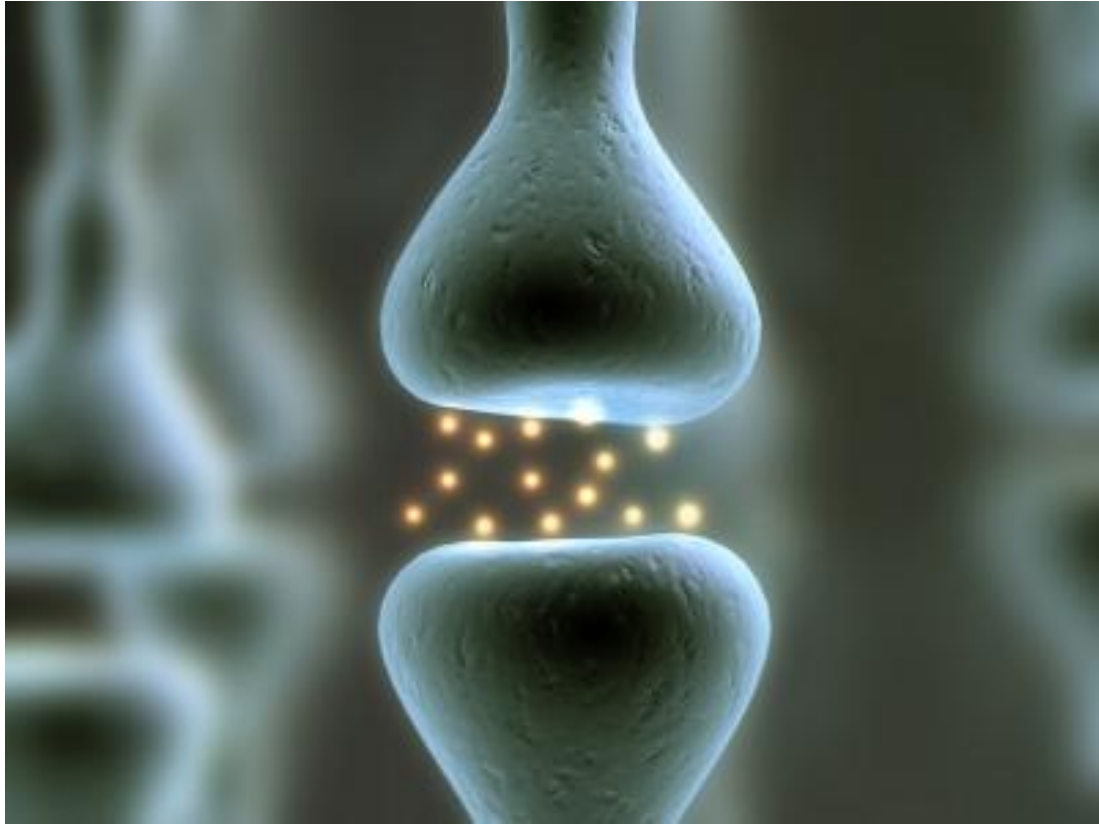


Biochemistry of the CNS



2nd lecture:

Vitamin A

Done by:

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Outlines:

- General biochemistry and types
- General functions
- Functions in the vision cycle
- Deficiency and diseases

♣ Blue color for either the doctor's notes or more explanation

❖ **Vitamin A:**

- **Essential**
 - **Noncaloric** (Doesn't provide you with energy, as appose to carbohydrates and fat. BUT they help in the metabolism of carbohydrates and fat)
 - **Required in very small amounts**
- ♣ Vitamins are organic compounds. Required in the body, but the body can't synthesize them. So, they have to be obtained from the diet. They are needed for the Metabolism and many other functions.

