

DISCUSSION 5



CHARLES DARWIN AND THE EYE

PART 2.

Complex Eyes

Ariel A. Roth

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OUTLINE

- 1. Complexity of eyes: Special and interdependent parts**
- 2. Evolution's incomplete eye**
- 3. The inverted retina: It works very well**
- 4. Conclusions**
- 5. Review questions**

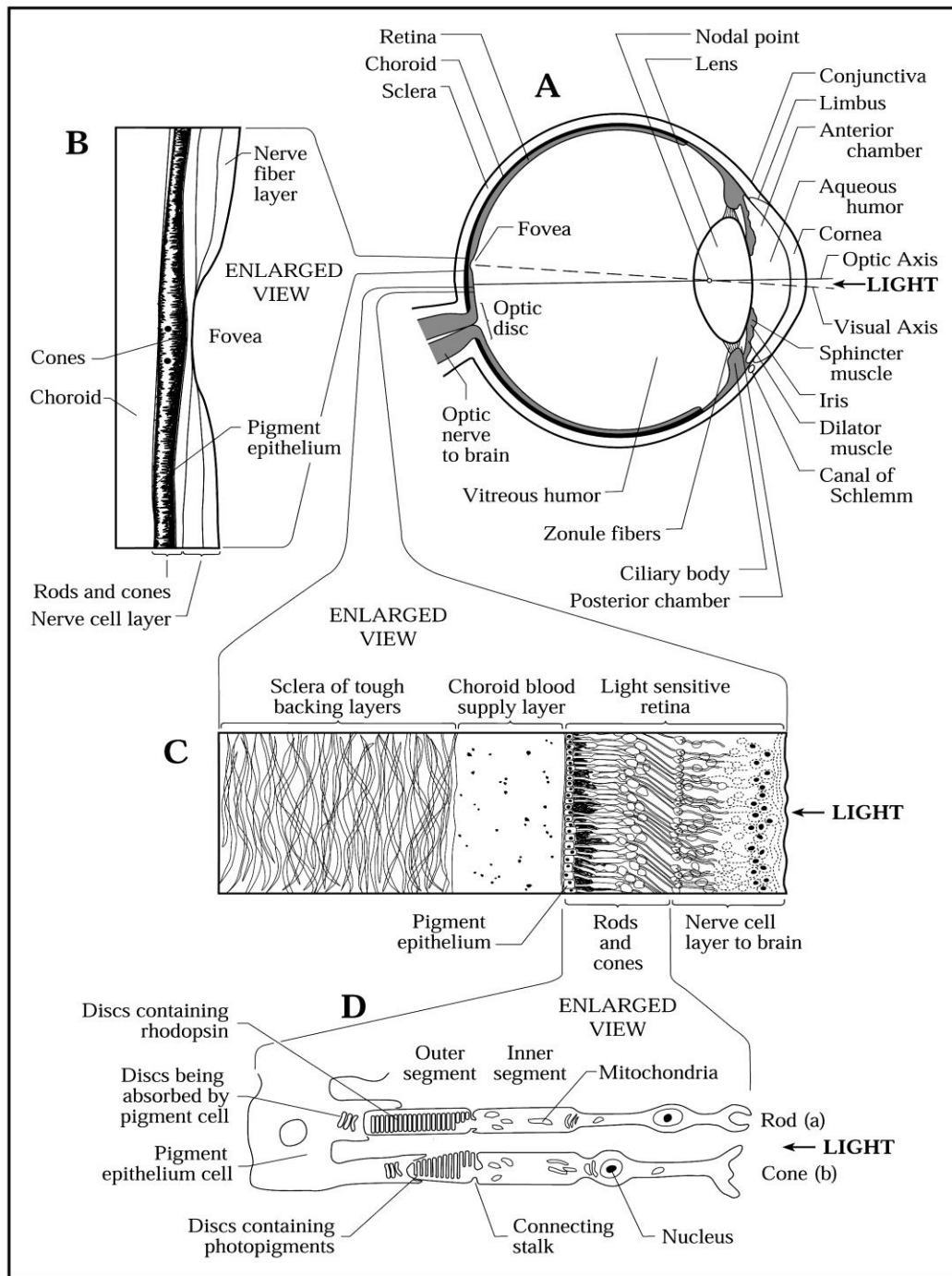
1. THE COMPLEXITY OF THE EYE

1. COMPLEXITY OF THE EYE

The eye is much more complicated than first surmised.

The next figure gives a few more details about our eyes that are basically the “simple” single lens vertebrate eye, also known as the “camera eye. In diagram A, note all the special parts to the right associated with the **lens, iris and pupil**. These parts are composed of many smaller interdependent parts that are necessary for proper function. Hence, they raise the question of how could these gradually evolving parts provide any evolutionary survival value before all the necessary ones were present so the system could work.

VERTEBRATE EYE



A. The complex vertebrate eye.

B, C, D, enlarged details.

1. COMPLEXITY OF THE EYE

In the slide above note that there are three main coats (layers) to the wall of the eye (diagram C): The tough outer whitish *sclera*; the middle *choroid*, that is rich in blood vessels; and the complicated inner *retina* that is nearly transparent. We will discuss these later when considering the inverted retina.

The retina harbors many nerve cells and also the light-detecting cells (photoreceptors) known as the *rods* and *cones* (diagram D). The rods function in detecting dim light while the cones detect bright and colored light.

1. COMPLEXITY OF THE EYE

DETECTION OF LIGHT

One rod may contain **40,000,000** protein molecules called *rhodopsin*. When light strikes a rhodopsin molecule it bends it. That response is passed on to many more of several different kinds of molecules in an avalanche type of chemical reaction that increases the negative electric charge of the outside of the rod or cone. That change in charge sends an impulse to other nerve cells. In the rod or cone the whole process is reversed in preparation to receive more light. At least **a dozen different kinds of protein molecules** are involved.

Strangely, the eye of the scallop (*Pecten*) has a double retina, and the inside retina cells become electrically more negative when stimulated - as is the case for man - while in the outside (deeper) retina the cells become more positive. This all adds to the picture we see of a great variety of complex eyes in animals.

1. COMPLEXITY OF THE EYE

THE TRILOBITE EYE

You may recall that earlier, in the first discussion about Charles Darwin and the eye (No. 4), we mentioned Darwin's concern about complicated eyes, including their ability to correct for *spherical aberration*. Spherical aberration prevents a sharp image because parallel light rays coming into the eye do not converge on the same plane. See the two red arrows in the next slide. The even curvature of an ordinary lens is such that light coming in around the outside of the lens focuses on a different plane than light coming through the center, so the image is blurred. There are several ways to correct for spherical aberration. Some trilobites do it by using a very special kind of lens.

