



Vitamin A & visual cycle



OVERVIEW:

- Fat-soluble vitamins
- Biochemistry and types of vitamin A
- Absorption and transport
- Functions
- Functions in the visual cycle
- Deficiency and diseases



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Fat-soluble vitamins:

A, D, K and E

- Large amounts are stored in liver and adipose tissue, because of this we don't need them daily and deficiency-related diseases are rare
- Excess can cause toxicity. e.g. vitamin A and D toxicity.
- Absorbed slowly with fats.

Water-soluble vitamins*:

- Ascorbic acid (vitamin C)
- Thiamine (Vitamin B1)
- Riboflavin (Vitamin B2)
- Niacin (Vitamin B3)
- Pyridoxine (Vitamin B6)
- Cobalamin (Vitamin B12)
- Biotin
- pantothenic acid
- folate

Vitamins

OVERVIEW

- Organic compounds present in small quantities in different types of food
- Help in various biochemical processes in cell (act as coenzymes)
- Important and essential for growth and maintaining good health
- Non-caloric
- Required in very small amounts

*They differ from fat-soluble ones in terms of absorption, our bodies will absorb the needed amount and excrete the rest

Chemical structures of vitamin A

Retinol

Alcohol form

(can be converted to other forms)

Retinal or Retinaldehyde.

Aldehyde form

(essential in vision)

Retinoic acid

Acid form

(for skin and bone growth)

Animal (preformed)

Digested as retinoids**

=> active form (ready to be consumed)

=> Converted to one of the chemical forms depending on the target tissue

Plants (Provitamins*)

Digested in inactive form e.g. β -carotenes.

Metabolism of Carotenoids (β -carotene) and cryptoxanthin by the body can yield retinoids

=> (One molecule of β -carotene can be cleaved into two molecules of retinal in the intestine)

Sources of vitamin A

Provitamin: Vitamin precursor that the body converts to its active form through metabolic process

Retinoids: Include both natural and synthetic forms of vitamin A.

Functions of Vitamin A

Vision

It is a
Component
of the visual
pigment
Rhodopsin

(Opsin
+retinal)

Vitamin A
deficiency is
the most
common
cause of
blindness in
the
developing
world

Growth

Vitamin A
deficiency
causes loss
of appetite.
Slow bone
growth.
Affects CNS.

Gene transcription

Reproduction

Retinol and retinal
are essential for
normal
reproduction
(synthesis of
steroid hormone)

Maintenance of epithelial cells:

Essential for
normal
differentiation of
epithelial tissues
and mucus
secretion

Immune functions

Bone metabolism

Skin health

Anti- oxidant activity

1

Vitamin-A containing food from:
 plant source (e.g. carrot) => you will get β -carotene => Converted to Retinol finally
 Animal source (e.g. Liver) => You will get Retinol

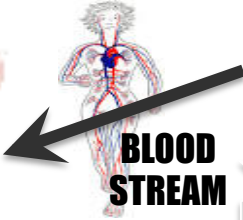


Absorbed by the intestine
 => Retinol combine with fatty acids
 => Form Retinyl esters
 => Retinyl esters will go to the liver (their store) through the bloodstream.

2



INTESTINE



BLOOD STREAM

Retinol
 + RBP*

3



LIVER

In case of need to vitamin A :
 => The fatty acid will be removed
 => It leaves the liver in the form of Retinol

Retinol will be converted to Retinoic acid
 => Retinoic acid will bind to a nuclear receptor and activate it
 the receptor will combine to a specific gene and initiate the transcription.

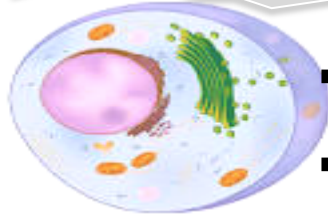
In the visual cycle
 => Retinol will be converted to Retinal
 (Discussed further later)



EYES



RBP: Retinol binding protein



TARGET TISSUE

Retina:

light-sensitive layer of cells at the back of the eye where an image is formed.