Vitamins Classification: (Based on Solubility)

Fat-Soluble Vitamins	Water-Soluble Vitamins
<i>A (our main focus here)</i>	ascorbic acid (vitamin C)
<i>D</i>	thiamin (vitamin B ₁)
<i>E</i>	riboflavin (vitamin B ₂)
<i>K</i>	niacin
	pyridoxine (vitamin B ₆)
	biotin
	pantothenic acid
	folate
	cobalamin (vitamin B ₁₂)

Vitamin A Classification: (Based on their source)

A. Vitamin A from plants:

Provitamin (inactive form, needs activation)

- They are **inactive** but can be converted into **retinoids** when metabolized in the body (You eat the plant >> metabolize it >> cleave it ! by making it Vitamin >> it is converted to Retinoids (We have 3 types of Retinoids in our body, we will talk about it later on)
- **Eg: Carotenoids (b-carotene) and cryptoxanthin**

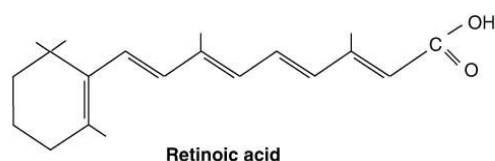
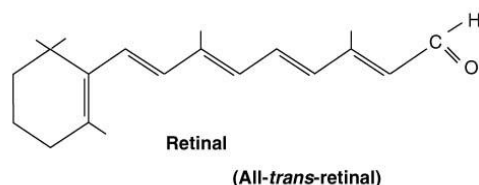
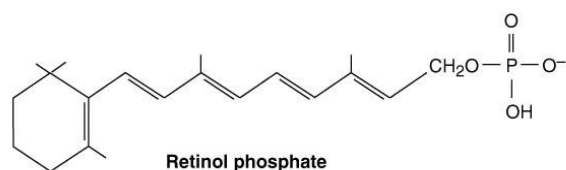
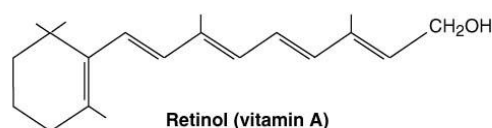
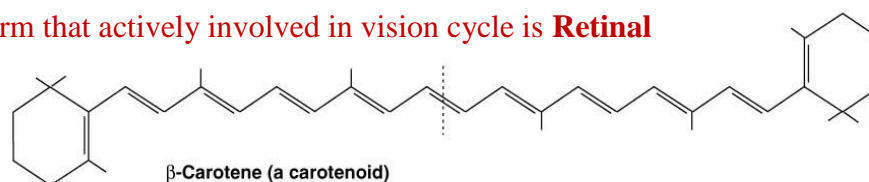
B. Vitamin A from animal sources: (Cheese, milk, and especially Liver)

Preformed (active form)

- Are metabolically active
- Three preformed compounds (retinoids)
 - **retinol** – is convertible to other forms of vit A .. –ol means Alcohol
 - **retinal or retinaldehyde** – **essential in vision** .. –al means aldehyde
 - **retinoic acid** – essential for skin health and bone growth

♣ The form that actively involved in vision cycle is **Retinal**

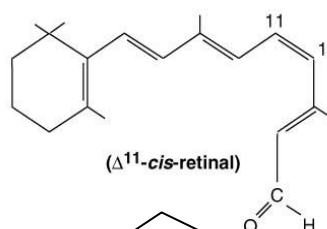
♣ No need to memorize the structures.



Vitamin A comes in two forms in nature

1- Preformed, which means that it's ready to eat and already active (Active form of Vitamin A)

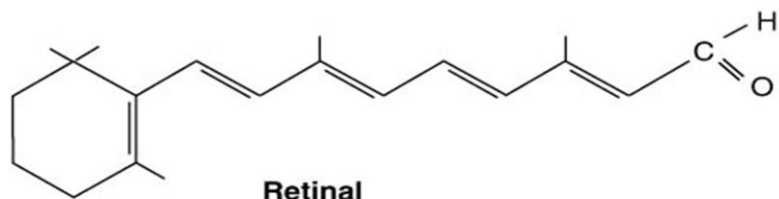
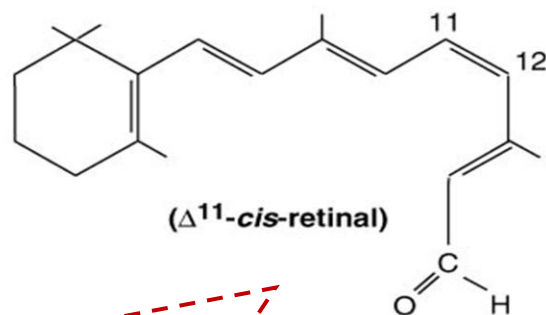
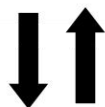
2- Provitamin, that means it's not active and the body needs to activate it (Non Active form of Vitamin A)



11th – at Carbon number 11

Cis = Bent (curve) form

Figure 28.2. Structures of vitamin A and related compounds.

