

VITAMIN A

Color index:

- **Important**
- Extra explanation
- Lippincott's notes

“DON'T WATCH THE CLOCK; DO WHAT IT DOES : KEEP GOING”

Check [this link](#) before studying to know if there is any corrections in the teamwork

OBJECTIVES

By the end of this lecture the Second Year students will be able to:

- 1-Identify the types of vitamin A and their functions.
- 2-Discuss the transport and metabolism of vitamin A.
- 3-Comprehend the role of vitamin A in visual cycle
- 4-Correlate the deficiency of vitamin with vision impairment and blindness.

Vitamins

Facts about vitamins:

Organic compounds present in small quantities in different types of food

Help in various biochemical processes in cell

Most act as coenzymes

Important for growth and maintaining good health

Essential

Non-caloric

Required in very small amounts

in micrograms or milligrams.

That means they don't give energy.

A nice short video that will give you a brief idea about the lecture.



[Vitamin A](#)

Vitamins are Classified Based on Solubility:

Fat-Soluble Vitamins

A, D, E, and K

Water-Soluble Vitamins

1. Ascorbic acid (vitamin C)
2. Thiamin (vitamin B1)
3. Riboflavin (vitamin B2)
4. Niacin
5. Pyridoxine (vitamin B6)
6. Biotin
7. Pantothenic acid
8. Folate
9. Cobalamin (vitamin B12)

These eight together are called : B complex.

Fat-Soluble Vitamins

Fat-Soluble Vitamins

This fat soluble vitamins are stored in the body (in the adipose tissue & liver), while water soluble vitamins can't be stored with one exception : B12 is stored in the liver.

Stored in the liver and adipose tissue (because they are fat soluble)

Excess may accumulate and cause toxicity (cases of toxicity with vitamin A and D have been reported).

Do not need to be consumed each day due to storage in the body.

Absorbed slowly with fats

Diseases due to deficiency are rare, why?
A: because large amounts of them are stored in the body.

Vitamin A

Vitamin A from animal sources (Preformed)

- Three preformed compounds called retinoids (this is the group's name NOT the compounds) that are metabolically active and found in animal products:
 1. Retinol:
 - alcohol form.
 - (can be converted to other forms which are retinal and retinoic acid).
 2. Retinal or Retinaldehyde:
 - aldehyde form.
 - (essential in vision).
 - Can be converted back into retinol.
 3. Retinoic Acid:
 - acid form.
 - (for skin and bone growth).
 - Can't be converted back.
 - Derived from oxidation of retinol.
 - Mediates most of the action of retinoids (except for vision).

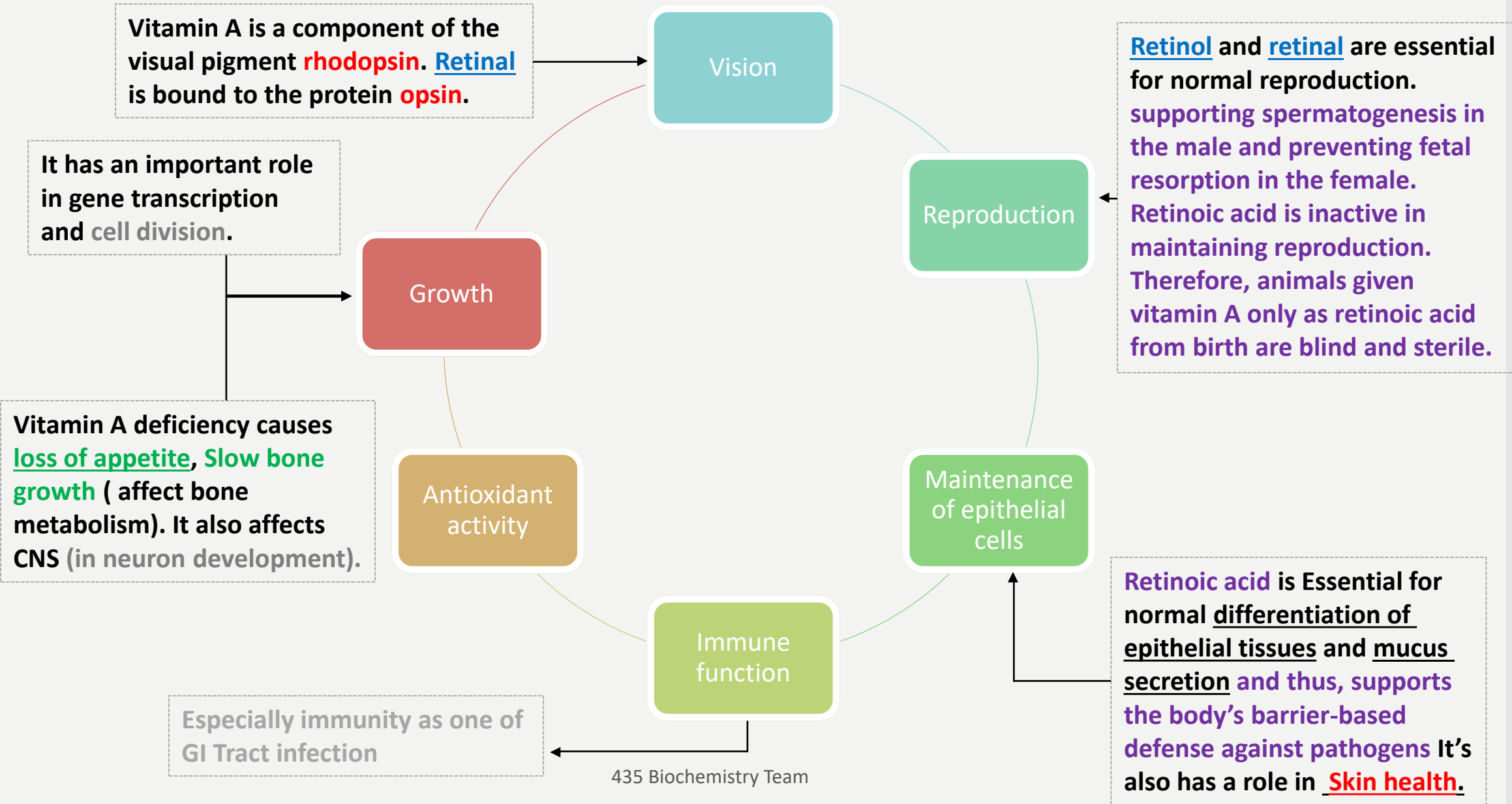
Vitamin A from plant sources (Provitamin)*

- Carotenoids (b-carotene) and cryptoxanthin can yield retinoids when metabolized in the body.
- These are from plant sources.
- One molecule of **b-carotene** can be cleaved into two molecules of retinal in the intestine.
- Not as active as the form they are present in animal ->
- 1 microgram of retinol equal 12 microgram carotenoids.

the yellowish – orange color of carrot is because it's rich of the carotene.

