

[lecture 2]

Vitamin A



The Objectives

Make sure you know:

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

Red =
Important

Blue =
explain

Green =
addition
notes

Done By : Latifah Al-fahad And Seham Al-Anazi /
Reviewed By : Arwa Al-Mashaan And Basil AlSuwaine



Mind map

Vitamin A

forms

functions

Vit. A and vision

Deficiency and Diseases

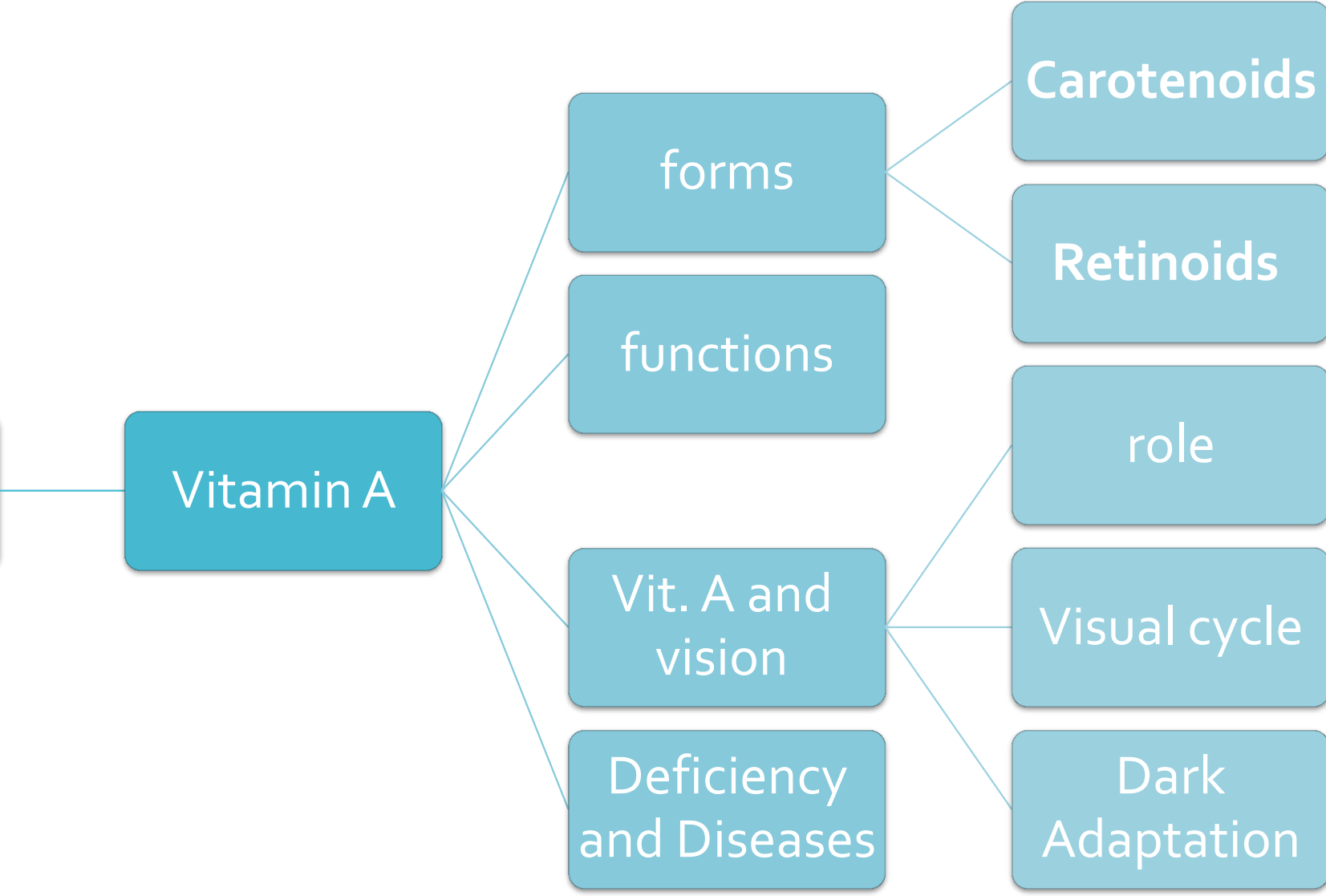
Carotenoids

Retinoids

role

Visual cycle

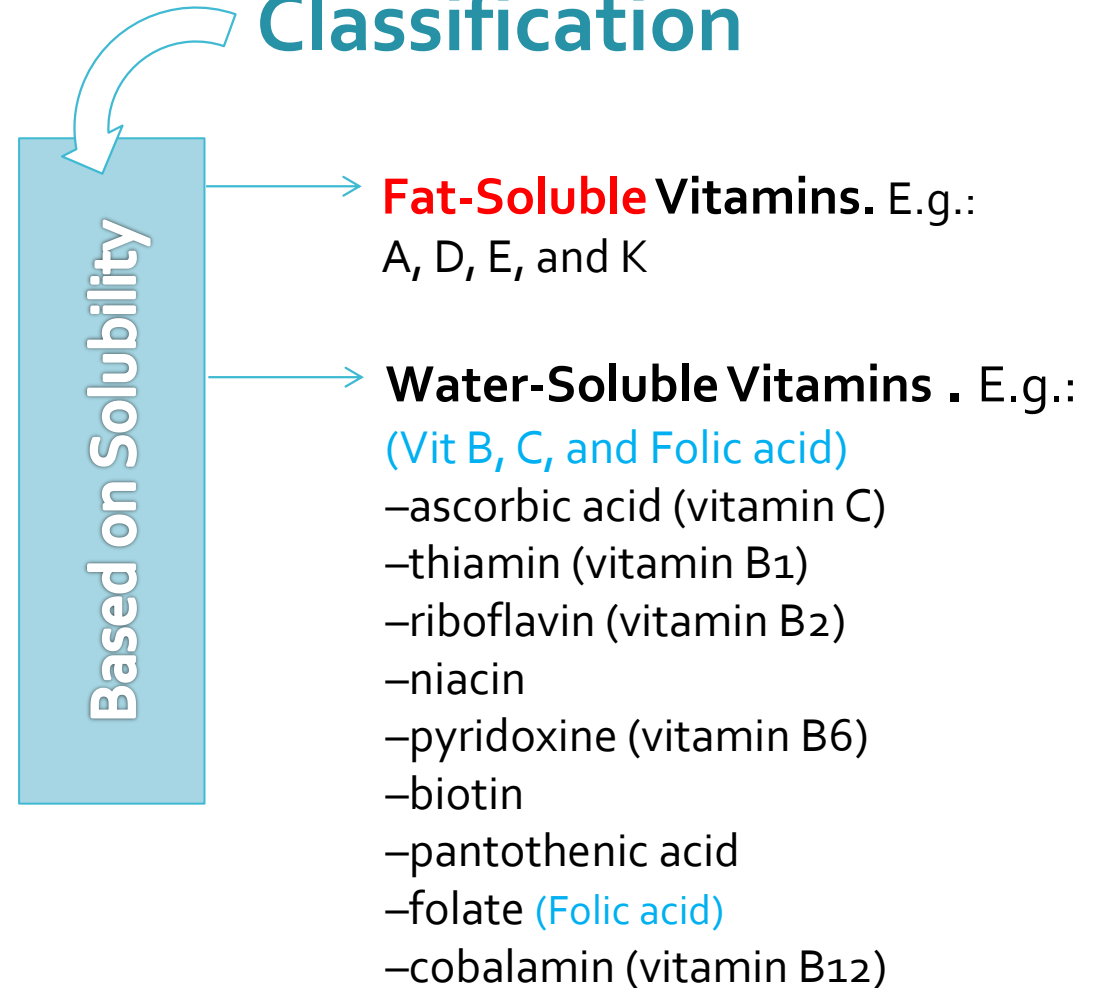
Dark Adaptation



About vitamins:

- They are organic compounds present in small quantities in different types of food
- Help in various biochemical processes in cell
- Most act as **coenzymes** (especially water soluble vitamins)
- Important for growth and maintaining good health
- **Essential**
- **Non-caloric** (Not giving you energy)
- **Required in very small amounts**

Classification



Vitamin A

Fat-soluble Vitamins

1. •Stored in the liver and adipose tissue
2. •Excess may accumulate and **cause toxicity**
3. •Cases of toxicity with **vitamin A and D** have been reported
4. •Do not need to be consumed each day due to storage in the body
5. •Absorbed slowly with fats
6. •**Diseases due to deficiency are rare** as large amounts are stored in the body

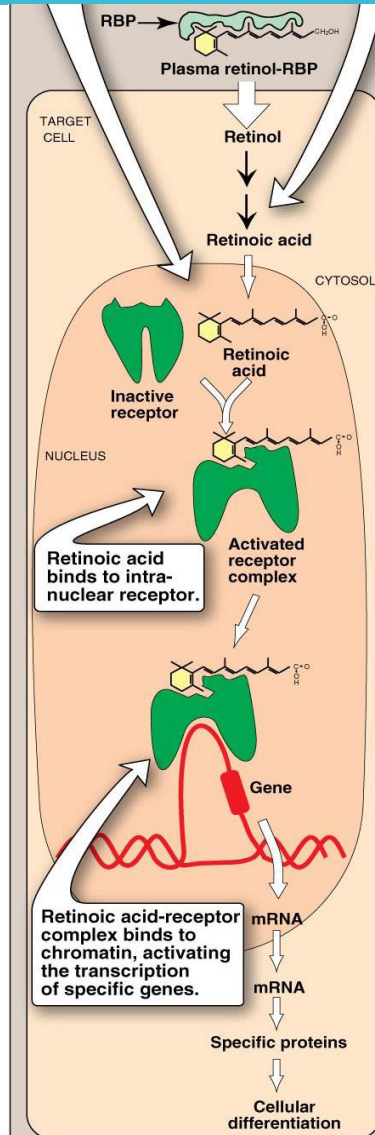
Sources of Vit. A

Source	Plants	Animals
They're	Provitamins (precursors)	Preformed (metabolically active)
In the form of	Carotenoids (b-carotene) and cryptoxanthin ❖ Are inactive but can be converted into retinoids when metabolized in the body ❖ One molecule of b-carotene can be cleaved into two molecules of retinal in the intestine . (but an inefficient process)	Retinoids (3 preformed compounds): <ol style="list-style-type: none"> 1. Retinol: is convertible to other forms of vit A. found in animal tissues as retinyl esters (stored form) 2. retinal or retinaldehyde: essential in vision 3. retinoic acid : essential for skin health and bone growth . It cannot be reduced in the body and therefore cannot give rise to either retinal or retinol

Functions of Vit. A

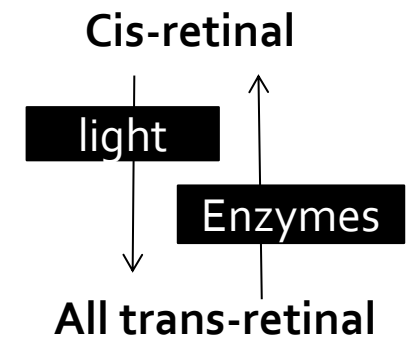
Functions of Vitamin A

- Vision (Cis and all-trans retinal)
- Gene transcription (retinoic acid)
- Immune function (retinoic acid)
- Embryonic development and reproduction (retinal)
- Bone metabolism (retinoic acid)
- Skin Health (retinoic acid)
- Antioxidant activity (b-carotene)
- Growth: Vitamin A deficiency causes loss of appetite. Slow bone growth. Affects CNS.
- Reproduction: Retinol and retinal are essential for normal reproduction
- Maintenance of epithelial tissues.