SPHERICAL ABERRATION

Light going through the lens does not converge on the same plane

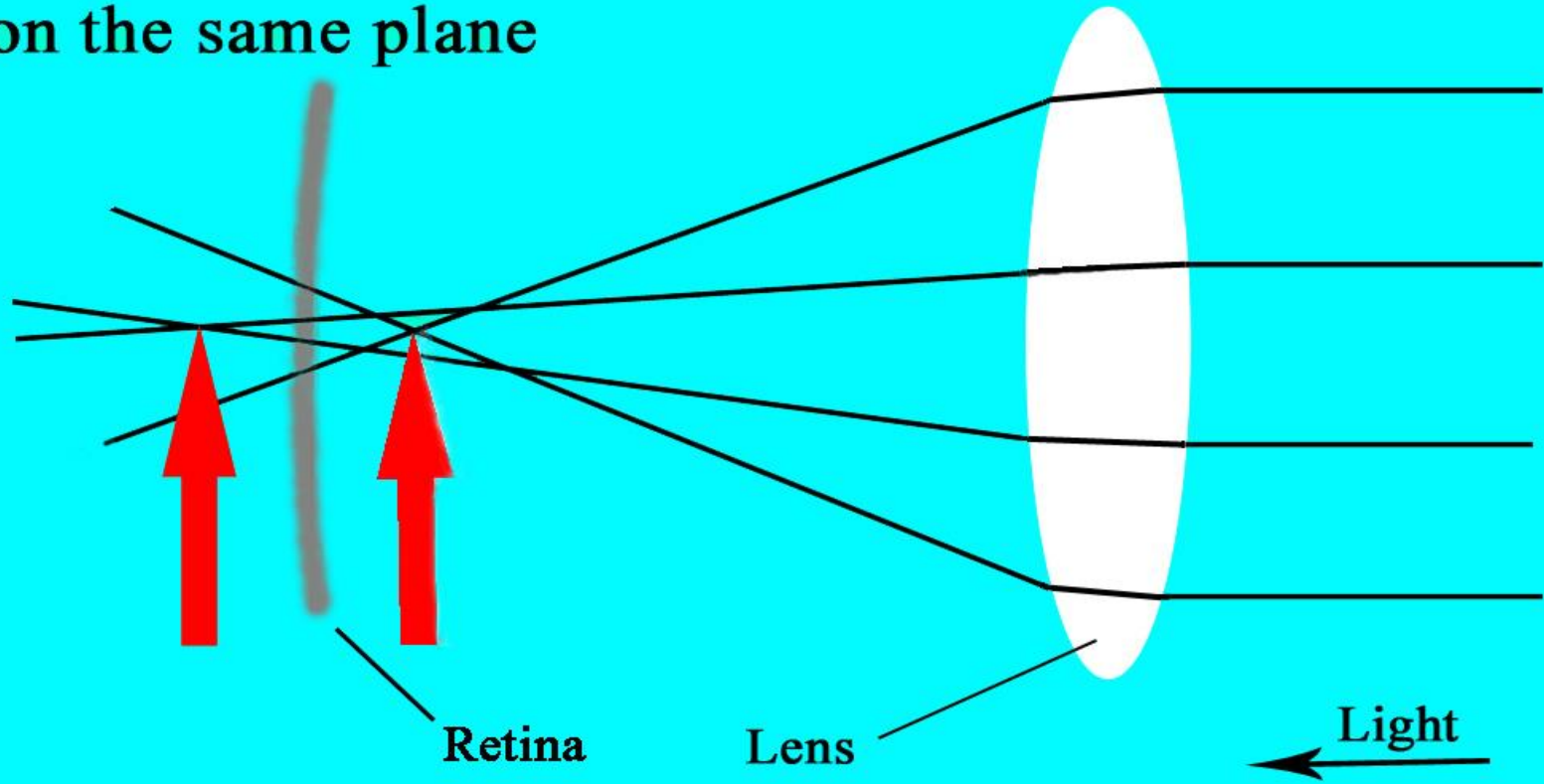


ILLUSTRATION OF SPHERICAL ABERRATION. The light rays going through different parts of the lens do not converge (red arrows) on the same plane (retina).

1. COMPLEXITY OF THE EYE

THE TRILOBITE EYE

The trilobite eye is of special interest because it appears to be one of evolution's first image-forming eyes that we find in the fossil record as we go up through the geologic layers. We find trilobites in the Cambrian, which is at the bottom of the fossil-rich Phanerozoic part of the geologic column.

The next slide is a photograph of Mount Stevens in the Canadian Rockies. The darker layers on the hillside are deep Cambrian rocks that have been obviously pushed up. They contain an abundance of trilobites.

The slide following the next is a sample of one of these trilobites from Mount Stevens. The arrow points to the eye region. Note the Canadian coin for scale.



MOUNT STEVENS in the Canadian Rockies. Trilobite fossils are found in the dark middle layers.



CAMBRIAN TRILOBITE FOSSIL. From Mount Stevens in the Canadian Rockies. The red arrow points to the compound eye. Note coin for scale.

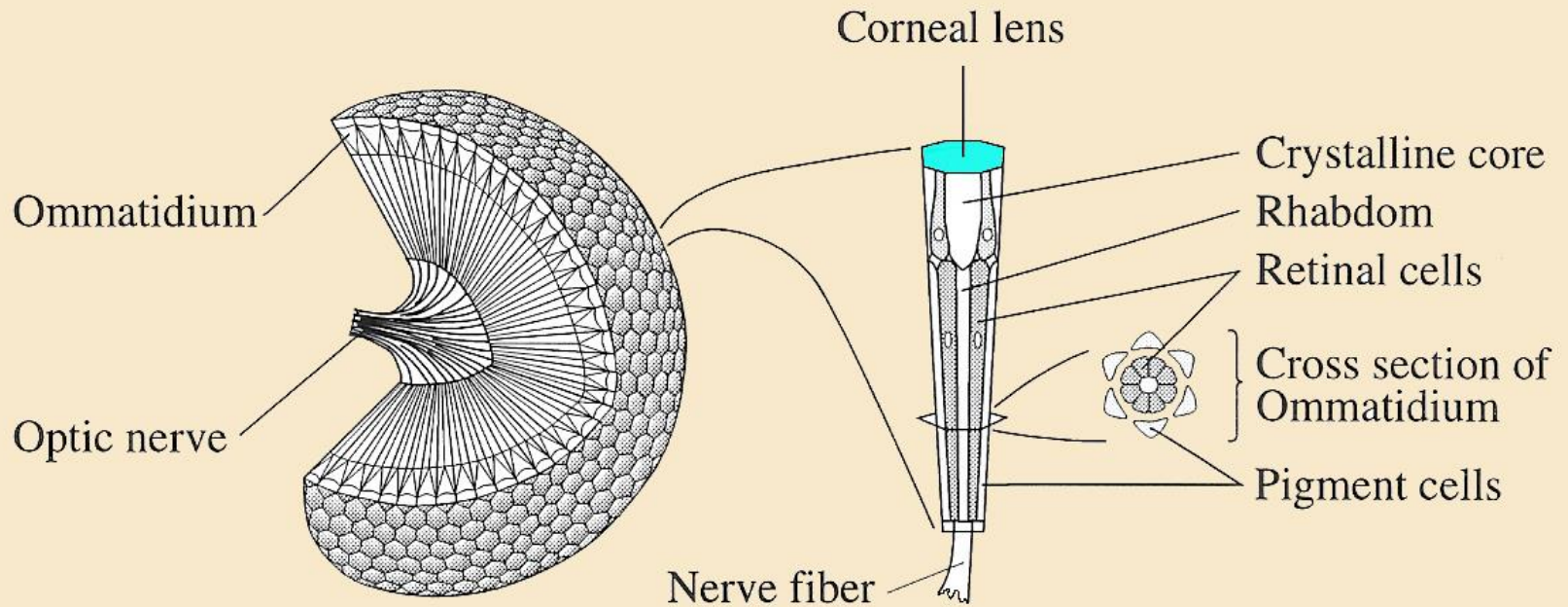
1. COMPLEXITY OF THE EYE

THE TRILOBITE EYE

The trilobite eye, like the eye of an insect, is a compound eye. It has many **ommatidia** (tubes) each pointing in a slightly different direction, and each ommatidium has its own lens so as to give a precise image of what lies in the exact direction it is pointing.

A general diagram of the compound eye used earlier is provided in the next slide for review.

COMPOUND EYE



After: Raven and Johnson, 1992, p. 831

THE COMPOUND EYE. Each ommatidium points in a slightly different direction and detects what is in that direction.

