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Sensory Physiology: Vision, Rods & Cones

Printable Flashcards — Pre-Med Biology

Retina structure, photoreceptors (rods vs cones), phototransduction cascade, rhodopsin and visual cycle, color vision, night vision, dark adaptation, and vitamin A.

162 cards — Print double-sided, flip on long edge, then cut along dashed lines.

162 cards — Printable Flashcards

Free & Open-Source

Generated February 20, 2026

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1

Vision in one sentence: what does the retina actually do?

2

Rods and cones are...

3

Big trap: rods/cones are neurons or receptors?

4

Signal path (super high-yield): photoreceptor -> ... -> ... -> optic nerve

5

Light path is kind of 'backwards': light hits the retina from the... side first.

6

So: light travels one way, the electrical signal travels the opposite way. True?

7

Where are rods and cones located in the retina layers?

8

Retinal pigment epithelium (RPE) is important because it...

2

Photoreceptors (the cells that detect light) in the retina.

1

It turns light into an electrical signal and sends it to the brain.

4

Photoreceptor -> bipolar cell -> ganglion cell -> optic nerve.

3

They're neurons (specialized sensory neurons) that act as receptors.

6

Yes.

5

Ganglion cell side (inner retina) first, then it reaches rods/cones at the back.

8

Recycles retinal (visual pigment) and supports photoreceptors.

7

At the back of the retina, near the retinal pigment epithelium (RPE).

9

Blind spot is where...

10

Trap: the blind spot is the fovea. True or false?

11

Fovea is special because it's packed with...

12

Why do faint stars disappear
when you look straight at them?

13

Signal chain: photoreceptor -> {{c1::bipolar}}
-> {{c2::ganglion}} -> optic nerve.

14

Cell type whose axons form the optic nerve:

15

Rods are mainly for...

16

Cones are mainly for...

10

False.

9

The optic nerve leaves the retina (optic disc), so there are no photoreceptors there.

12

Because fovea is cone-heavy; rods (better in dim light) are more in the periphery.

11

Cones (and very few rods).

14

Ganglion cells

13

Signal chain: photoreceptor -> bipolar -> ganglion -> optic nerve.

16

Daylight vision, color, and sharp detail.

15

Dim light (night vision) and motion detection, not color.

17

Trap: rods are for color because they are more sensitive. True or false?

18

Which is more sensitive to light: rods or cones?

19

Which gives better detail (acuity): rods or cones?

20

Why do rods have low acuity?

21

Why do cones have high acuity (especially in fovea)?

22

Fast rule: rods = _____ sensitivity / _____ acuity. Cones = _____ sensitivity / _____ acuity.

23

Rods work best in... (lighting)

24

Cones work best in... (lighting)

18

Rods.

17

False.

20

Many rods converge onto fewer bipolar/ganglion cells, so detail gets 'averaged'.

19

Cones.

22

Rods: high sensitivity / low acuity.
Cones: low sensitivity / high acuity.

21

Less convergence (more one-to-one wiring) so the brain can pinpoint location better.

24

Bright light (photopic vision).

23

Low light (scotopic vision).

25

Why do colors look dull at night?

26

Rods are mostly found...

27

Cones are mostly concentrated in the...

28

Trap: the fovea is best for night vision. True or false?

29

Which is better at detecting motion in dim light?

30

In very bright light, rods can...

31

When you go from bright sunlight into a dark room, what's the slow part of adapting?

32

Color vision needs at least... types of cones.

26

In the peripheral retina (not in the fovea).

25

Because rods dominate in low light
and rods don't encode color well.

28

False.

27

Fovea (central retina).

30

Saturate (basically max out), so cones take over.

29

Rods (peripheral retina).

32

Two (better: three for normal color vision).

31

Rods regenerating their pigment
(rhodopsin) - dark adaptation takes time.

33

Rods: {{c1::high}} sensitivity, {{c2::low}} acuity, best in {{c3::dim}} light.

34

Cones: {{c1::low}} sensitivity, {{c2::high}} acuity, best in {{c3::bright}} light and color.

35

Photoreceptors mainly used for night vision:

36

Phototransduction =

37

Big trap: do photoreceptors depolarize or hyperpolarize in LIGHT?

38

So in the DARK, photoreceptors are relatively...

39

The neurotransmitter released by rods/cones onto bipolar cells is mainly...

40

Dark state: cGMP is... and cGMP-gated Na^+ channels are...

34

Cones: low sensitivity, high acuity, best in bright light and color.

33

Rods: high sensitivity, low acuity, best in dim light.

36

How light gets converted into an electrical signal in rods/cones.

35

Rods

38

Depolarized and they release more neurotransmitter (glutamate).

37

They hyperpolarize.

40

High; open.

39

Glutamate.