*Provitamin: a substance which is converted into a vitamin within an organism.

Functions of Vitamin A



Facts about vitamin A:

- Essential role in vision and normal cell differentiation .
- Deficiency is the most significant cause of blindness in the developing world (although it's rare nowadays because our food now is rich with vitamins).
- Large doses over a prolonged period of time can produce **intoxication** and eventually lead to **liver disease**.
- Excessive carotenoids intake (e.g. eating a lot of carrot) can result in yellowing of the skin, but it appears to be harmless (which means it's just because of the pigmentation and it will return to normal after some time).

Vitamin A

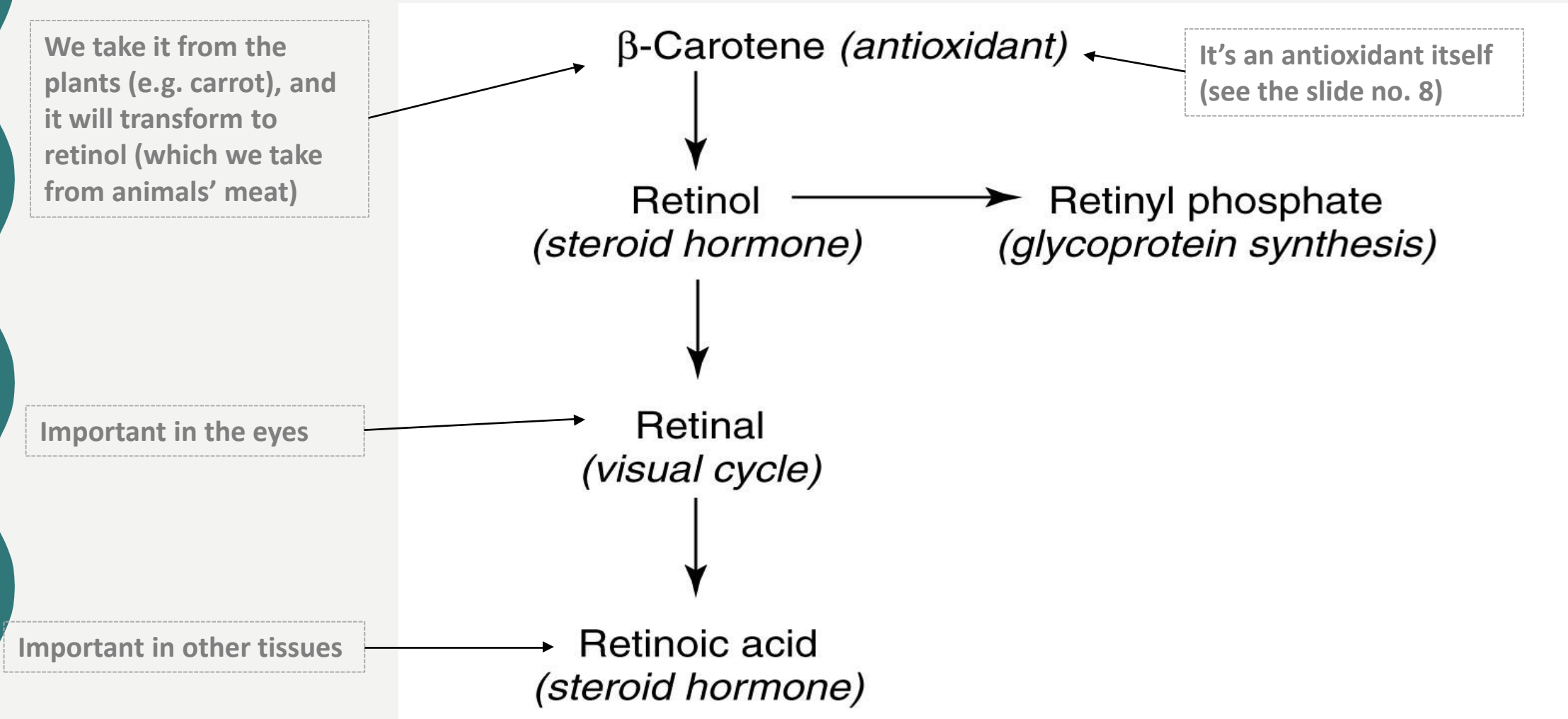


Figure 28.3. Vitamin A metabolism and function.