1. COMPLEXITY OF THE EYE

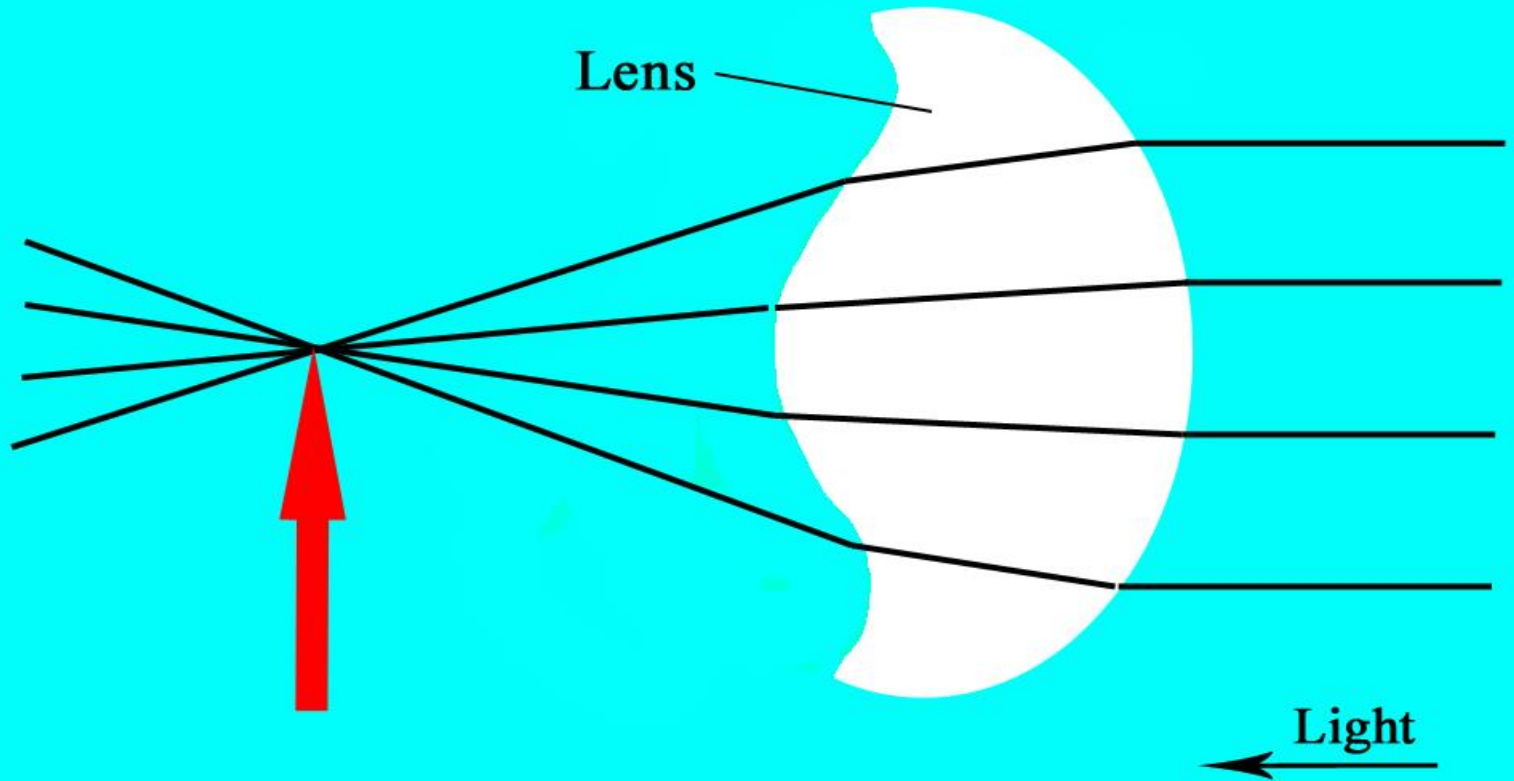
THE TRILOBITE EYE

In order to get around the problem of spherical aberration, researchers in Europe, such as Descartes and Huygens, working several centuries ago, designed special lenses that corrected for spherical aberration. An example is provided in the next slide. Note that the incoming light rays coming from the right side all converge on the same plane.

Amazingly, when the eyes of some trilobites were closely examined it was discovered that their lenses were of the same type as those invented by Descartes. These lenses corrected for spherical aberration and thus provided the trilobite with a sharp image of what it was looking at.

APLANATIC LENS OF DES CARTES AND HUYGENS

The light rays going through the lens meet on one plane.



Trilobites have a similar kind of lens.

PATTERN OF LIGHT RAYS THROUGH AN APLANATIC LENS. Note the special shape of the lens, and the light rays that converge on one plane (arrow).

1. COMPLEXITY OF THE EYE

THE TRILOBITE EYE

This sophisticated feat of optical function found in trilobite lenses poses problems for evolution because we don't find in the fossil record the evolutionary ancestors of these advanced eyes. As evolution would proceed by **random mutations**, trying one kind of lens shape after another, the number of ineffective shapes tried would be enormous. Yet none have been found.

1. COMPLEXITY OF THE EYE

THE TRILOBITE EYE

Furthermore, the lenses of trilobites are made of crystals of the mineral calcite (calcium carbonate, CaCO_3). Calcite is a complicated mineral that bends the light rays entering or leaving it (index of refraction) at different angles (degree of bending) depending on the orientation of the crystal. In trilobite eyes the calcite of the lenses is oriented in just the proper direction so as to give the right focus. Thus one can wonder about how many random tries it would take before evolution would have produced calcite minerals in the right orientation. And we haven't found the fossils expected for this extended evolutionary process.

In several ways the trilobite eye strongly favors the creation concept.

1. COMPLEXITY OF THE EYE

A COMMON GENE FOR THE EYE

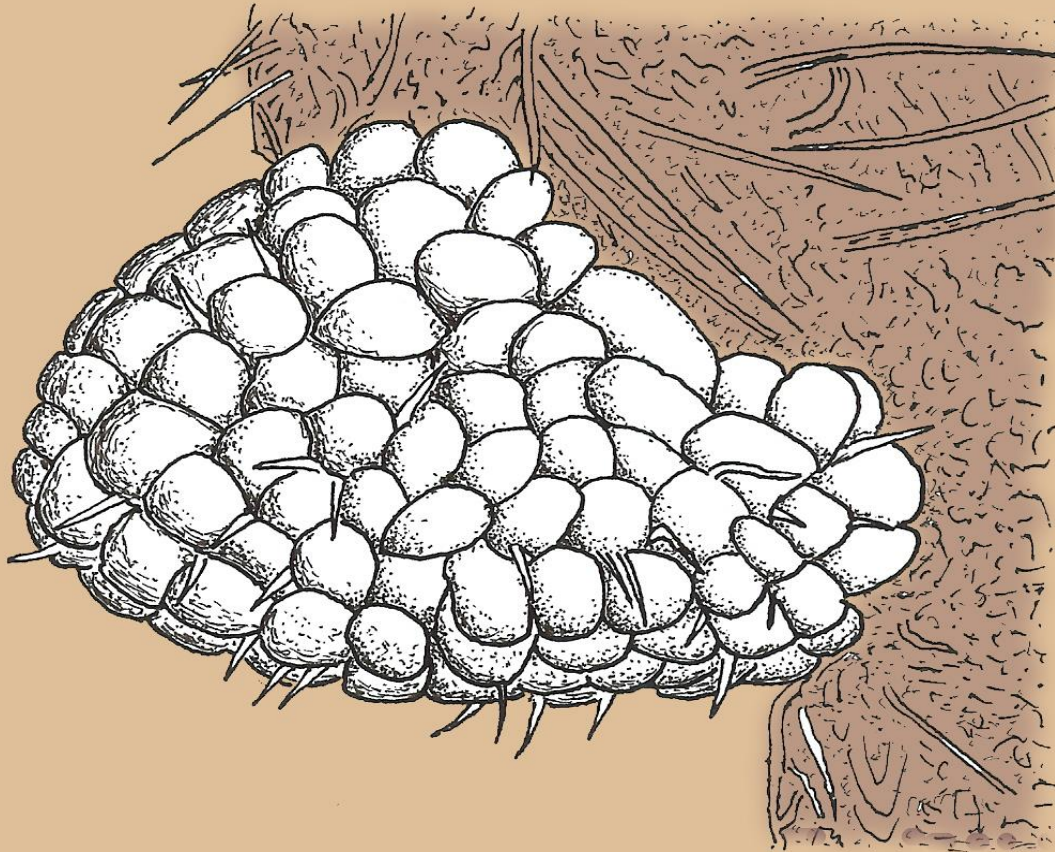
Evolutionists have perceived some evidence for their theory of eye development from a common ancestor based on the genetic makeup of various organisms. It has been found that there is one of those master genes (i.e. **Pax 6**, a homeobox gene found in many animals) that is associated with the development of the eye in different animals. Evolutionists assume that a common master gene means common evolutionary ancestry.