41

Light state: cGMP becomes...
so cGMP-gated channels...

42

What does light do to glutamate
release from photoreceptors?

43

Rhodopsin is made of...

44

In darkness, retinal in rhodopsin is in the... form.

45

A photon hits rhodopsin and
converts 11-cis retinal into...

46

Rhodopsin activation turns on a G protein called...

47

Transducin activates an enzyme
that lowers cGMP called...

48

So the clean cascade is: light -> rhodopsin ->
transducin -> PDE -> ... -> channels close.

42

It decreases it.

41

Low; close.

44

11-cis retinal.

43

Opsin (protein) + retinal (a vitamin A-derived molecule).

46

Transducin.

45

All-trans retinal.

48

cGMP decreases.

47

Phosphodiesterase (PDE).

49

What type of ion channels close in light?

50

Why does closing cation channels hyperpolarize the photoreceptor?

51

In light, photoreceptors fire action potentials?

52

Trap: rods/cones use action potentials like neurons. True or false?

53

If a question says 'light opens Na^+ channels in rods', your reaction should be...

54

Simple memory: DARK = cGMP _____ = channels _____ = glutamate _____.

55

So LIGHT = cGMP _____ = channels _____ = glutamate _____.

56

ON vs OFF bipolar cells (super simple): why does 'less glutamate' still create a signal?

50

Because less positive charge enters (Na^+ 'dark current' stops).

49

cGMP-gated cation channels (let Na^+ / Ca^{2+} in).

52

False (mostly).

51

No. They change membrane potential and neurotransmitter release (graded potentials).

54

High; open; high.

53

Nope - light closes the cGMP-gated channels.

56

Because some bipolar cells are turned ON by glutamate dropping, and others are turned OFF.

55

Low; closed; low.

57

Quick trap: if photoreceptors release LESS glutamate in light, how can the brain know there's light?

58

Dark: cGMP {{c1::high}} -> cGMP-gated channels {{c2::open}} -> photoreceptor {{c3::depolarized}} -> glutamate {{c4::high}}.

59

Light: rhodopsin -> transducin -> PDE -> cGMP {{c1::down}} -> channels {{c2::close}} -> photoreceptor {{c3::hyperpolarizes}} -> glutamate {{c4::down}}.

60

Light converts 11-cis retinal into:

61

What does 'bleaching' of rhodopsin mean?

62

Bright light causes lots of rhodopsin to be...

63

Dark adaptation (going into darkness) mainly requires...

64

Light adaptation (going into bright light) happens faster or slower than dark adaptation?

58

Dark: cGMP high -> cGMP-gated channels open -> photoreceptor depolarized -> glutamate high.

57

Because the circuit is wired so changes (including decreases) carry information.

60

All-trans retinal

59

Light: rhodopsin -> transducin -> PDE -> cGMP down -> channels close -> photoreceptor hyperpolarizes -> glutamate down.

62

Activated/bleached (rods can saturate).

61

Light has activated rhodopsin so much that the pigment needs to be regenerated before it can detect more light.

64

Faster.

63

Regenerating rhodopsin (especially in rods).

65

Why does a bright phone screen ruin your night vision for a bit?

66

Where does retinal get converted back to 11-cis form? (high-level)

67

Retinal vs retinol (trap): what's the difference?

68

The molecule that flips cis/trans in the photopigment is...

69

Vitamin A matters for vision because...

70

Classic symptom of vitamin A deficiency (vision side) is...

71

Why does vitamin A deficiency hit rods first?

72

The visual cycle is basically:

66

In the retinal pigment epithelium (RPE) as part of the visual cycle.

65

It bleaches rod pigment, so rods need time to recover.

68

Retinal (11-cis <-> all-trans).

67

Retinol is vitamin A alcohol; retinal is the aldehyde used in rhodopsin/cone pigments.

70

Night blindness.

69

It's the precursor for retinal, which is needed to make rhodopsin and cone pigments.

72

11-cis retinal (ready) -> light -> all-trans retinal (used) -> recycled back to 11-cis.

71

Rods rely heavily on rhodopsin regeneration for dim light sensitivity.

73

Trap: in darkness, retinal is all-trans and light turns it cis. True or false?

74

After rhodopsin is activated, all-trans retinal eventually...

75

Why does dark adaptation take time (concept)?

76

Trap: night adaptation is mainly from pupil dilation. True or false?

77

Why can cones adapt faster than rods (simplified)?

78

Scenario: a student says 'I can't see well at night but daytime is fine'. The most classic deficiency to think is...

79

Dark (ready) pigment uses {{c1::11-cis retinal}}. Light converts it to {{c2::all-trans retinal}}.

80

Vitamin A -> {{c1::retinal}} -> photopigments. Deficiency -> {{c2::night blindness}}.