Transcription function:
Retinol is oxidized to retinoic acid in **cytosol**. Retinoic acid binds to **intra-nuclear** receptor and form an active complex. The complex activated the transcription of the gene (on the DNA)

Convergence from cis-retinal to all trans-retinal for visual cycle:





Biochemistry Team

Absorption, storage and transport of Vit. A

Overview

1 From inactive provitamin to an active form:

b-carotene (antioxidant)

Intestinal cells

Retinol (steroid hormone)

2 Storing Retinol:

Retinol + fatty acid

Liver & adipose tissue

Retinyl esters

(Retinyl palmitate In liver)

3 Using Retinol:

Retinol

Glycoprotein synthesis

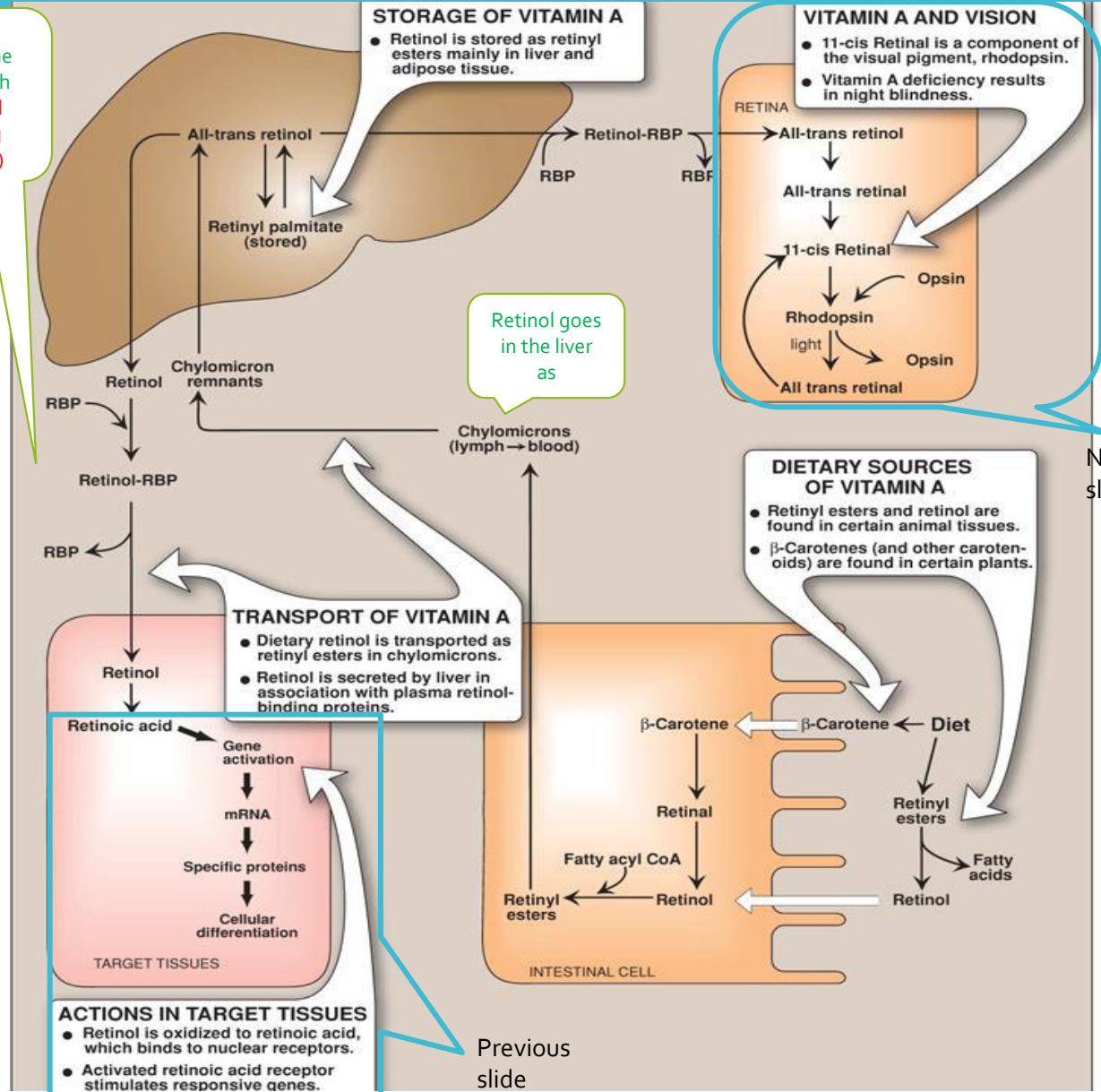
Retinal (for visual cycle)