(All-*trans*-retinal)

♣ **Retinal can be converted into two forms:**

Trans & Cis

Trans : is the straight form

Cis : is the bend form

♣ This conversation is a reversible process; Trans can be converted to Cis and vice versa

❖ Functions of Vitamin A

- **Vision**
- **Gene transcription**
- **Immune function**
- **Embryonic development and reproduction**
- **Bone metabolism**
- **Skin Health**
- **Antioxidant activity**

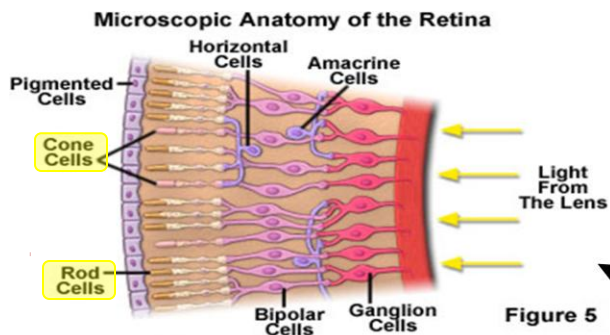
❖ Vitamin A

- Essential role in vision and normal cell differentiation.
- **Deficiency** most significant cause of **blindness** in the developing world
- **Large doses** (supplements not the natural source) over a prolonged period of time can produce **intoxication** and eventually lead to **liver disease**. Why? Because Vitamin A is fat soluble, which is absorbed in the body along with the fat. And then stored in the liver >> liver disease.
- **Excessive carotenoids** (from the plant) intake can result in **yellowing of the skin**, but appears to be harmless

- Toxicity = from supplements
- Yellowing of skin (no harm) = from plants (carotenoids)

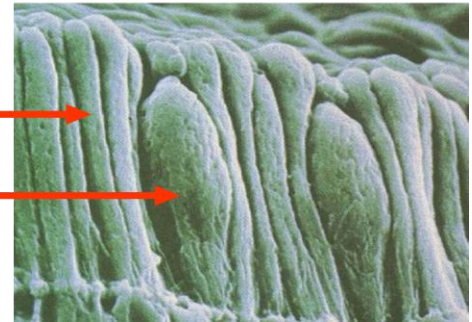
❖ Role of Vitamin A in Vision

- Normal vision depends on the **retina** and on adequate **vitamin A**
- George Wald was awarded Nobel Prize in 1967, for identifying the role of vitamin A in vision
- Retina is a light-sensitive layer of cells at the back of the eye where an image is formed
- **Retina consists of Rod and cone cells (photosensitive cells)**
 - **1. Rod cells process black & white image (in dark area)**
 - **2. Cone cells process color image (in bright area)**
- ♣ In both Rod and Cone cells, vitamin A is formed of Retinal. They differ in the protein they interact with. The final product in Rods is: rhodopsin, and in Cones: iodopsin
- Vitamin A in the form of retinal (in both rhodopsin and iodopsin) binds opsin proteins to make rhodopsin (in rods) and iodopsin (in cones)
 - Retinal (in both) → + **opsin proteins** → **rhodopsin (in rods - dark)**
 - Retinal (in both) → + **opsin proteins** → **iodopsin (they are actually 3, but iodopsin is the most common one) (in cones - light)**

