration and/or atrophy
  - PEM + vitamin deficiencies (mostly A)
- Impaired taste perception

# Y MOUTH / XEROSTOMIA



**INCREASE OF PATHOGENIC BACTERIA  
IN A PATHOGENIC BIOFILM**



# Oral health manifestations of PEM – Increased risk of oral diseases

- Impaired immunity
  - Unable to contain infections
  - ↑cariogenic/non-cariogenic bacteria ratio
- Reduced salivary defence
  - ↑plaque formation -> ↑cariogenic „behaviour“ of bacteria
- Delayed wound healing
  - PEM, ↓zinc, ↓vitamins -> ↓lack of macrophages (vitamin A) -> improper collagen synthesis, granulation tissue formation disorders
  - ↓containment of „non-sterile“ conditions -> ↑complications
    - Wound dehiscence, gingivitis, periodontitis, abscesses, bacteriemia, sepsis



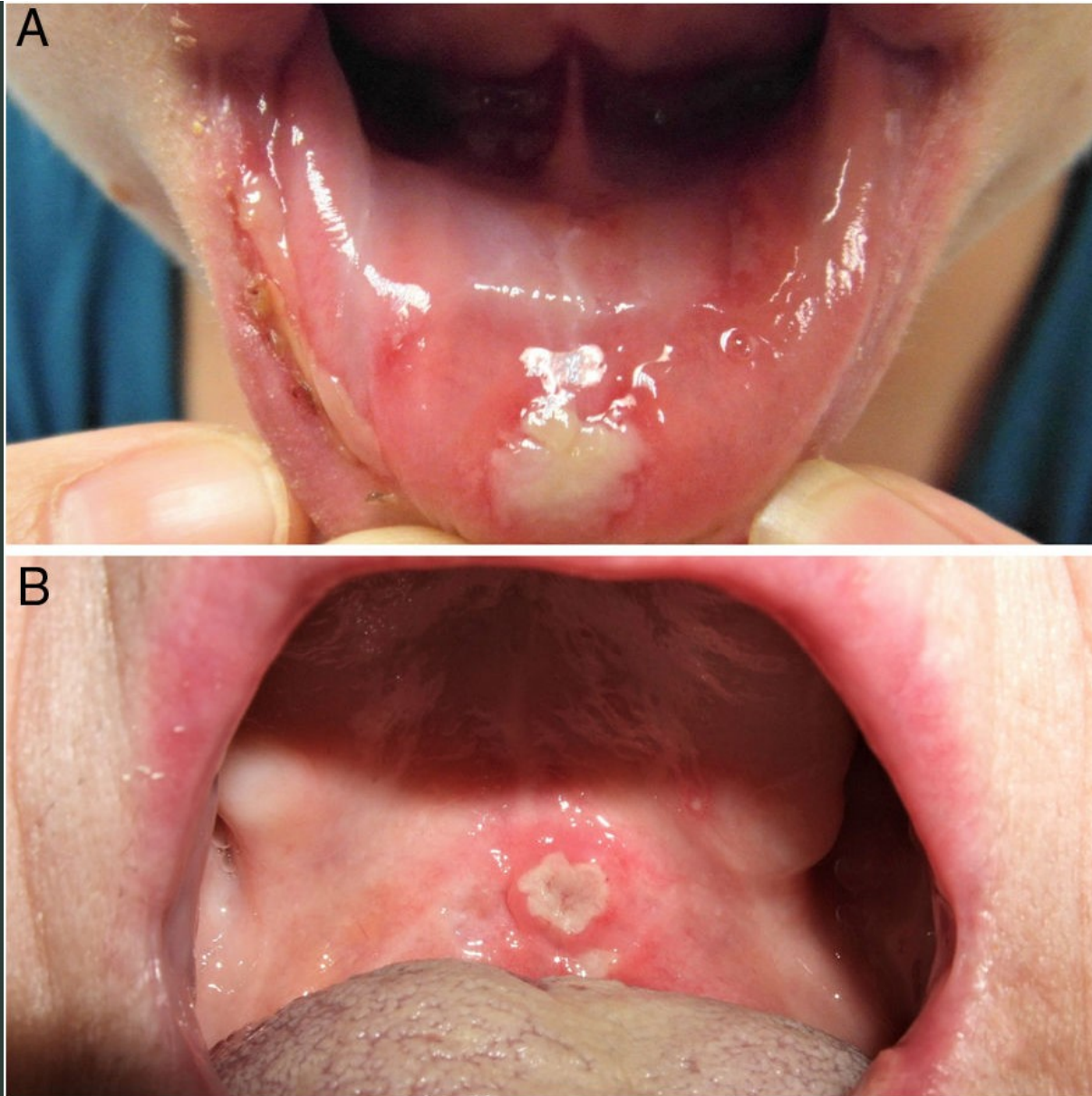
Wound dehiscence  
Corticosteroids use, alcoholism,  
thiamine deficiency