Some complicated genetic engineering experiments conducted in Switzerland have succeeded in taking this eye-inducing gene from a mouse, which has a simple eye, and putting it in the DNA of a fruit fly, which has a compound eye, and that gene caused the development of an extra compound eye on the leg of the fly.

1. COMPLEXITY OF THE EYE

A COMMON GENE FOR THE EYE

An illustration of this extra eye is shown on the next slide. The eye is to the left of the brown leg. Each of the many bumps on the surface of the white eye is the end of an ommatidium of this compound eye. The ommatidia of this extra eye responded to light by generating a nerve impulse when stimulated by light. So at least the ommatidia were functional.



Ectopic eye on leg of a fruitfly produced using Pax-6 gene from a mouse.

(After Halder, Callaerts and Gehring, 1995, Science 267:1791)

EXTRA EYE ON THE LEG OF A FLY. Each of the white bumps is an ommatidium of this compound eye.

1. COMPLEXITY OF THE EYE

A COMMON GENE FOR THE EYE

Evolutionists consider the action of this master gene that causes eye development in different kinds of animals to be strong evidence of a **common evolutionary origin**. But this needs to be the case only if you assume evolution. On the creation side, it could also mean that one Designer had planned the same kind of basic developmental process in various animals. **Why not use the same system of master genes** that work in different animals, instead of inventing a different system for each kind of animal? This would seem like efficient planning.

1. COMPLEXITY OF THE EYE

A COMMON GENE FOR THE EYE

Evolutionists also need to keep in mind that **several thousand genes** are involved in the development of the eye of the fly and that eye is **very different from that of a mouse eye. Evolution needs to account for all these new genes.** So one similar master gene does not at all solve the problem of the great variety of different genes producing the variety of eyes that we find.

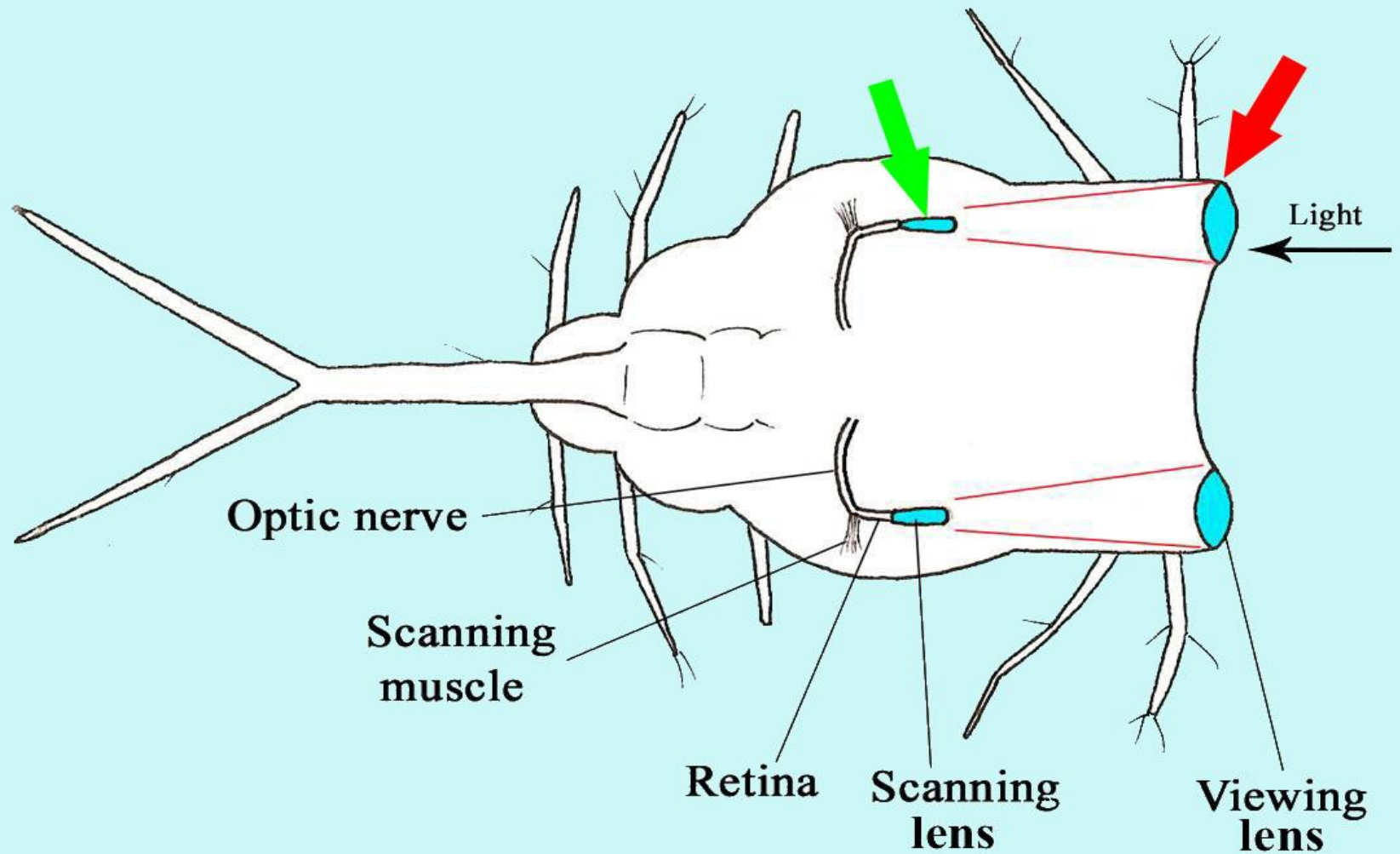
1. COMPLEXITY OF THE EYE

THE SCANNING EYE OF *COPILIA*

We mentioned earlier (Discussion 4) the intriguing eye system of the copepod *Copilia*. Recall that the animal lives in the Mediterranean Sea and is only about one millimeter wide, yet it uses a scanning system that goes back and forth to form an image, somewhat like a television camera does.

The system is illustrated in the next slide. The animal uses four lenses, two in front for viewing and two behind to scan the image captured by the viewing lenses. Muscles cause the scanning lenses (green arrow) to vibrate back and forth about once per second or faster as it views the image seen by the viewing lenses (red arrow).

SCANNING OPTICAL SYSTEM OF *Copilia*



THE SCANNING SYSTEM. An image is formed by a vibrating scanning lens (green arrow) analyzing the image brought into focus by a viewing lens (red arrow).

1. COMPLEXITY OF THE EYE

THE SCANNING EYE OF *COPILIA*

Such an eye provides another example of the great variety of different basic kinds of eyes we find. It does not seem possible that these very different visual systems would evolve from each other.