Consists of: Rod and cone cells
(photosensitive cells)

Rod cells process (Black & white) images

Cone cells process (Color) image

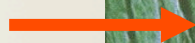
(see picture below)

Role of Vitamin A in Vision

Rod Cell



Cone Cell



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 to the brain (nerve impulse)

=> The brain processes the signal into an image

Vitamin A is found in the eye in the form of RETINAL.

Retinal has two forms:

Trans (straight form)
Active

Cis (Bent form)
Inactive

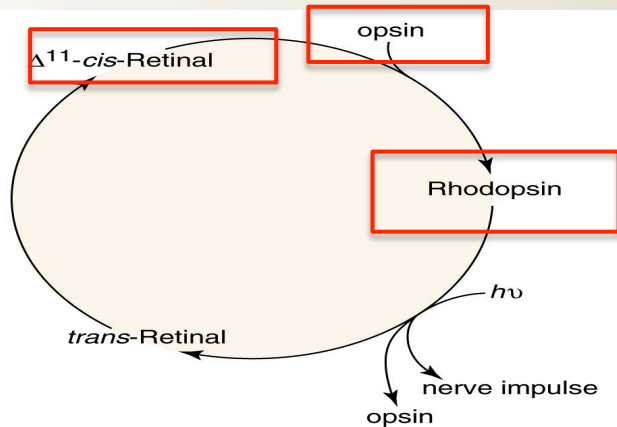


Figure 28.4. Role of vitamin A in vision.

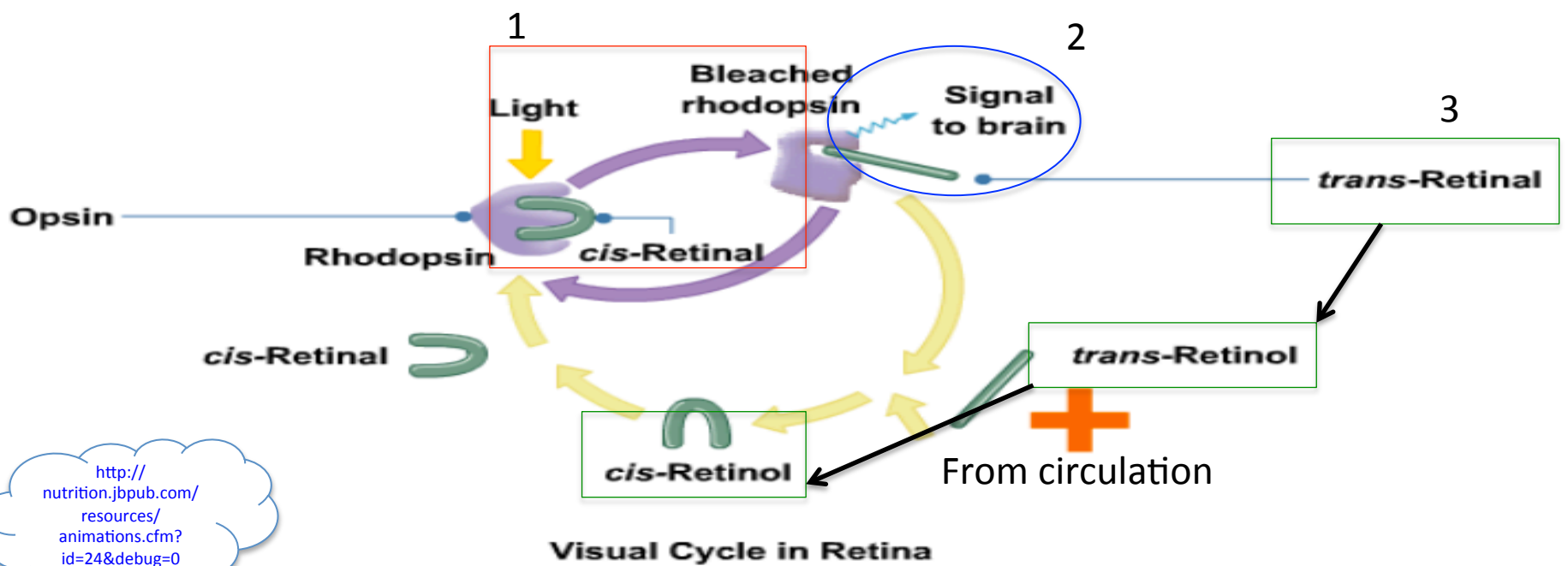
Textbook of Biochemistry With Clinical Correlations, Sixth Edition, Edited by Thomas M. Devlin. Copyright © 2006 John Wiley & Sons, Inc.