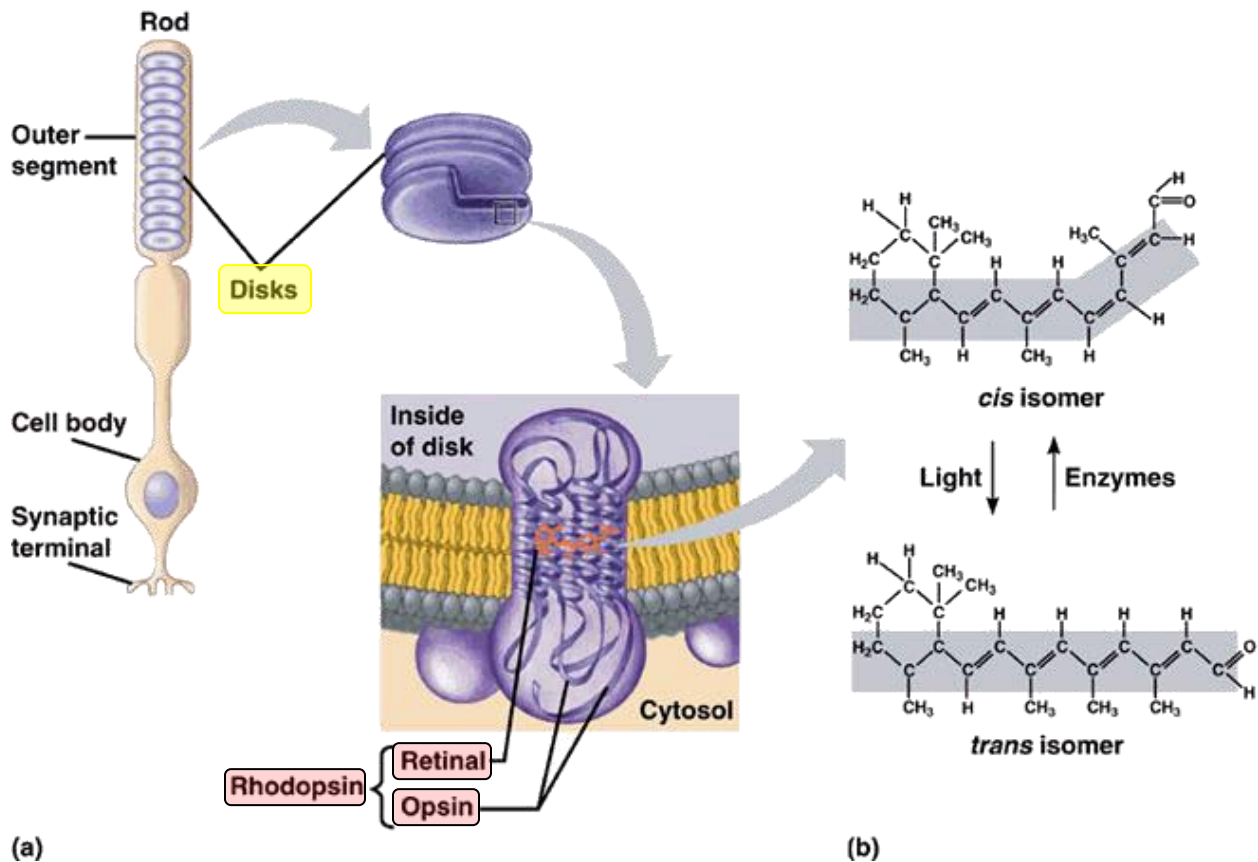


Rod Cell

Cone Cell



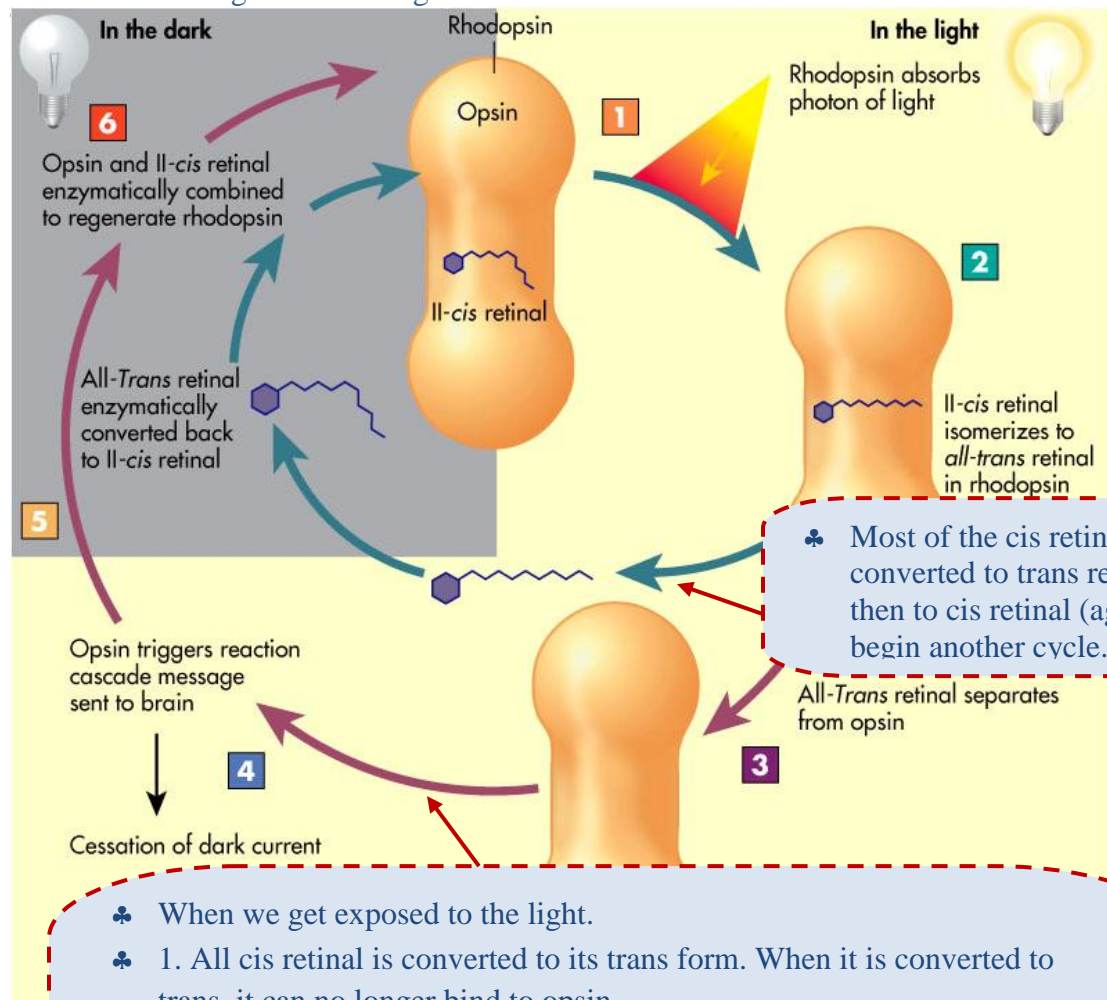
❖ Rhodopsin and retinal structures



- ♣ Retinal and Opsin are found in trans-membrane protein
- ♣ Then, they bind together and it is in the cis form (rhodopsin– in Rods– dark)
- ♣ Then in the presence of light, it changes to the trans form (iodopsin– in Cones– light)

Visual Cycle:

- ♣ Basically a cycle means it is a continuing process, which continues on and on until you sleep.
- ♣ Light impact on the retina → electrical signal to the brain (by the optic nerve) → the brain convert the signal to an image



- It is the process where light impacting (Falling) on the photosensitive cells of the retina is converted into an electrical signal to the optic nerve
- The nerve impulse generated by the optic nerve is conveyed to the brain where it can be interpreted as vision.

❖ Role of Vitamin A in Vision

- When stimulated by light vitamin A changes (or isomerizes) from its bent 'cis' form to a straighter 'trans' form and detaches from opsin
- The opsin molecule changes shape, which sends a signal to the brain and an image is formed
- Most retinal released in this process is quickly converted to trans-Retinol and then to cis-Retinal, to begin another cycle

❖ Dark Adaptation time