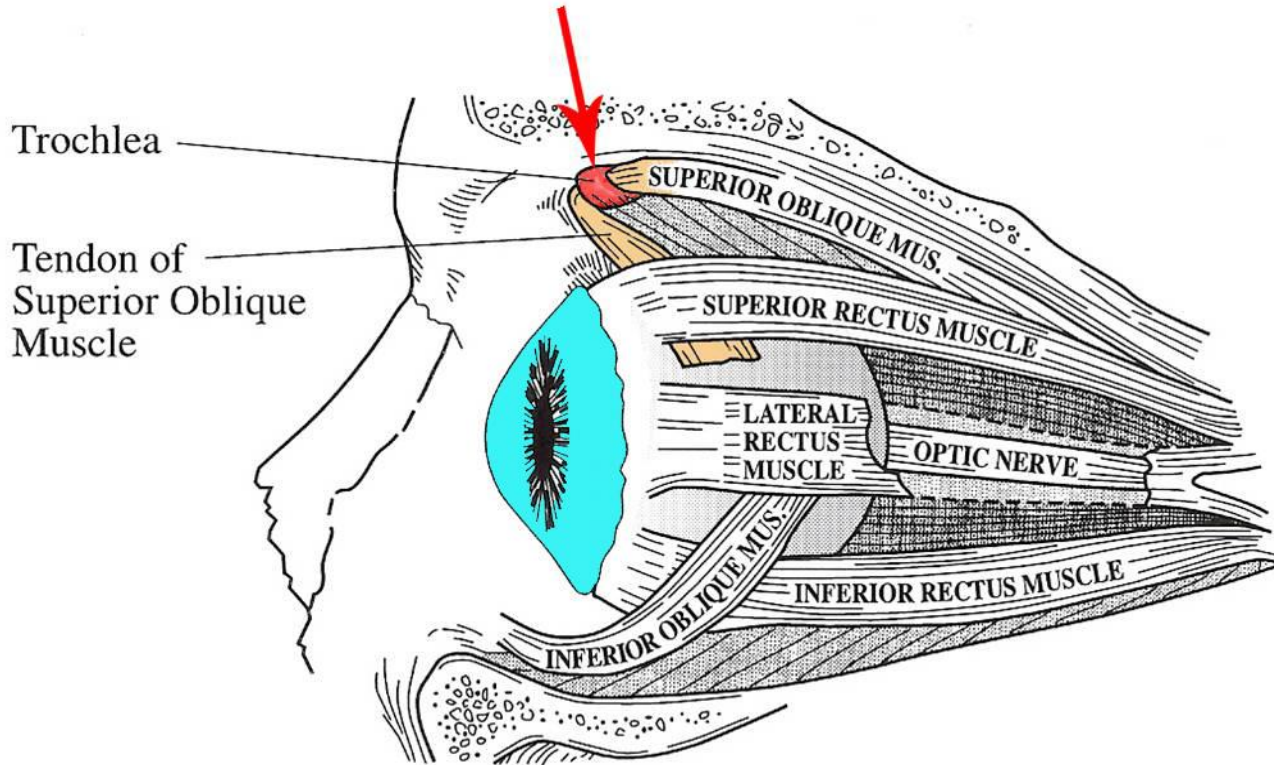
The *Copilia* eye also illustrates the difficulty of evolving complex systems. For instance in evolving this kind of eye, of what use would be the muscle that vibrates the scanning lens without the evolution of the scanning lens, and of what use would the scanning lens be without a special complicated system in the brain to interpret the scans? Here, as usual, there seem to be too many **interdependent parts** that are necessary to provide survival value until all are present. Random mutations would not be expected to suddenly provide all the parts of complex working systems so that there could be some survival value.

1. COMPLEXITY OF THE EYE

THE TROCHLEA

There is a simple ring-like structure associated with our eyes that raises the same kind of question as *Copilia* does. How could such interdependent parts ever evolve gradually by an unguided random evolutionary process? The structure, called the **trochlea**, is illustrated at the end of the red arrow in the next slide. A tendon that pulls the eye up and forward slides through that ring so as to change the direction of motion provided by the superior oblique muscle.

EXTERNAL MUSCLES OF THE LEFT HUMAN EYE



Based on Newell FW. 1992. Ophthalmology, 7thEd., p38.

ARRANGEMENT OF THE SUPERIOR OBLIQUE EYE MUSCLE. The tendon (tan) of the muscle passes through the ring-like trochlea (red).

1. COMPLEXITY OF THE EYE

THE TROCHLEA

In an evolutionary process of modification, that needs to provide advantageous survival value in order to succeed, one can wonder how these interdependent parts ever gradually evolved? Did the trochlea ring evolve first? It would be a useless encumbrance by itself. Did the tendon become longer first, so it could extend through the trochlea? Its excess length would negate the usefulness of the muscle. Or did the mechanism that threads the tendon through the trochlea evolve first? That would be useless without first having both a long tendon and a trochlea. You need at least all three factors at the same time to provide evolutionary survival value. **Interdependent parts** pose serious challenges to evolution.

1. COMPLEXITY OF THE EYE

OTHER EXAMPLES OF INTERDEPENDENT PARTS:

- (a) The brain system that adjusts the **focus** of the lens is useless without special muscles that change the shape of the lens and a mechanism that determines that the eye is out of focus.
- (b) The mechanism that adjusts the **size of the pupil** is useless without a mechanism that detects how much light is present.
- (c) An eye is useless without a **part of a brain** to interpret what is seen.
- (d) Many specialized protein molecules are dependent on each other in order to produce the complex molecular avalanche **light detection** system mentioned above.

1. COMPLEXITY OF THE EYE

OTHER EXAMPLES OF INTERDEPENDENT PARTS:

On the next slide is a picture of an eye. While it looks quite simple, behind what you see are the intricate systems mentioned above. Recall that there is no survival value to parts of systems that don't work unless other necessary parts are also present.



1. COMPLEXITY OF THE EYE

CONCLUSIONS

1. The very complex eyes of trilobites with sophisticated optics appear very **early** in the fossil record of animals. How could such complexity gradually evolve without leaving any fossil record? The abrupt appearance of such complex functions is better explained by creation.

2. The major problem with the evolution of the eye is generally ignored by evolutionists. Complex systems with **interdependent parts** like the visual system of *Copilia*, have no evolutionary survival value until all essential parts are present so as to be able to provide the needed survival value. Until then, excess non-functioning parts are only cumbersome impediments. This is the **irreducible complexity problem**.

1. COMPLEXITY OF THE EYE

CONCLUSIONS

Charles Darwin, in 1859, in his famous book, *Origin of Species*, (p 219, Penguin Edition, 1968) obviously did not understand the problem of interdependent parts. He states:

“If it could be demonstrated that any complex organ existed, which could not possibly have been formed by numerous, successive, slight modifications, my theory would absolutely break down. But I can find out no such case.”

Darwin tries to protect his view by using the “just prove it is impossible” type of argument when he says “not possibly.” But his “numerous, successive, slight modifications” that would not have any survival value until something worked, indicates that, in his own words, his theory has **“absolutely”** broken down many times.

2. EVOLUTION'S INCOMPLETE EYE

2. EVOLUTION'S INCOMPLETE EYE

Some evolutionists in Sweden have tried to suggest that the eye could evolve very fast. The reference for their study is:

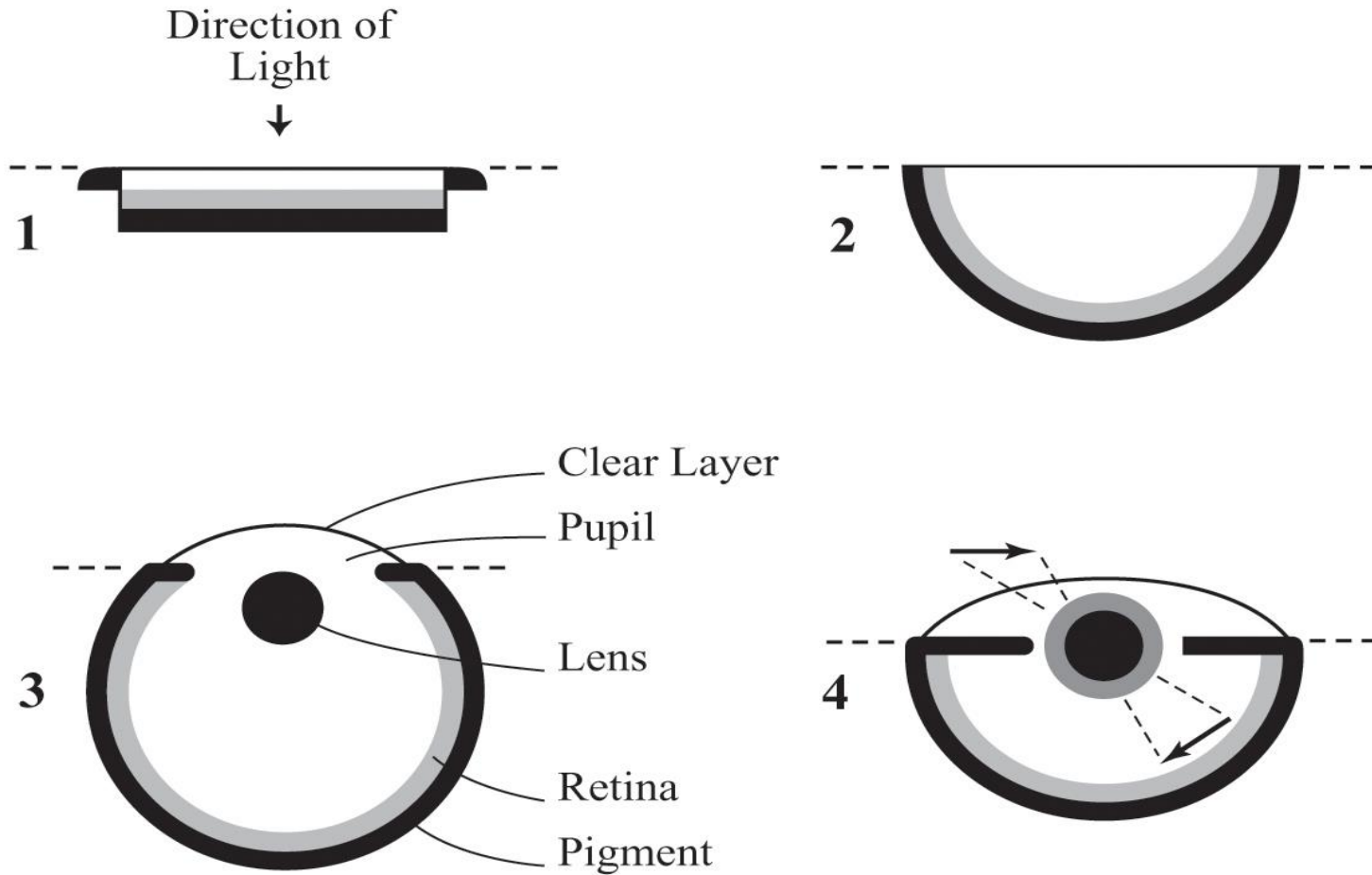
Dan-E Nilsson, Susanne Pelger (Lund University) 1994. *A Pessimistic Estimate of the time required for an eye to evolve*. Proceedings Royal Society of London, B 256:53-58.