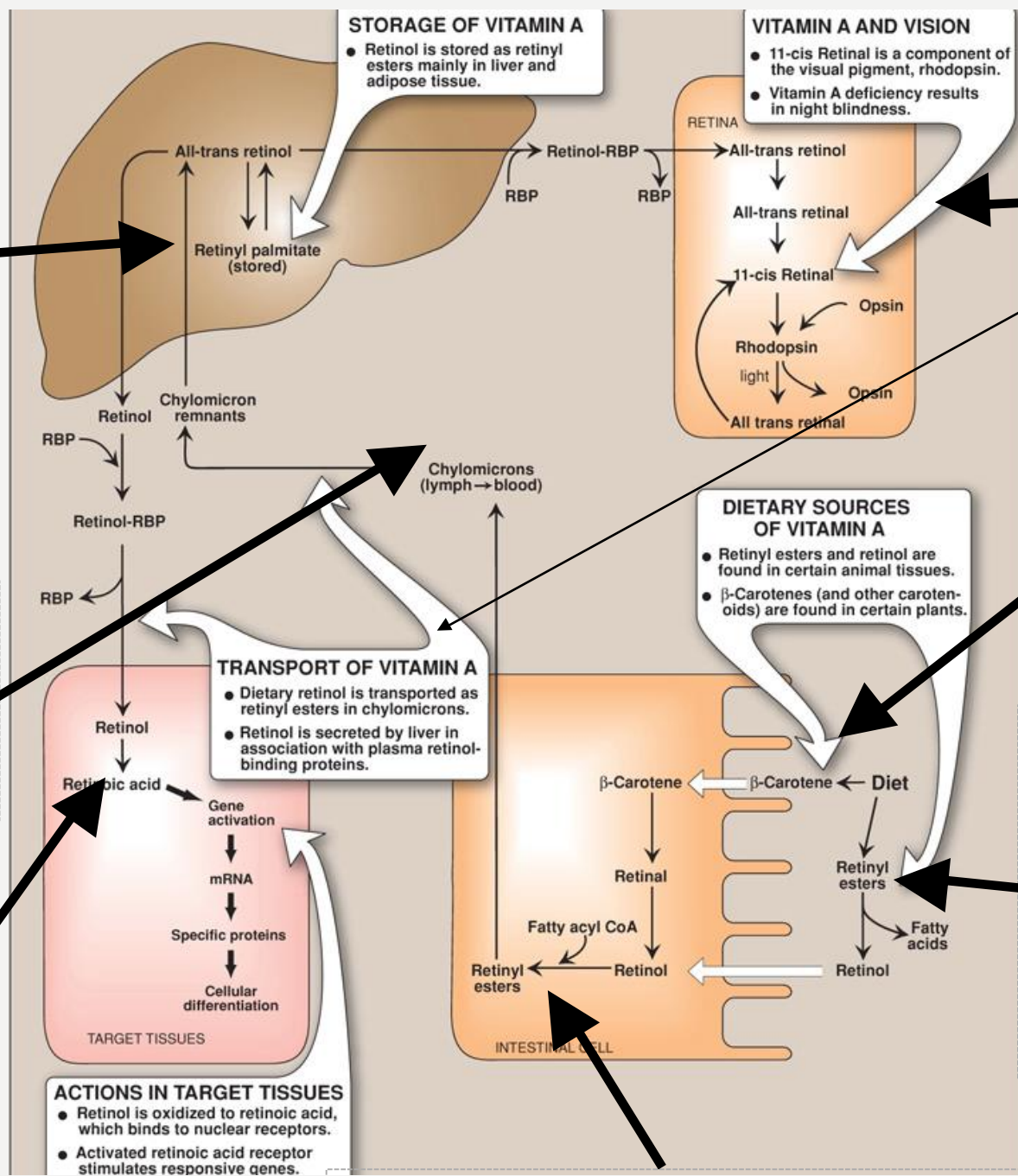
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Retinyl palmitate is the stored form of vitamin A. It's a fatty acid (it's retinol which is combined to the fat and stored in the liver). vitamin A can't be stored freely, it must be combined with fatty acids.

it's a fat transporter in the body (the inside portion is hydrophobic while the outside is hydrophilic).

It goes inside the nucleus to activate a gene for gene expression.

See the next slide for better explanation



Remember : retinol is converted to retinal in the eyes, while it will get converted to retinoic acid in other tissues.

The carotene will be absorbed as is, and then it will get converted to retinol in the intestine

إذا أكلنا كبدة - على سبيل المثال- فإننا نحصل على الـ retinyl ester الخاص بالحيوان (سواء كان خروف مثلا أو حاشي ☺) ، هذا الإستر يتم تكسيره وتحويله إلى ريتينول لكي يدخل للأمعاء ، ثم يتم تحويله مرة أخرى إلى retinyl ester ولكن هذه المرة يكون الاستر الخاص بأجسامنا ، ثم بعد ذلك يتم إرساله إلى الكبد ليُخزن حتى وقت الحاجة.

Note that when fatty acid bind to other molecules, the bond is ester bond.

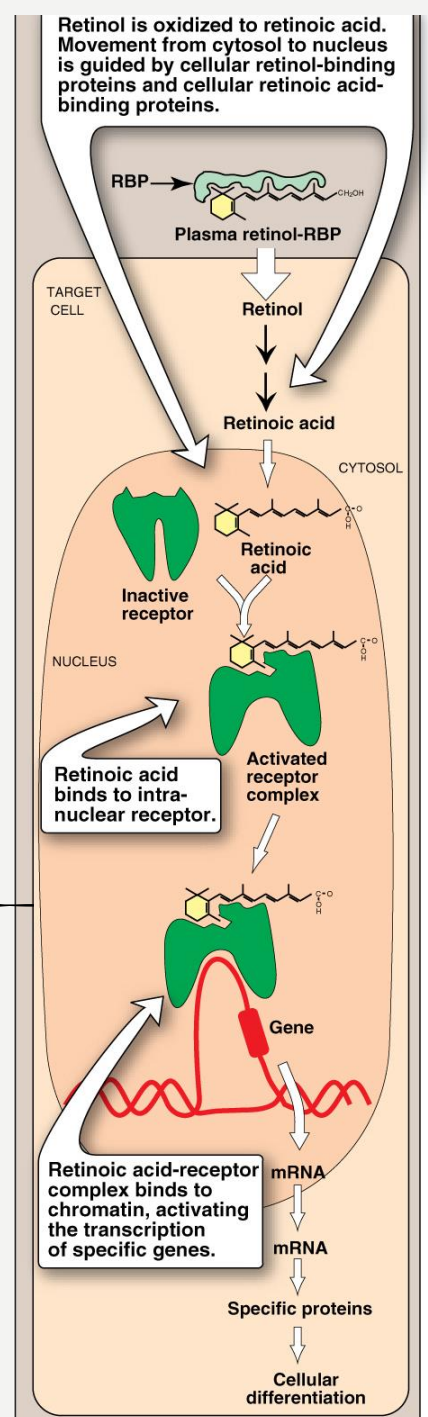
Explanation for vitamin A pathway in the body (the previous slide)

When we eat meat , we get the retinyl ester of the animal, this ester will lose the fatty acids and converted to retinol, which will enter the intestine and react with acyl CoA to make our own retinyl ester. This ester will be a component of chylomicron (the lipoprotein), which will travel through the lymphatic system to give this ester in the liver as trans- retinol, this retinol will be stored in the liver as retinyl palmitate.