- Bright light depletes (**lowers**) stores of rhodopsin in rods
- A sudden shift from bright lights to dimly lit area causes difficulty in seeing
- Rhodopsin is synthesized in few minutes and vision is improved
- This time is called the **dark adaptation time**
- Dark adaptation time is **increased** in vitamin A deficiency

❖ Recommended Dietary Allowance (RDA)

- Vitamin A for Adults
- Women: 700 µg or 2,330 IU µg
- Men: 900 µg or 3,000 IU
- UL Men or Women: 3,000 µg or 10,000 IU

The doctor just read those very quickly, not that important

♣ UL : Upper Limit , the maximum limit which we can take without any toxins effect

❖ Vitamin A Deficiency and Diseases:

- **Night blindness** or **Nyctalopia** -patient cannot see in low light or near darkness conditions (**problems in reading or driving at night**)
- **Xerophthalmia** - dryness of the conjunctiva and cornea
- **Bitot's spots**- localized increased thickness of conjunctiva

Bitot's spots (foamy patches on the white of the eye) - white plaques of keratinized epithelial cells - are found on the conjunctiva of young children with vitamin A deficiency.



- **Keratomalacia** – prolonged **xerophthalmia** leads to drying and clouding of cornea (**cornea starts to break due to dryness of the eyes**)
- **Blindness**