These authors conclude that the eye could have evolved in just 1829 steps of arbitrary 1% theoretical improvements.

Furthermore, they suggest that it would take less than 364,000 years for a simple eye to evolve from a light sensitive patch.

They conclude that there is enough geologic time since the Cambrian for “eyes to evolve more than 1500 times.”

The main steps in their proposed model are illustrated in the next picture.



EVOLUTION OF THE EYE. Cross sections of four stages in gradual development. After Nilson & Pelger, PRSL B 256:53-58.

2. EVOLUTION'S INCOMPLETE EYE

Their proposed model **cannot be taken seriously** because many important parts of the eye are not considered. Their approach is reminiscent of what is sometimes called “**fact-free science.**” While their valiant efforts are worthy of some respect, the argumentation illustrates the all too common great weakness of many evolutionary propositions, namely, details are overlooked.

MISSING PARTS:

1. Retina (the most important and most complex part of the eye)
2. Brain parts to interpret what the eye sees
3. Nerve connection between eye and brain
4. Lens focusing mechanism
5. Pupil size adjusting mechanism
6. A functional lens (they make a vague suggestion)
7. New embryological process needed for vertebrates, where the eye originates from the brain, not the skin as they propose
8. Muscles that move the eye

2. EVOLUTION'S INCOMPLETE EYE

Despite these major omissions, some evolutionists were excited about the model. Some of their endorsing comments follow:

Richard Dawkins, Oxford University. 1994. *The Eye in a Twinkling*. Nature 368:690-691. Results were “swift and decisive” and the time required for the evolution of the “eye is a geological blink.”

Daniel Osorio, Sussex University. 1994. Eye evolution: *Darwin's Shudder Stilled*. Trends in Ecology & Evolution 9:241-242. The eye has been such a problem for evolution that it is sometimes referred to as “Darwin's shudder”

INTERNET: “The eye has turned out to be the BEST PROOF of evolution.” (This overstatement has since been removed from its original web page!)

To a significant degree these comments, that are highly inaccurate, likely reflect over-reactions by evolutionists to the problem the eye has posed for them for over two centuries.

3. THE INVERTED RETINA

3. THE INVERTED RETINA

Many evolutionists claim that the eye is badly designed!

They claim that the retina of vertebrates (fish, amphibians, reptiles, birds and mammals) is **inverted** from the way it should be. In most other animals they consider it to be **verted** or properly arranged.

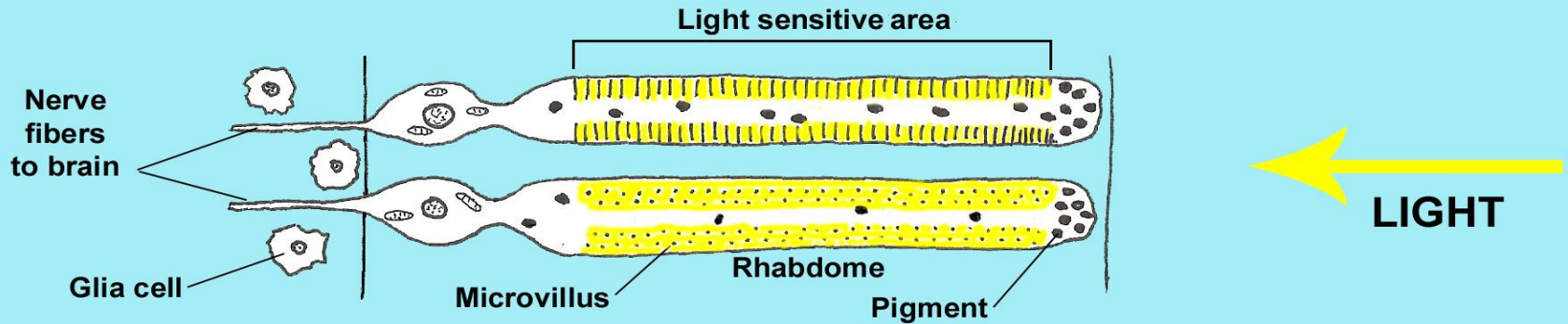
The claim of inversion is based on the fact that in vertebrates the light sensitive part (**discs**) of the photoreceptor cells (rods and cones) is turned away from the light instead of towards it. This is analogous to turning a surveillance camera towards a wall instead of into an open room.

3. THE INVERTED RETINA

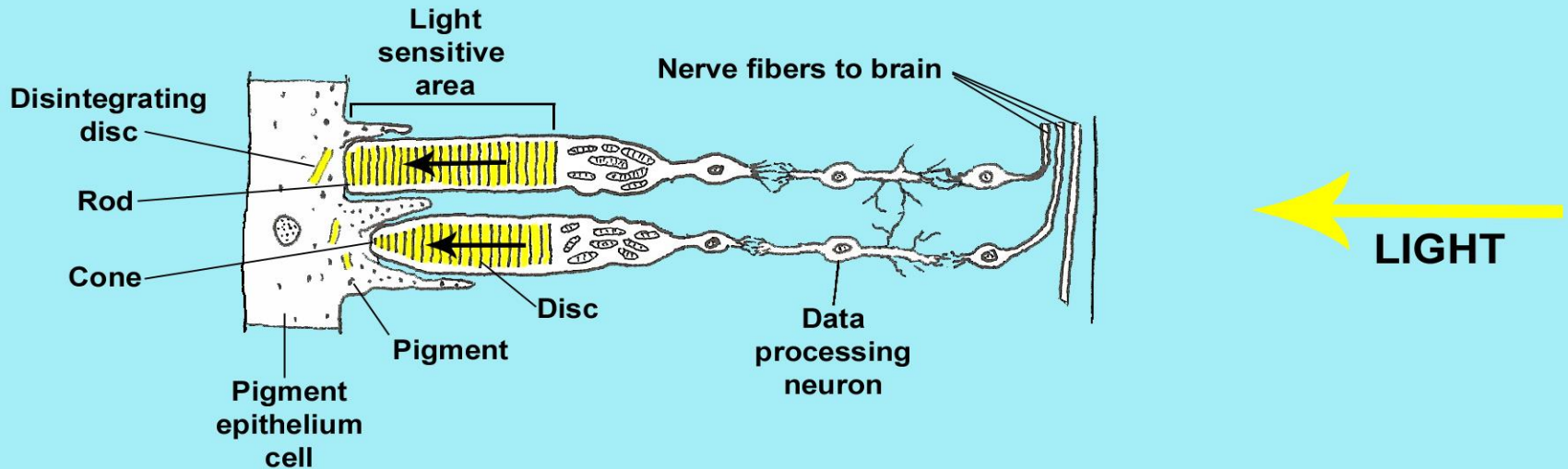
The next slide illustrates the cells in the two main kinds of arrangements for the retina. Note the direction the light travels, and note the location of the **light sensitive area** of the photoreceptors (**yellow color**).