When there's a need for it in the eye, it will be converted again to trans- retinol (by removing the fatty acid attached) and leave the liver by binding to RBP (retinol binding protein) which is the "taxi" that get the retinol to the eyes and leave. This retinol will be converted to retinal which is the active form in the eyes.

-when there's a need for retinol in other tissues (e.g. epithelial tissues), it will travel the same way (by RBP) to that tissue, then it will be converted into retinoic acid (NOT retinal!!!). This acid will bind to an inactive intra-nuclear receptor (which called retinoic acid receptor "RAR") to make an activated receptor complex (retinoic acid-RAR) . Finally, this complex will bind to chromatin to activate the transcription for a specific gene which responsible for retinoid-specific RNA synthesis, and leads to the production of specific proteins that mediate several physiologic functions (e.g. retinoids control the expression of the gene for keratin in most epithelial tissues of the body).

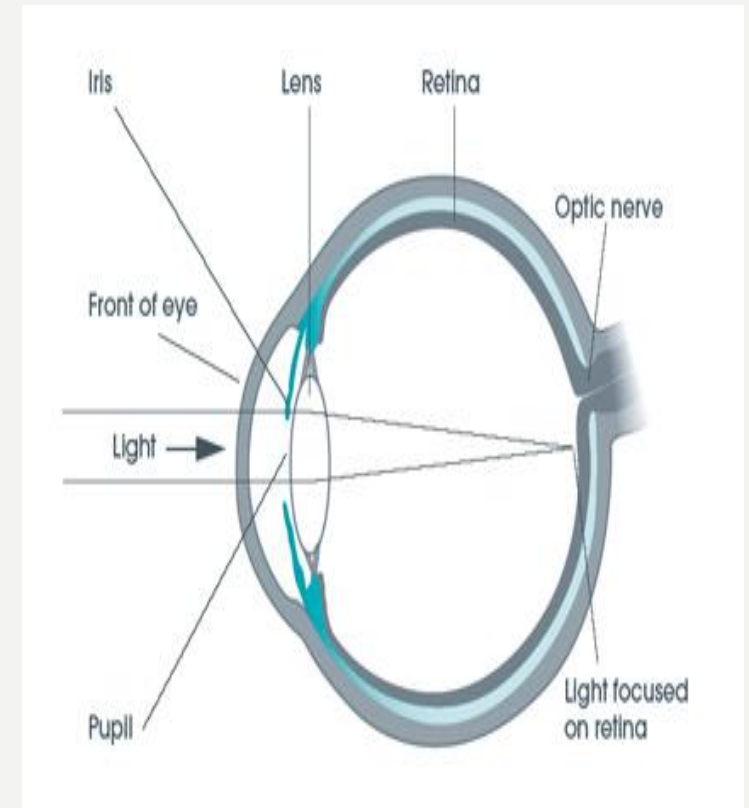
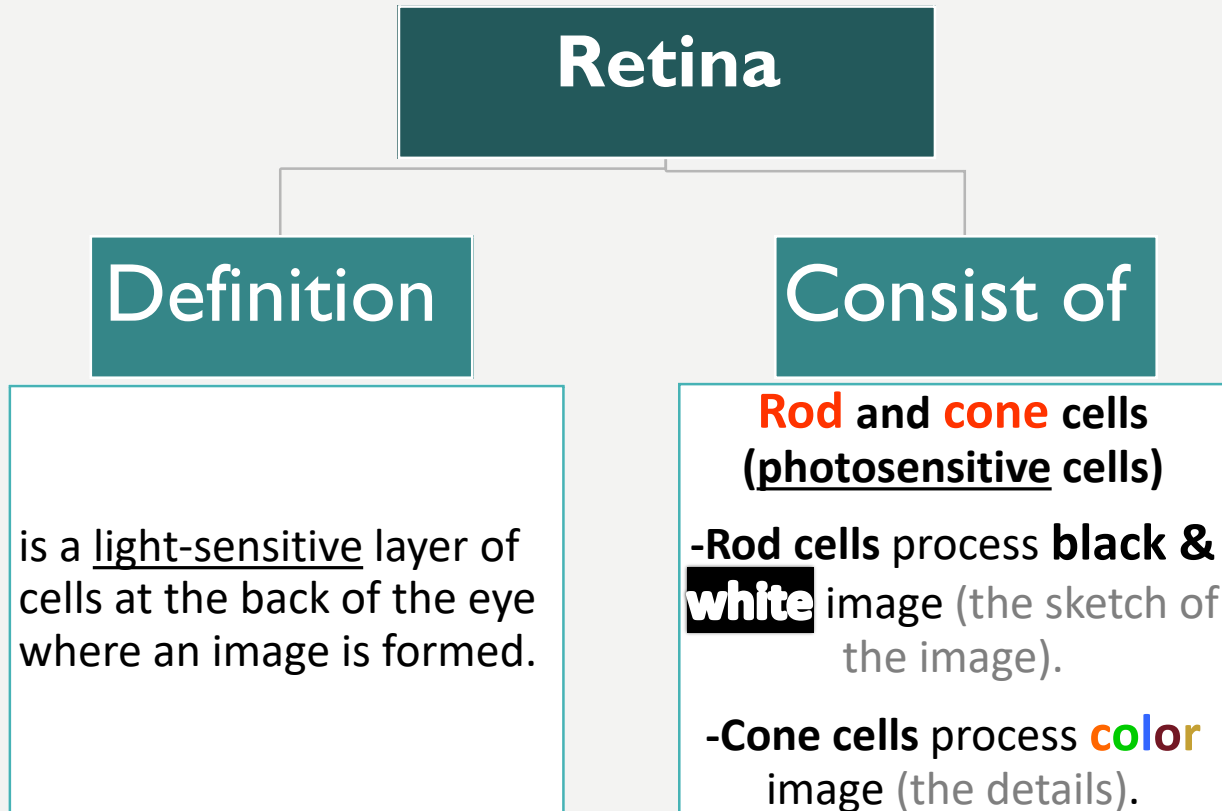
NOTE: the binding protein here will leave without entering the cell.