Chronic infection -> pus and fistula  
Multiple diseases (mouth floor ca., Crohn's  
disease, axonal polyneuropathy, ethanol abuse,  
depression) led to secondary undernutrition

## Oral health manifestations of PEM – Oral tissue inflammation

- ↓iron, folic acid, vitamin B12 -> recurrent aphthous stomatitis
- Repeated gingival inflammation -> transition to chronicity
  - Ligaments inflammation -> alveolar bone inflammation



Recurrent aphthous stomatitis

# Oral health manifestations of PEM – Oral tissue inflammation

- Necrotising gingivitis
  - Malnutrition + poor oral hygiene
    - *Prevotella intermedia*, *Fusobacterium* spp., *Bacteroides* spp., *Treponema* spp., etc.
  - Manifestations -> severe gum pain, profuse gum bleeding after minimal or no irritation, „punched out“ interdental papillae (ulcerated with dead tissue)
    - Foul breath, metallic taste
    - Fatigue, fever, cervical lymphadenopathy are very rare (compared to herpetic stomatitis)
  - Noma (*cancrum oris*) as a possible fatal complication
    - Rapidly-progressing gangrenous infection of mouth and face in debilitated children



Acute necrotising ulcerative gingivitis



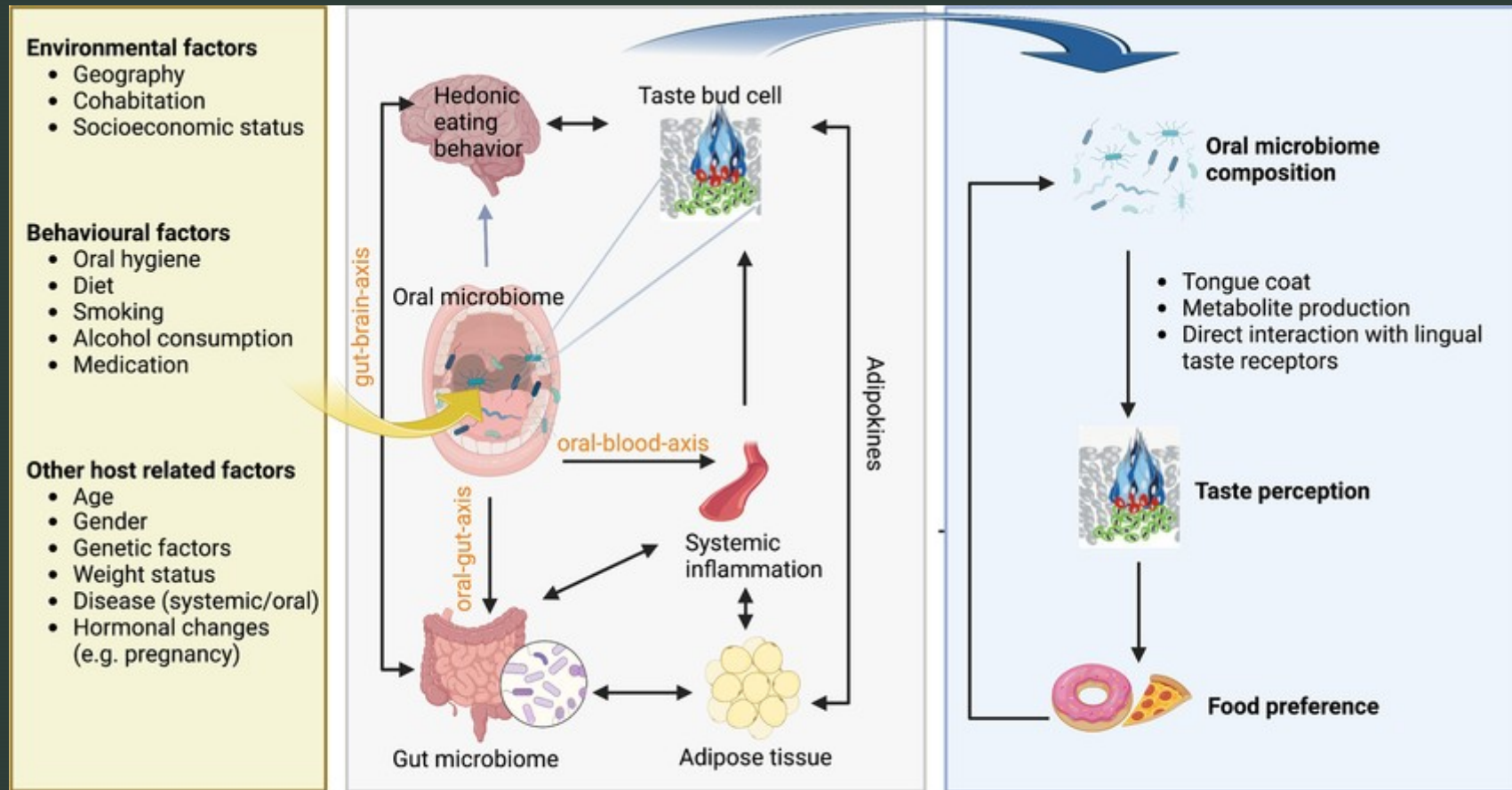
Noma (*cancrum oris*)

<https://www.emdocs.net/wp-content/uploads/2020/04/Screen-Shot-2020-04-13-at-12.54.26-AM.png>  
<https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcSOgylEQkscKcbiulPEzdwPM0P7VKINKk1uUg&s>  
<https://ars.els-cdn.com/content/image/1-s2.0-S0266435604000531-gr2.jpg>



# Overnutrition and obesity

- Overnutrition or increased caloric intake may lead to fat tissue accumulation
- Obesity and metabolic syndrome development
  - ↓insulin sensitivity (insulin resistance)
  - Low-grade systemic inflammation (below threshold of chronic inflammation)
- Oral and systemic health influence each other