Retinyl phosphate

Retinoic acid

Retinol leaves the liver With (Retinol Binding Protein)

Retinol goes in the liver as



Next slides

Previous slide

Vitamin A

About vit.A

- Essential role in vision and normal cell differentiation
- Deficiency most significant cause of blindness in the developing world (you will know why in visual cycle below)
- Large doses over a prolonged period of time can produce intoxication and eventually lead to liver disease.

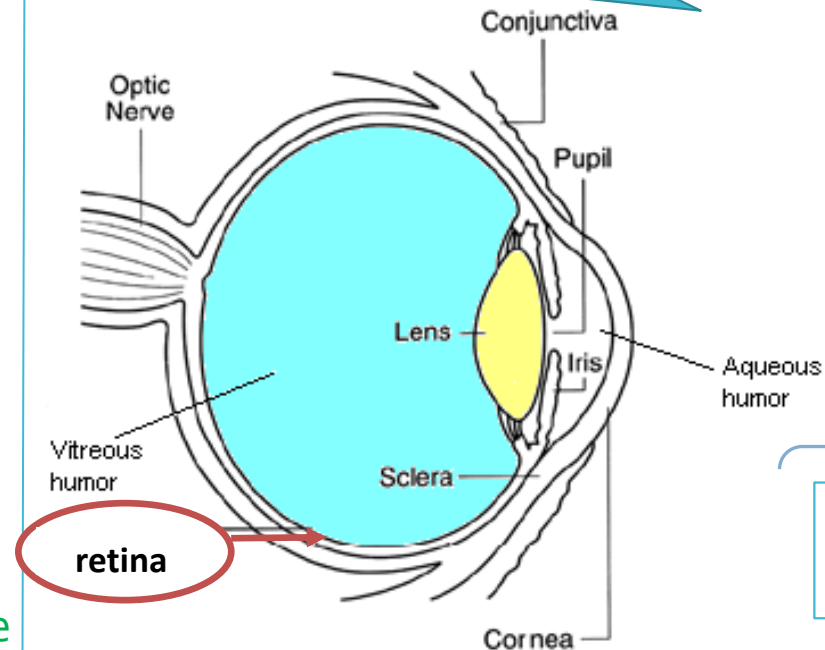
because vit.A is fat soluble vitamin (storage vitamin) so, when increase in the body you will store more and more which lead to toxicity

- Excessive **carotenoids** intake can result in **yellowing** of the skin, but appears to be harmless

Excessive carotenoids intake **can not lead to toxicity** because its conversion to retinol is not efficient process(slide 6), but can lead to yellowish of skin.

#It differ from yellowish that you see in jaundice, in jaundice the sclera and nails also become yellow.

Role of Vitamin A in Vision



George Wald was awarded Nobel Prize in 1967, for identifying the role of vitamin A in vision

Retina has photoreceptors, when the light com it goes to them

Normal vision depends on

Retina

Adequate vit.A

cont, 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).