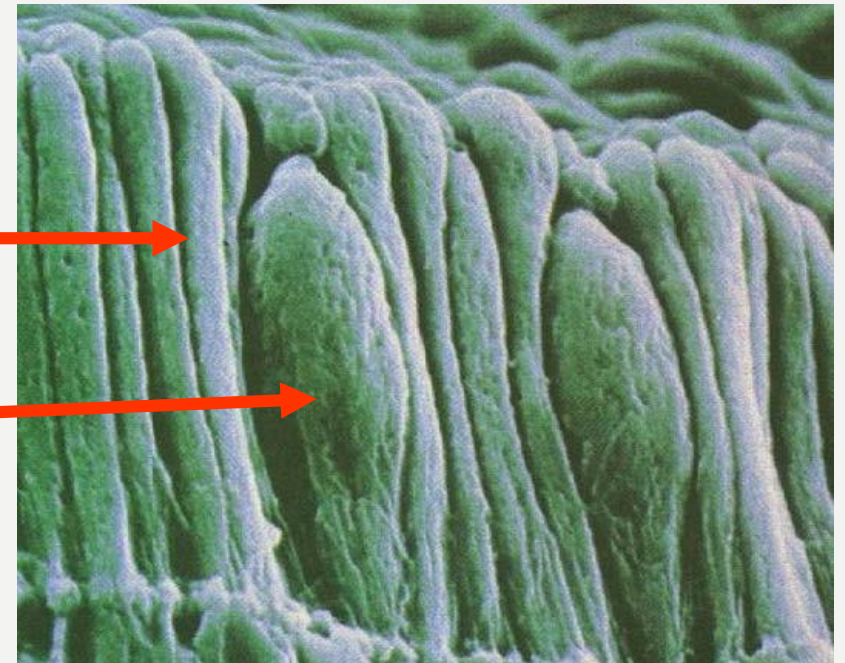
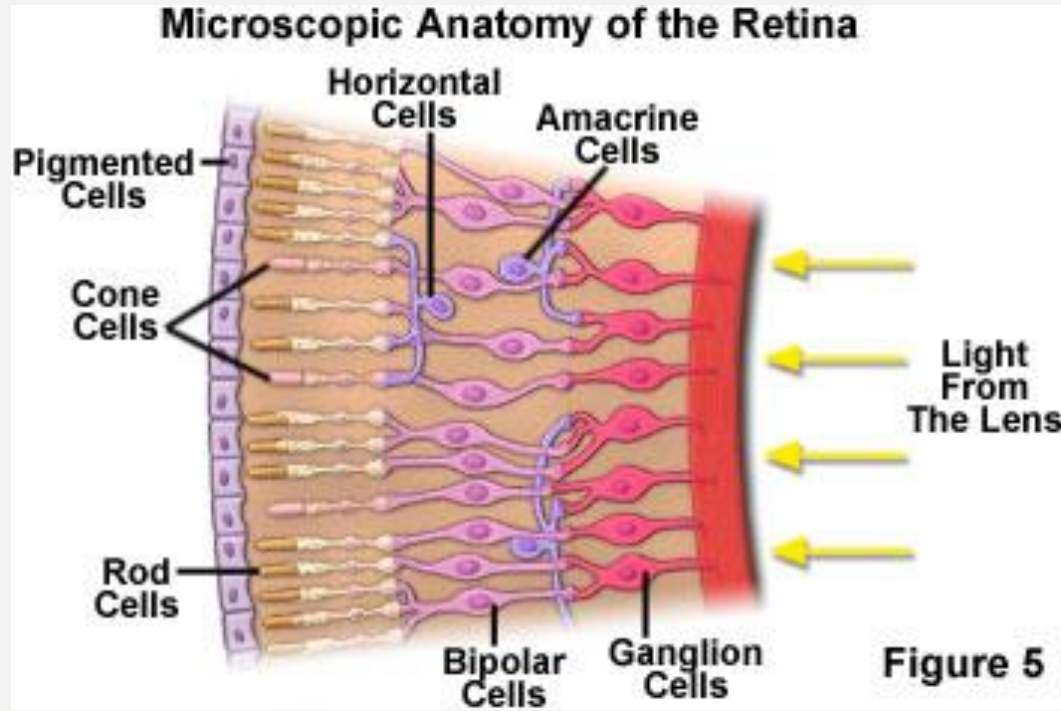
Role of vitamin A in vision

Visual cycle :

A process by which light impacting on the retina of the eye is converted to an **electrical signal**. The optic nerve carries the electrical signal (then as optic tract) to the brain (nerve impulse), then the brain processes the signal into an image.