The upper figure is the **verted** arrangement as found in squids, spiders and many snails, etc. The lower figure is the **inverted** arrangement as found in vertebrates like you. Here, not only does the light have to first go through part of the rod and cone cells to reach the light sensitive discs, it has to also go through layers of neurons; and many evolutionists consider this to be a very bad design.

THE VERTED RETINA (NON-INVERTED RETINA)



THE INVERTED RETINA



TWO KINDS OF RETINAS. Note the light sensitive area towards the light in the verted retina and away from the light in the inverted retina.

3. THE INVERTED RETINA

In the next slide, used earlier in discussing convergence, you have examples of eyes with these two kinds of retinas. The left is that of a squid that is verted, and the right is that of a vertebrate that is inverted. At this scale, you can barely notice the difference within the thin retinas.

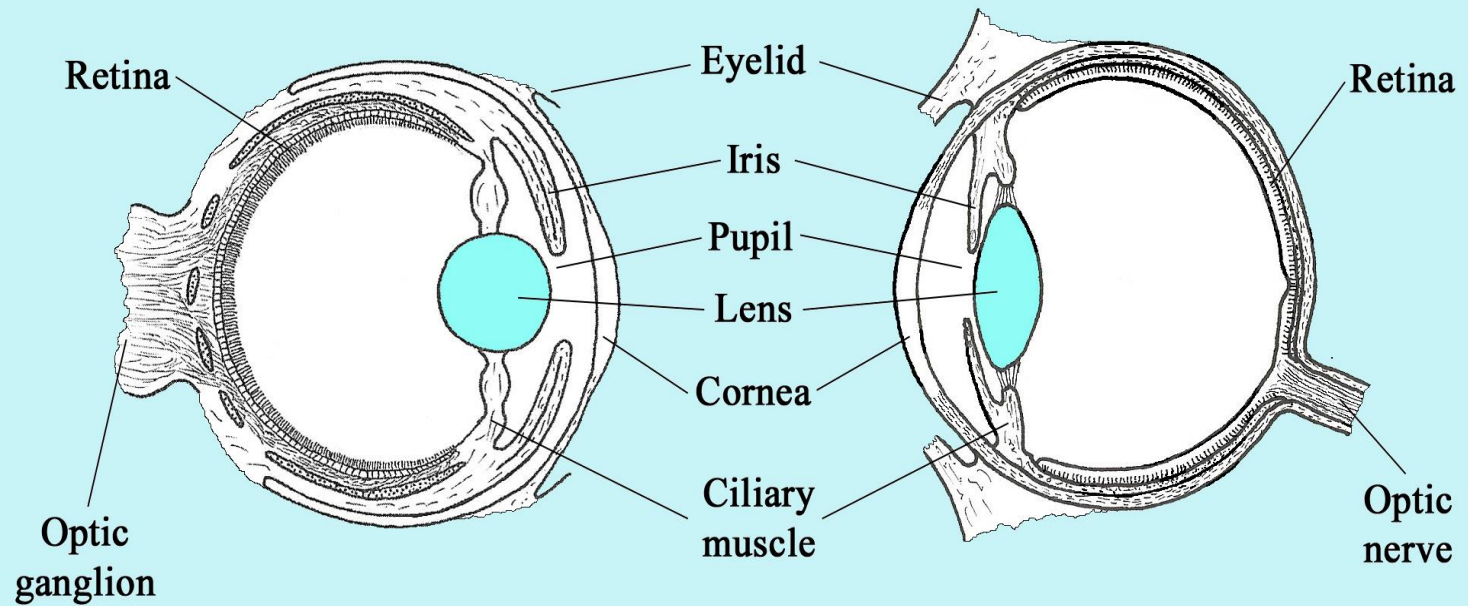
SIMILARITY IN THE BASIC STRUCTURE OF THE EYES OF TWO VERY DIFFERENT KINDS OF ANIMALS

CEPHALOPOD EYE

Octopus, squid, Sepia

VERTEBRATE EYE

Fish, amphibians, (reptiles), birds, mammals



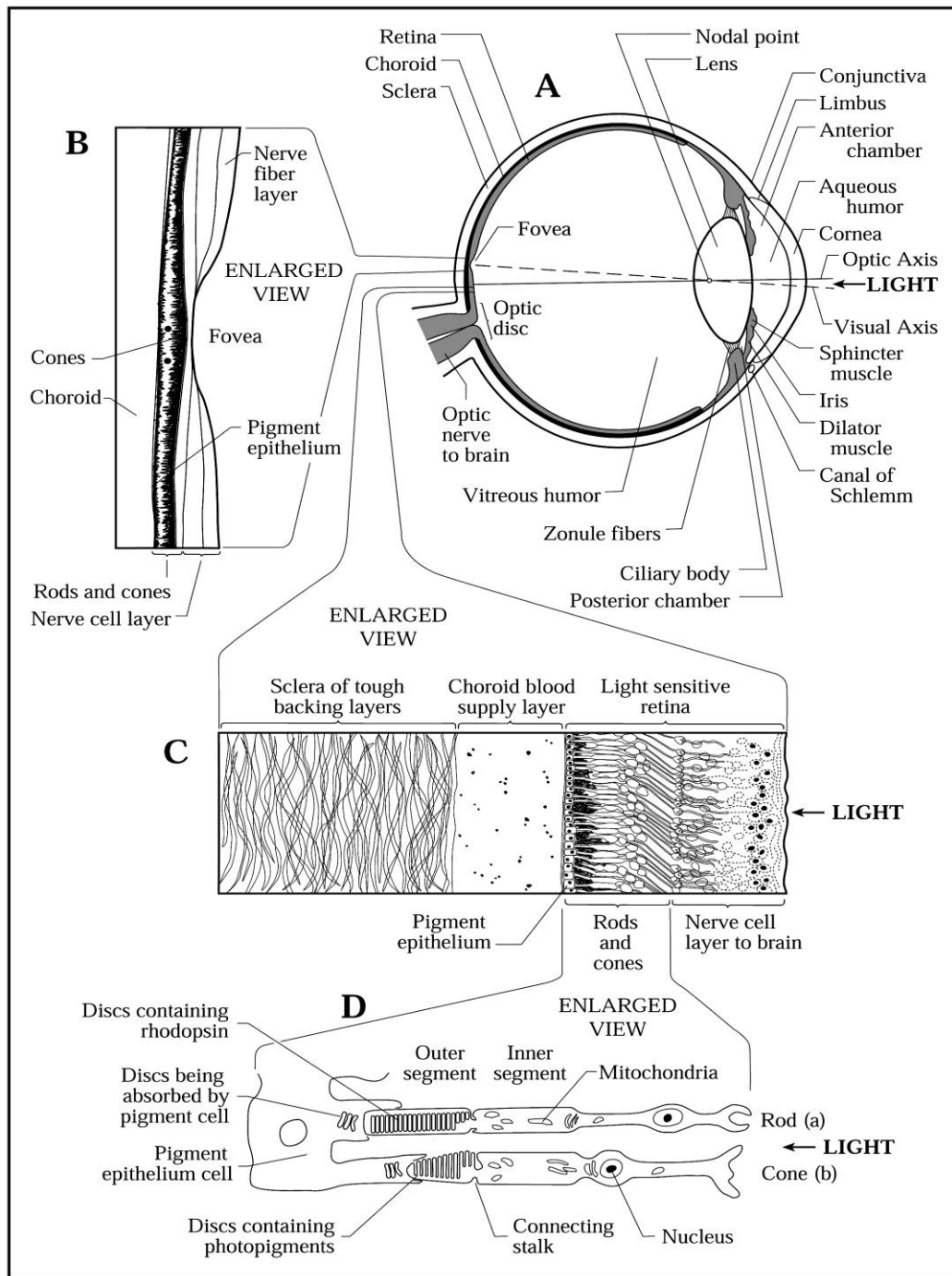
Based on Hegner, 1933, Fig. 274; and Futuyama, 1998, Fig.5:20

3. THE INVERTED RETINA

The two kinds of retinas are quite different in microscopic details. The cephalopod retina has numerous elongated **microvilli** (illustrated three slides back) that contain the light sensitive molecules, while in vertebrates those light sensitive molecules are found in **discs** that are constantly being replaced.