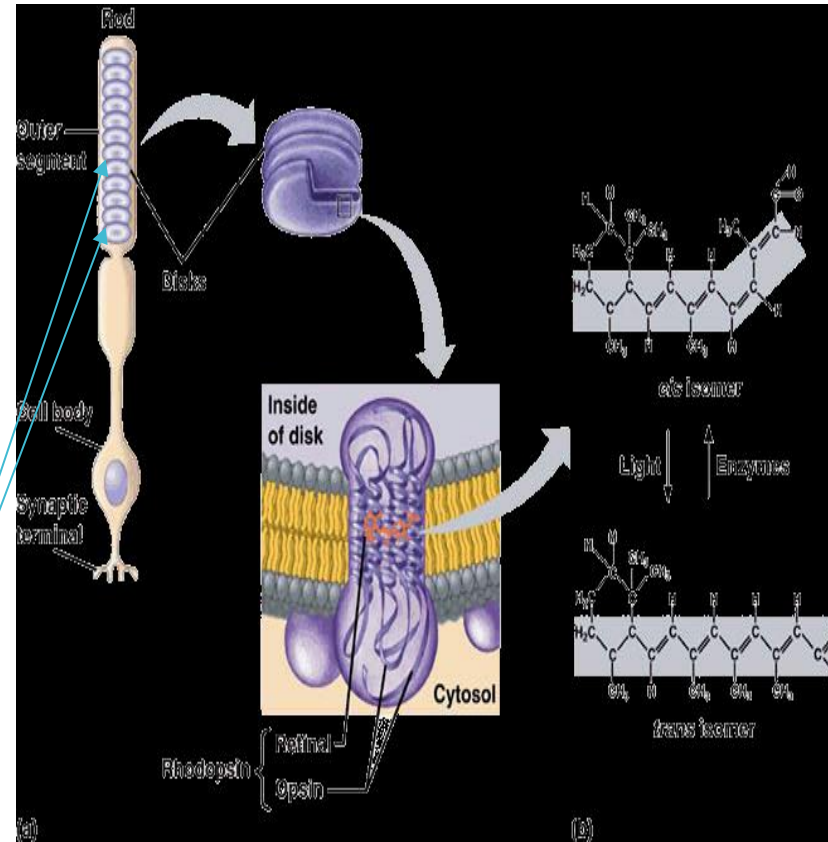
Rod cells process black & white image.
Rod cells translate the signals into white & black vision.

Cone cells process **color** image.

Vitamin A in the form of retinal binds opsin proteins to make **rhodopsin** (in rods) and **iodopsin** (in cones). **Rhodopsin** and **iodopsin** are light-sensitive pigments

Inside the rod there are disks containing RHODOPSIN

Visual cycle



Light impacting on photo-sensitive cell of retina.

It is converted into an electrical signals

It goes to optic nerve

The nerve impulse generated by the optic nerve is conveyed to the brain where it can be interpreted as vision. (The brain processes the signal into an image)