Role of vitamin A in vision



Rod cell →

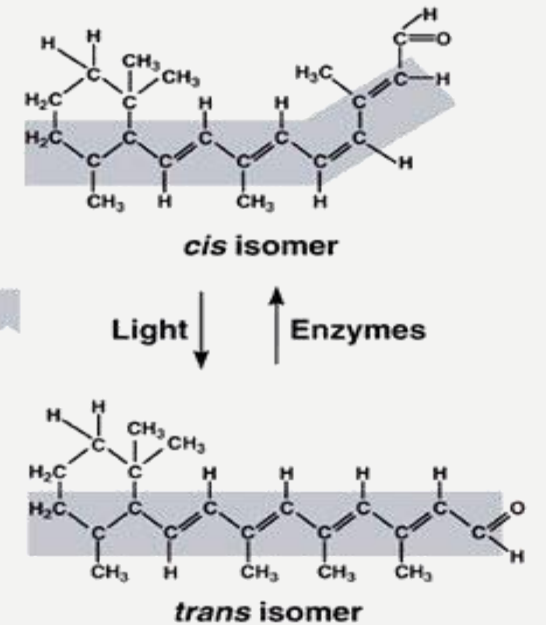
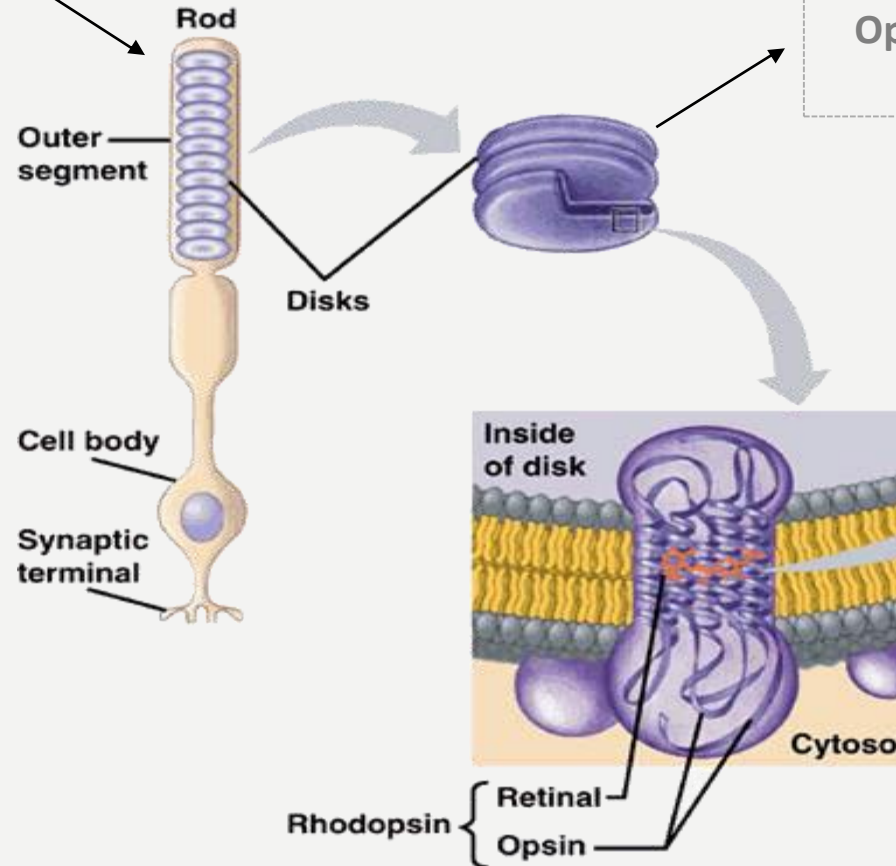
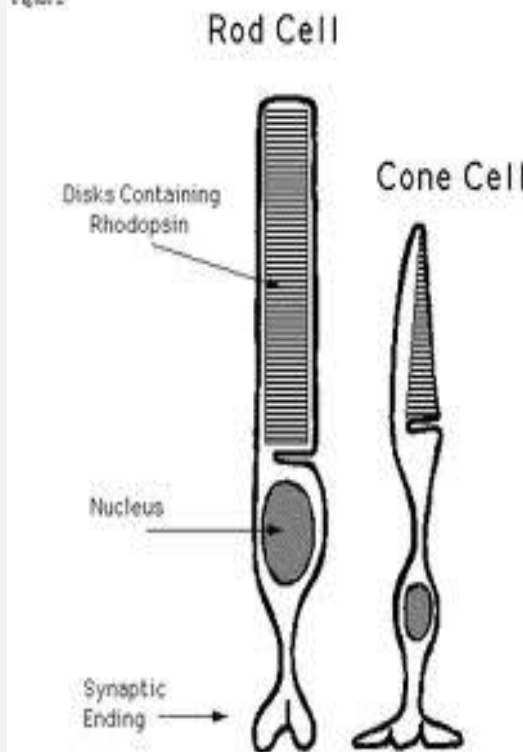
Cone cell →

Rhodopsin and Retinal Structures

if you cut it apart you'll see discs, these discs have rhodopsin inside.

Opsin protein inside disk which will bind to cis-form

Figure 2



(a)

(b)

Role of Vitamin A in Vision

- Normal vision depends on the [retina](#) and on adequate [vitamin A](#).
- First discovered by **George Ward** in 1967 (a Nobel Laureate). (Before it was called ward visual cycle).
- In the retina, vitamin A in the form of retinal binds to a protein called **opsin** to make **rhodopsin** (in rod cells) and **iodopsin** (in cone cells).
- **Rhodopsin** and **iodopsin** are light-sensitive (explained in the next slide).