Normal vision depends on the retina and on adequate vitamin A.

In the retina:

Vitamin A (in form of Retinal) bind to a protein called opsin to make rhodopsin (in rod cells) and iodopsin (in cone cells)

=> These are light-sensitive pigments.



<http://nutrition.jbpub.com/resources/animations.cfm?id=24&debug=0>

- 1- When the light shines, vitamin A isomerizes from its bent 'cis' form to a straighter 'trans' form and detaches from opsin.
- 2- The opsin molecule changes shape, which sends a signal to the brain via optic nerve and an image is formed
- 3- The released-retinal in this process is quickly converted to *trans*-retinol and then to *cis*-retinal, to begin another cycle.

Dark adaptation time

Sudden shift from bright light to darkness causes difficulty in seeing



Because Bright light depletes rhodopsin (photobleaching)



Rhodopsin is synthesized in a few minutes and vision is improved in the dark

The time required to synthesize rhodopsin in the dark is called Dark adaptation time

It is increased in case of vitamin A deficiency

Recommended Dietary Allowance (RDA)

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

* UL: upper limit, above this it might cause vitamin A toxicity.

Vitamin A Deficiency and Diseases

Nyctalopia (night blindness)

patient cannot see
in low light or near
darkness
conditions

May proceed to
full blindness

Xerophthalmia

dryness of the
conjunctiva and
cornea

Bitot's spots

localized
increased
thickness of the
conjunctiva

Keratomalacia

prolonged
xerophthalmia
leads to drying
and clouding of
cornea

Complete blindness
(in severe deficiency)



<p>1- Which of the following vitamin A forms is important for skin and bone growth?</p> <p>A- retinol B- retinal C- retinoic acid</p>	<p>6- Which ONE of the following is The clinical manifestation of Xerophthalmia ?</p> <p>A- dryness of the conjunctiva and cornea B- clouding of cornea C- increased thickness of the conjunctiva</p>
<p>2- Which of the following is an important function of vitamin A ?</p> <p>A- Vision B- Growth C- Reproduction D- Maintenance of epithelial cells E- All of the above</p>	<p>7- The dark adaptation period is referred to?</p> <p>A- The time required to synthesize iodopsin in the dark B- The time required to synthesize rhodopsin in the dark C- The time required to degrade rhodopsin in the dark D- The time required to degrade iodopsin in the dark</p>
<p>3- What is the most significant cause of blindness?</p> <p>A- Vitamin A deficiency B- Vitamin A toxicity C- Vitamin A degrading enzymes</p>	<p>8- Which ONE of the following is a presentation feature of a patient suffering from vitamin A deficiency?</p> <p>A- Decreased dark adaptation period B- Increased dark adaptation period C- Normal dark adaptation period</p>
<p>4- What is the clinical presentation of a patient who has ingested carotenoids in a large dose?</p> <p>A- Yellowing of the skin B- Night blindness C- Bitot's spots D- Xerophthalmia</p>	<p>9- Vitamin A leaves the liver in the form of:</p> <p>A- Retinoic acid B- Retinol C- Retinal D- Retinyl esters</p>
<p>5- Which ONE of the following is a role of vitamin A in vision?</p> <p>A- synthesis of rhodopsin B- Synthesis of iodopsin C- Degradation of iodopsin D- A & B</p>	<p>10- The most-likely outcome of using large doses of vitamin A over prolonged period of time is:</p> <p>A- Kidney diseases B- Liver disease C- They will be excreted D- Night blindness</p>

If you have any questions or comments, don't hesitate to contact us



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Thank You!

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