Visual cycle

1-Opsin protein bind to 11-cis retinal

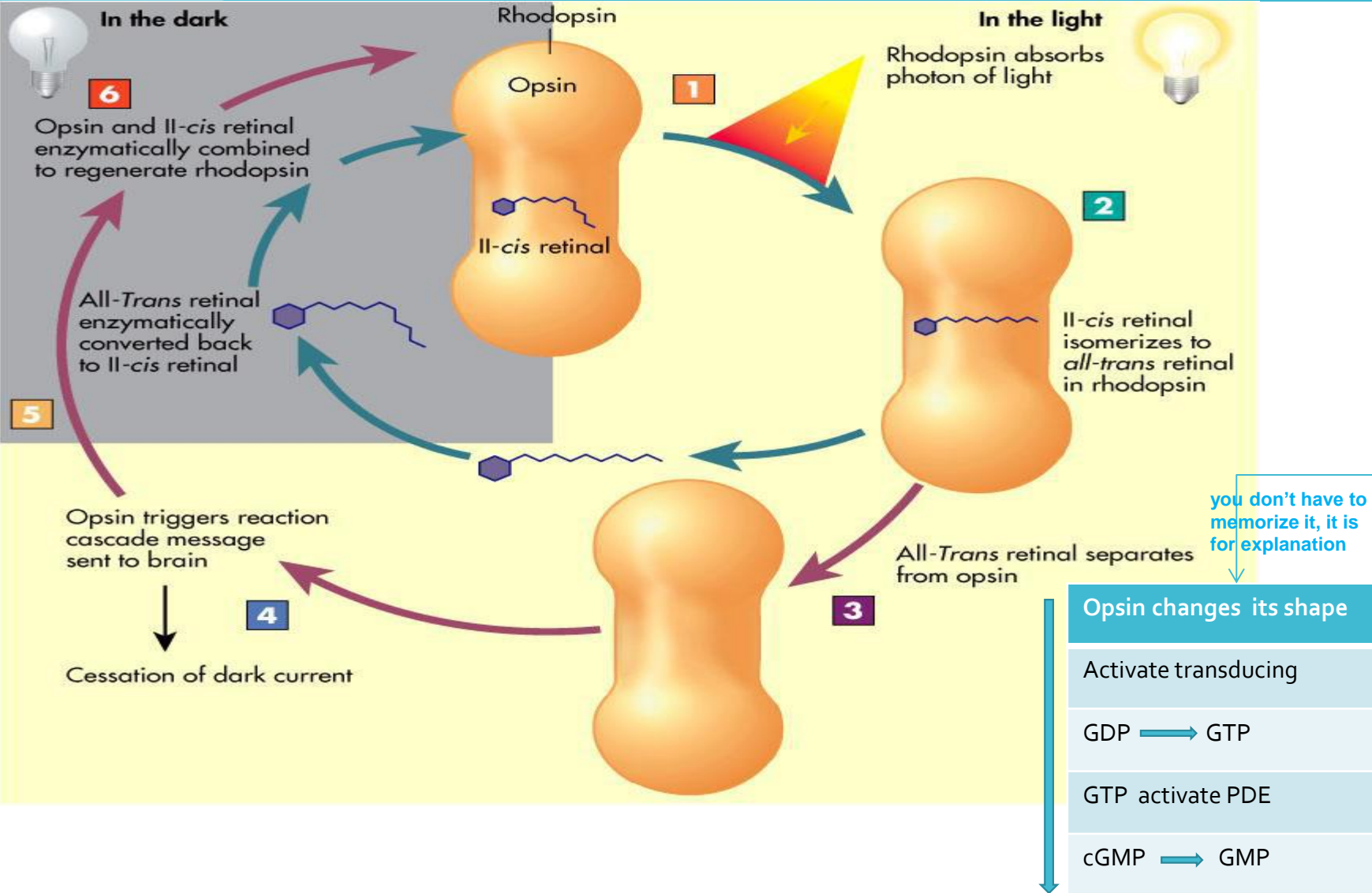
2-When the light comes all cis converts into all trans

3-All Trans retinal does not like opsin so, it will separate from it

4-Opsin changes its shape, that triggers cascade of reactions, end of the message is reached to optic nerve

5- All trans retinal enzymatically converted back to 11-cis retinal.

5-All 11-cis retinal enzymatically combined to opsin to form rhodopsin and repeat the cycle



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-Retinal and then to cis-Retinal, to begin another cycle.