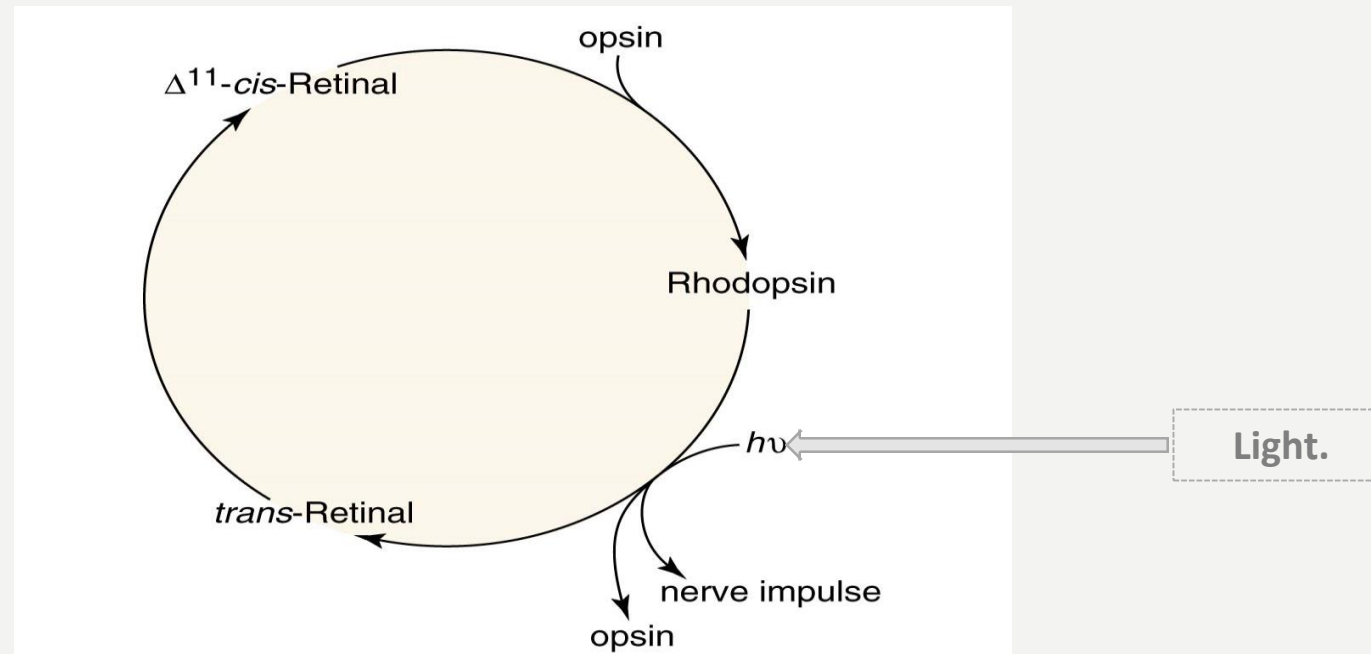
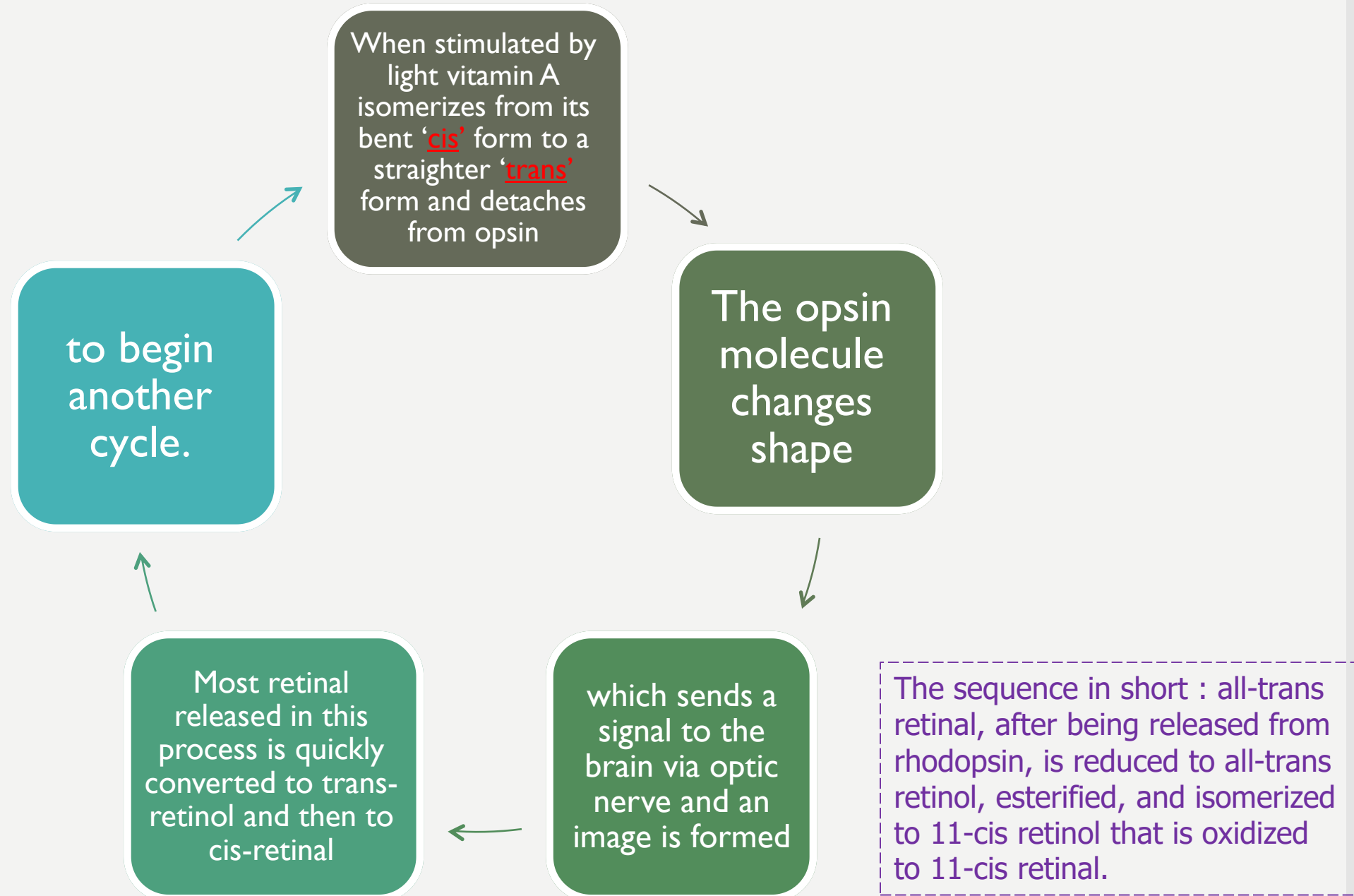


Figure 28.4. Role of vitamin A in vision.

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Role of Vitamin A in Vision



• Dark Adaptation time :

What is it?

It's the time required to synthesize rhodopsin in the dark. (Regeneration of rhodopsin)

- Bright light depletes rhodopsin (photobleaching).
- Sudden shift from bright light to darkness causes difficulty in seeing.
- Rhodopsin is synthesized in a few minutes and vision is improved in the dark.
- It is increased in vitamin A deficiency.

شرح إضافي: إذا كنت واقف في مكان فيه نور ساطع راح يتم استخدام الرودوبسين بصورة مستمرة ، فلو مثلا كنت في الخارج وراح تدخل البيت - وكانت أنوار البيت مطفأة - ، فإنك ستحتاج دقيقة حتى تتعود عينيك ع الظلمة وتبدا تشوف بشكل أوضح ، لأن الرودوبسين راح يكون قليل والوقت الي اخذه الجسم ليصنعه هو dark adaption time .