74

Leaves opsin and must be converted back to 11-cis to reset the pigment.

73

False.

76

False (that's part of it, but not the main long-term effect).

75

Because pigment regeneration (cis retinal supply) takes time, especially for rods.

78

Vitamin A deficiency (night blindness).

77

Cones recover and function better in bright conditions; rods take longer to fully regain sensitivity in the dark.

80

Vitamin A -> retinal -> photopigments. Deficiency -> night blindness.

79

Dark (ready) pigment uses 11-cis retinal. Light converts it to all-trans retinal.

81

Site that helps regenerate 11-cis retinal (high-level):

82

Color vision works because you have cones with...

83

Humans usually have... main cone types.

84

Why does one cone type alone not give true color information?

85

Trap: 'red cone' only detects red light. True or false?

86

Rods don't give color mainly because...

87

Classic color vision deficiency is...

88

If cones are damaged but rods are fine, you'd expect problems with...

82

Different wavelength sensitivities that the brain compares.

81

Retinal pigment epithelium (RPE)

84

Because intensity vs wavelength can look the same to a single sensor.

83

Three (S, M, L).

86

They have basically one pigment type, so there's nothing to compare.

85

False.

88

Daytime detail and color vision more than night detection.

87

Red-green color blindness (usually missing/altered M or L cones).

89

If rods are damaged but cones are fine, you'd expect problems with...

90

Cones are concentrated in the... so color vision is best when you...

91

Trap: peripheral vision is the best for reading tiny text. True or false?

92

Normal color vision uses {{c1::three}} cone types. Color is the brain comparing their {{c2::relative activity}}.

93

Photoreceptors used mainly for color vision:

94

Rhodopsin is the main pigment in...

95

Why do rods work better in low light? (simple)

96

Night vision is worse for... compared to day vision.

90

Fovea; look directly at it.

89

Night vision and peripheral dim-light detection.

92

Normal color vision uses three cone types. Color is the brain comparing their relative activity.

91

False.

94

Rods.

93

Cones

96

Detail and color.

95

They're more sensitive and their signals converge, so tiny light signals add up.

97

Why does red look darker at night/dusk? (basic)

98

Why do astronomers use red light at night?

99

Dark adaptation happens in two phases (idea):

100

If you walk into a dark cinema from outside and can't see, the cells you are waiting on are mainly...

101

Bright sunlight basically makes rods...

102

Purkinje shift (optional but useful idea): at dusk, your vision shifts toward...

103

Main photopigment in rods: {{c1::rhodopsin}}.

104

Vision in very low light (night vision) is called:

98

It keeps cones able to see the light but doesn't bleach rods as much, preserving night vision.

97

Rods are less sensitive to long (red) wavelengths, and cones aren't working well in dim light.

100

Rods.

99

Cones adapt quickly, rods adapt slowly but end up much more sensitive.

102

Blue-green sensitivity because rods take over.

101

Less useful (saturated/bleached), so cones dominate.

104

Scotopic vision

103

Main photopigment in rods: rhodopsin.

105

Name the 3 main 'vertical' neurons in retina (signal path).

106

Two main 'sideways' interneurons in retina are...

107

Horizontal cells mainly connect...

108

Amacrine cells mainly connect...

109

Lateral inhibition is basically...

110

Trap: the retina only detects brightness, not contrast. True or false?

111

Ganglion cells are the first retinal cells that definitely fire...

112

Trap: photoreceptors send action potentials down the optic nerve. True or false?

106

Horizontal cells and amacrine cells.

105

Photoreceptors -> bipolar cells -> ganglion cells.

108

Bipolar cells to ganglion cells (and ganglion to ganglion) laterally.

107

Photoreceptors and bipolar cells laterally.

110

False.

109

Neighboring cells suppress each other to enhance contrast/edges.

112

False.

111

Action potentials (spikes).

113

If you want the simplest retina layer order (signal), it's:

114

If you want the simplest retina layer order (light entering), it's:

115

Main vertical pathway: photoreceptor -> {{c1::bipolar}} -> {{c2::ganglion}}.

116

Retinal interneuron that does lateral connections near photoreceptors:

117

Why does the retina have ON and OFF pathways?

118

Photoreceptor glutamate release is highest in...

119

ON bipolar cells are (in simple terms) activated when...

120

OFF bipolar cells are (in simple terms) activated when...

114

Ganglion -> bipolar -> photoreceptor (then RPE).

113

Photoreceptor layer -> bipolar layer -> ganglion layer.

116

Horizontal cell

115

Main vertical pathway: photoreceptor -> bipolar -> ganglion.

118

Darkness.

117

To detect both increases and decreases in light (contrast changes).

120

Glutamate from photoreceptors increases (i.e., when light decreases / darkness).

119

Glutamate from photoreceptors decreases (i.e., light increases).