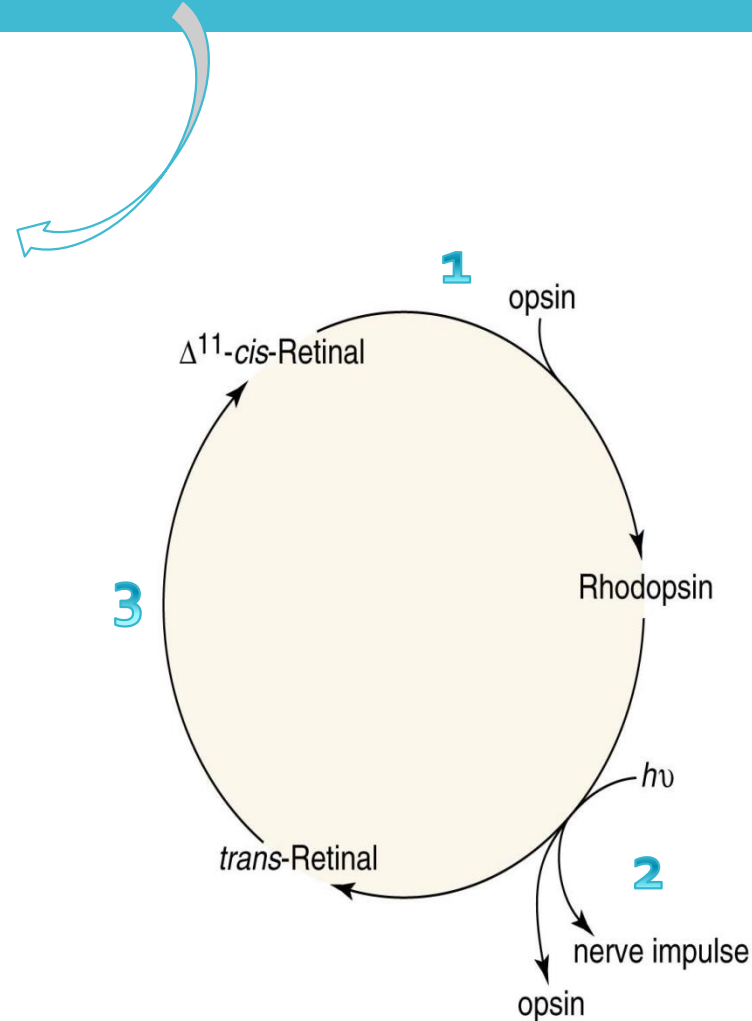


Figure 28.4. Role of vitamin A in vision.

Dark adaptation time; time needed for regenerate more rhodopsin.

Bright light depletes stores of rhodopsin in rods.
(photobleaching)

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**.

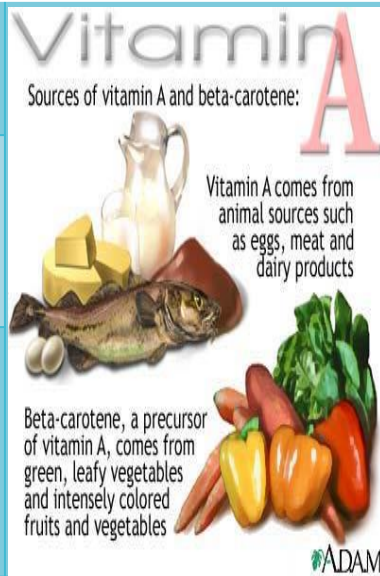
Recommended Dietary Allowance

Vitamin A for Adults

Women: 700 µg
or 2,330 IU

Men: 900 µg or
3,000 IU

UL Men or
Women: 3,000
µg or 10,000 IU



Animal
sources

Plants
sources

#Upper limit only for fat soluble vitamins (storage vitamins) which if increase lead to toxicity, unlike water soluble vitamins if increased will excreted from body.

Vitamin A deficiency and diseases

Night blindness or Nyctalopia - patient **cannot see** in low light or near darkness conditions

Xerophthalmia - **dryness** of the **conjunctiva and cornea**

Lead to ulceration → scarring → blindness

Bitot's spots- localized increased **thickness of conjunctiva**

Keratomalacia – prolonged xerophthalmia leads to **drying** and **clouding of cornea**

Blindness in severe deficiency

SUMMARY

1. Vitamins are either fat-soluble (e.g. Vit. A) or water-soluble.
2. Vitamin A is of 2 forms: Carotenoids (plants) or Retinoids (animals).
3. It has an essential role in vision and normal cell differentiation.
4. retinal binds opsin proteins to make rhodopsin (in rods) and iodopsin (in cones)
5. vitamin A changes by light from its bent 'cis' form to a straighter 'trans' form and detache from opsin
6. Bright light depletes stores of rhodopsin in rods. The time spend in re-synthesizing the rhodopsin is called dark adaptation time.
7. Vitamin A deficiency is rare.

Questions

1. All trans-Retinal converted to 11-cis-Retinal by presence of :

- A. Light
- B. Enzymes
- C. Carotenoids

2. Which ONE of the following can't be reduced in the body:

- A. Retinol
- B. Retinoic Acid
- C. Retinal

3. Which ONE of the following is caused by localized increase in thickness of conjunctiva:

- A. Xerophthalmia
- B. Night blindness
- C. Bitot's spots

3. C
2. B
1. B



If you find any mistake, please contact us:)

Biochemistry team leaders:
Basil ALSuwaine And Manar AlEid

Biochemistryteam@gmail.com