Recommended Dietary Allowance (RDA)

Vitamin A for Adults

Women

Men

700 µg or 2,330 IU

900 µg or 3,000 IU

Upper limit in Men or Women:

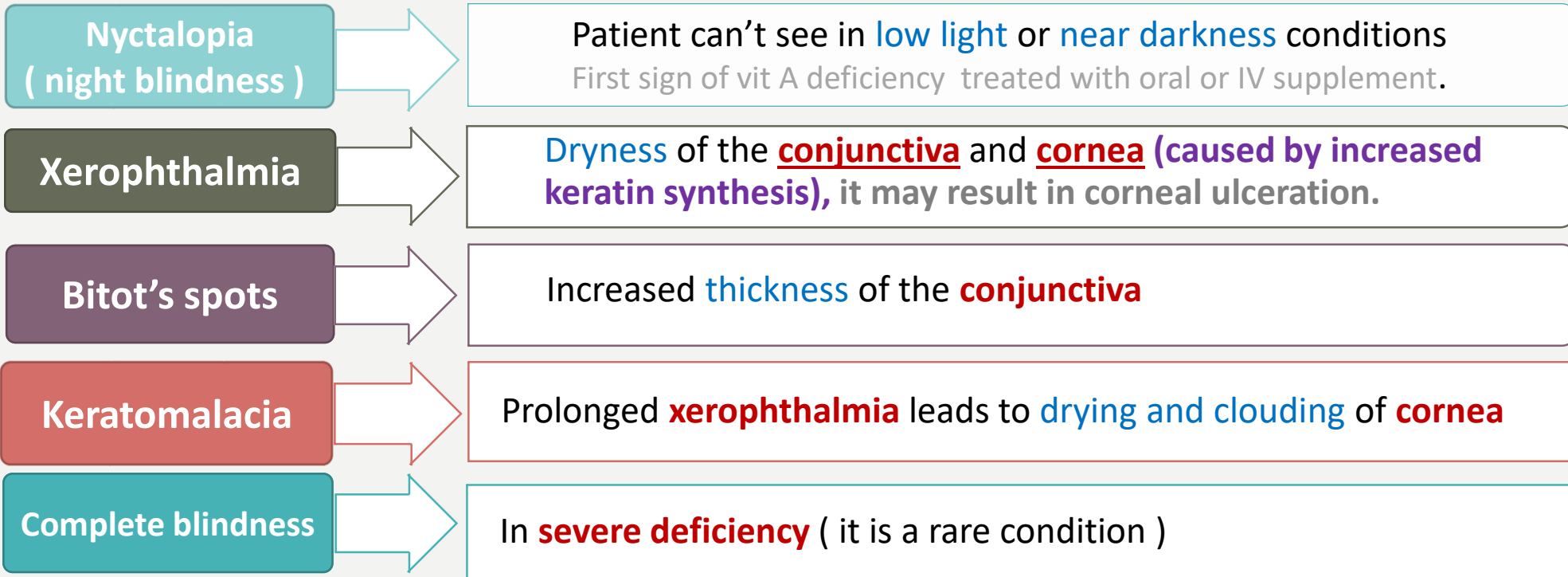
3,000 µg or 10,000 IU

Above we will have toxicity

Vitamin A Deficiency and Diseases

in night time we need more rhodopsin (which is deficient) so the patient can't see clearly.

Conjunctiva is :
The mucous membrane that cover the front of the eye and lines inside the eyelids.



Xerophthalmia



Bitot's spots



Keratomalacia

1-Which form of vitamin A is essential in vision?

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

2-Which one of the following is caused by localized increase in thickness of conjunctiva?

- A. Bitot's spots.
- B. Xerophthalmia.
- C. Nyctalopia.

3-Which cells are responsible for processing black and white image?

- A. Cone cells.
- B. Rod cells.
- C. Pigmented cells.

4-In the retina, vitamin A binds to which protein in order to make rhodopsin in rod cells?

- A. Crystallin.
- B. Iodopsin.
- C. Opsin.

5-The time required to synthesize rhodopsin in the dark is called?

- A. Dark adaptation time.
- B. Dark time.
- C. Adaptation time.

5-A
4-C
3-B
2-A
1-C

6-Vitamin A leaves the liver in the form of?

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

7-Retinol is stored in liver and asipose tissue as?

- A. Retinyl esters.
- B. Retinoic acid.
- C. Retinal.

8-The result of prolong use of large doses of vitamin A is?

- A. Kidney diseases.
- B. Night blindness.
- C. Liver diseases.

9-Normal vision depends on?

- A. Sclera.
- B. Retina and adequate vitamin A.
- C. Retina only.

10-What is the clinical presentation of a patient who has ingested carotenoids in alarge dose?

- A. Yellowing of the skin.
- B. Night blindness.
- C. Bitot's spots.

❖ Q1: Mention four fat-soluble vitamins and six water soluble vitamins.

A: Fat-soluble vit. : K,A,D,E

Water soluble vit. : C, B1, B2, Niacin ,B6 ,Biotin

❖ Q2: Mention the three preformed compounds “retinoids” that is found in animal products & what they’re essential for ?

A: Retinol → can be converted to other forms

Retinal → essential in vision

Retinoic acid → for skin and bone growth

❖ Q3: Explain the visual cycle.

A: A process by which light impacting on the retina of the eyes is converted to an electrical signal → the optic nerve carries the electrical signal to the brain (nerve impulse) → the brain processes the signal into an image.

❖ Q4:What kind of image do rod and cone cells process ?

A: Rod cells process **black & white** image.

Cone cells process **color** image.

❖ Q5: In case of vitamin A deficiency, what happens to the dark adaptation time ?

A: It's increased in vitamin A deficiency. (because vit. A is involved in the synthesis of rhodopsin which improves the vision in the dark)

❖ Q6: A patient was found that she has localized increased thickness of the conjunctiva, what disease caused by deficiency of vit. A could this be ?

A: Bitot's spots.

❖ Q7: A patient was found that he cannot see in low light or near darkness conditions, what disease caused by deficiency of vit. A could this be ?

A: Nyctalopia (night blindness).

Team Members:

Team Leaders:

- عبدالله الغزي.
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