121

Trap: 'less glutamate' always means 'less signal'. True or false?

122

If a bright spot appears in the center, which pathway is most directly excited?

123

If a dark spot appears on a bright background, which pathway is most directly excited?

124

Photoreceptor glutamate: dark {{c1::high}}, light {{c2::low}}.

125

If the question says 'light causes depolarization in rods', it's...

126

If the question says 'dark causes photoreceptors to stop releasing glutamate', it's...

127

If you forget the whole cascade, just remember: light makes cGMP...

128

Trap: PDE makes cGMP. True or false?

122

ON-center pathway.

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121

False.

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124

Photoreceptor glutamate: dark high, light low.

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123

OFF-center pathway.

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126

Wrong. Dark = more glutamate release.

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125

Wrong. Light causes hyperpolarization.

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128

False.

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127

Go down.

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129

Trap: transducin is a kinase enzyme. True or false?

130

If a question asks 'what directly closes the cation channels in light?', answer:

131

If a question asks 'what directly causes hyperpolarization in light?', answer:

132

If a question asks 'what turns rhodopsin ON?', answer:

133

If a question asks 'what turns rhodopsin OFF/reset?', answer (high-level):

134

Scenario: someone sees fine in daylight but struggles at night. Most likely photoreceptor to blame?

135

Scenario: someone sees in dim light but has trouble with color and reading fine print. Most likely photoreceptor issue?

136

Scenario: you stare at a bright light, then look at a dark room and can't see. What happened?

130

Low cGMP (because PDE is active).

129

False.

132

A photon causing 11-cis -> all-trans retinal.

131

Closing of cGMP-gated cation channels (less Na^+ enters).

134

Rods.

133

Retinal must be recycled back to 11-cis and recombine with opsin (visual cycle).

136

Photopigment bleaching + rods saturated, need recovery time.

135

Cones.

137

Scenario: you have a blind spot in one specific fixed spot in each eye. That spot is...

138

Trap: optic disc has the highest cone density. True or false?

139

If you want the simplest 'where is best acuity?' answer:

140

If you want the simplest 'where is best dim-light sensitivity?' answer:

141

Night blindness = think... deficiency of what nutrient?

142

Retina (tissue) vs retinal (molecule) - don't mix them: retinal is...

143

Light -> PDE active -> cGMP {{c1::down}} -> cGMP-gated channels {{c2::close}} -> photoreceptor {{c3::hyperpolarizes}}.

144

Photoreceptors are depolarized in (light or dark)?

138

False.

137

The optic disc (where optic nerve leaves).

140

Peripheral retina (rod-rich).

139

Fovea (cone-rich).

142

The vitamin A-derived molecule inside photopigments.

141

Vitamin A.

144

Dark

143

Light -> PDE active -> cGMP down -> cGMP-gated channels close -> photoreceptor hyperpolarizes.

145

Dark current means...

146

Fun trap: are photoreceptors 'resting' in the dark?

147

Energy logic: dark current means photoreceptors spend ATP mainly to...

148

Where is the photopigment located within rods/cones?

149

Rods and cones communicate with bipolar cells using...

150

Ganglion cells communicate to the brain using...

151

Receptive field idea (simple): ganglion cells respond best to...

152

Trap: shining uniform light everywhere activates all ganglion cells equally. True or false?

146

Not really - they are actually quite active (dark current, glutamate release).

145

In darkness, cGMP-gated channels are open and Na^{+} (and Ca^{2+}) continuously enter the photoreceptor.

148

In the outer segment membranes (disc stacks).

147

Pump ions back out (maintain gradients).

150

Action potentials.

149

Graded neurotransmitter release, not spikes.

152

False (concept).

151

Contrast/edges, not uniform brightness.

153

Convergence summary: many rods -> one bipolar/ganglion gives...

154

Convergence summary: one cone -> one bipolar/ganglion gives...

155

If a question says 'cones are better in dim light because they are in the fovea', that is...

156

Photopic vs scotopic: photopic =

157

Photopic vs scotopic: scotopic =

158

Mesopic vision (if they mention it) is...

159

Fast check: which is more numerous in the retina overall, rods or cones?

160

Trap: cones outnumber rods because cones give better vision. True or false?

154

Low sensitivity, high acuity.

153

High sensitivity, low acuity.

156

Cone-dominated bright light vision.

155

Wrong. Fovea is for detail; dim light uses rods.

158

In-between light levels where both rods and cones contribute.

157

Rod-dominated dim light vision.

160

False.

159

Rods.

161

Rods/cones: more light -> glutamate release {{c1::decreases}} (not increases).

162

Process where photopigment must be regenerated after light exposure:

162

Visual cycle (retinoid cycle)

161

Rods/cones: more light -> glutamate release decreases (not increases).