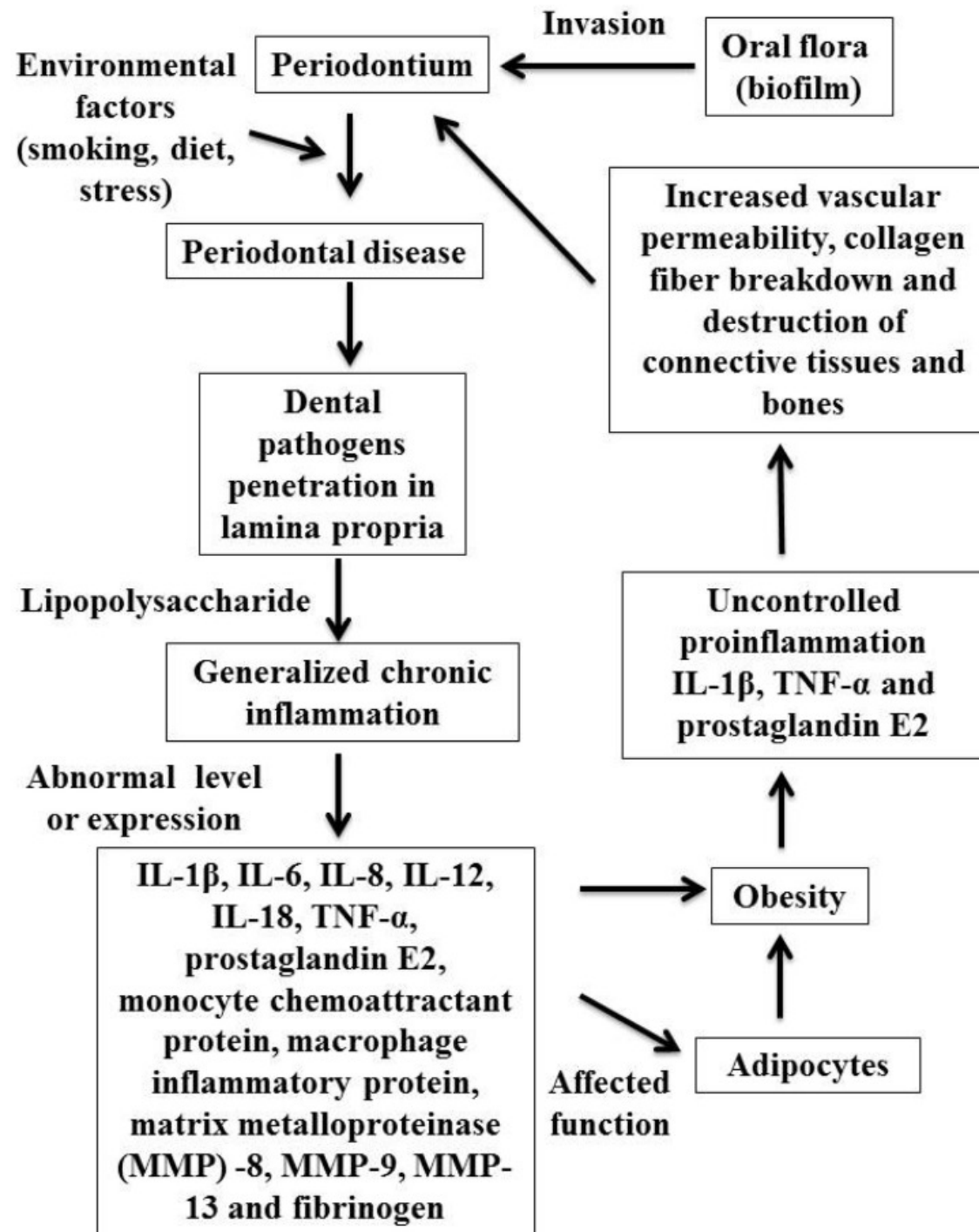
„Reprogramming“ of oral microbiota -> preference of „non-healthy“ food (dietary induced)

# Oral manifestations of overnutrition and obesity

- Many findings controversial
  - Related to dietary habits more than to obesity directly
- Increased caries incidence
  - Less frequent eating, high content of sugars, snacking more than one time per day
  - $\uparrow$ BMI  $\rightarrow$   $\downarrow$ tooth brushing ( $\leq 1$  time per day)
  - $\uparrow$ BMI  $\rightarrow$   $\downarrow$ salivary flow
- No significant relation between obesity and tooth loss

# Oral manifestations of overnutrition and obesity – periodontal disease

- Obesity -> metabolic syndrome
  - Often combined with lack of micronutrients at expense of excessive sugar and saturated fats
- 1. Bacterial flora invasion
- 2. Pro-inflammatory cytokines production -> e.g. TNF- $\alpha$ , IL-1 $\beta$  and IL-6
- 3. Adipokines secretion alteration -> pro-inflammatory adipokines prevail (e.g. leptin, resistin) and cytokines (PGE<sub>2</sub>)
- 4. Vascular permeability increase, collagen fibers breakdown



Thank you for your attention!