In the next slide, there are some details of the inverted vertebrate retina. Note especially parts C and the discs in part D. Light comes in from the right.

VERTEBRATE EYE



A. The complex vertebrate eye.

B, C, D, enlarged details.

3. THE INVERTED RETINA

DEROGATORY COMMENTS BY SOME EVOLUTIONISTS

George Williams. NY University, Stony Brook

“There would be no blind spot if the vertebrate eye were really intelligently designed.”

Jared Diamond. University of California at Los Angeles

“However the vessels and nerves aren’t located behind the photoreceptors, where any sensible engineer would have placed them, but out in front of them, where they screen some of the incoming light. A camera designer who committed such a blunder would be fired immediately. ... By contrast, the eyes of the lowly squid, with the nerves artfully hidden behind the photoreceptors are an example of design perfection. If the Creator had indeed lavished his best design on the creature he shaped in his own image, creationists would surely have to conclude that God is really a squid.”

3. THE INVERTED RETINA

DEROGATORY COMMENTS

Douglas Futuyma. University of Michigan and NYUSB

“The human eye has a ‘blind spot,’ It is caused by the functionally nonsensical arrangement of the axons of the retinal cells which run forward into the eye.”

William Thwaites. San Diego State University

“Vertebrates are cursed with an inside-out retina in the eye.... Did God at the time of the ‘Fall’ turn the vertebrate retina inside-out...?”

Richard Dawkins. Oxford University

“Any engineer.... would laugh at any suggestion that the photocells might point away from the light, with their wires departing on the side *nearest* to the light,.... Each photocell is, in effect, wired backwards.”

3. THE INVERTED RETINA DEROGATORY COMMENTS

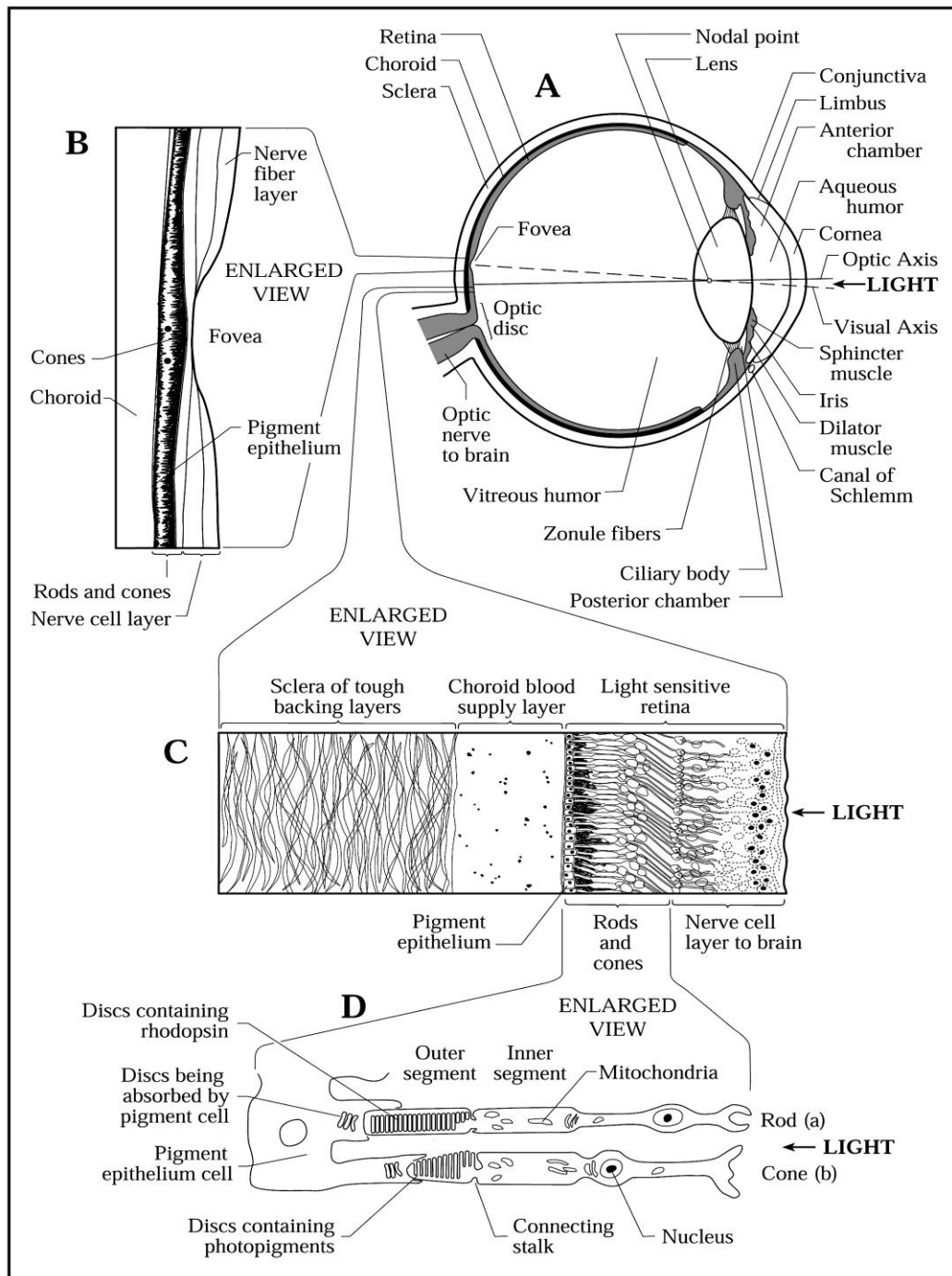
The conclusion is that the eye is so badly designed, that no intelligent designer would commit such a blunder. **The implication is that there is no God.**

THE ALLEGED PROBLEMS OF THE REVERSED OR INVERTED RETINA ARE:

- a. The light sensitive ends (discs) of the rods and cones are directed (headed) away from the light.
- b. The nerve processing cells in the retina are between the incoming light and the rods and cones.
- c. This necessitates a blind spot where the nerve fibers leave the eye to connect to the brain.

You may be able to note all these assumed problems on the image of the vertebrate eye repeated in the next slide. The blind spot is labeled “Optic disc” on part A.

VERTEBRATE EYE



A. The complex vertebrate eye.

B, C, D, enlarged details.

3. THE INVERTED RETINA

CRITICISMS ABOUT INVERTED RETINA ARE NOT VALID

- a.** The blind spot is not a problem. It is **to the side and small**. In our eyes we have a hard time finding it. Also each eye compensates for the blind spot in the other.

- b.** The area of acute vision (fovea) **does not have thick layers of neurons** between it and the incoming light that is found in other areas; hence, acute vision is hardly affected. See part B in the previous slide.

3. THE INVERTED RETINA

CRITICISMS ABOUT INVERTED RETINA ARE NOT VALID

- c. There appear to be very good reasons why the disc ends of the rods and cones are turned towards the back of the eye. The discs are **constantly being replaced**, probably to provide a fresh supply of molecules for the all important light detecting function of the eye. Each rod or cone replaces **80-90 new discs each day** out of a total of some 1000 per rod or cone. Only a few discs are illustrated in part D of two slides above. There the new discs are produced in the region labeled “Connecting stalk”; they travel towards the left and the old ones are extruded at the far end (left end) towards the back (outside) of the eye.
- (a) **The old discs need to be removed**, and this is done by the pigment epithelium.
- (b) The active rods and cones need to be near the **choroid blood supply of the wall of the eye that provides nutrients** for making all those new discs.

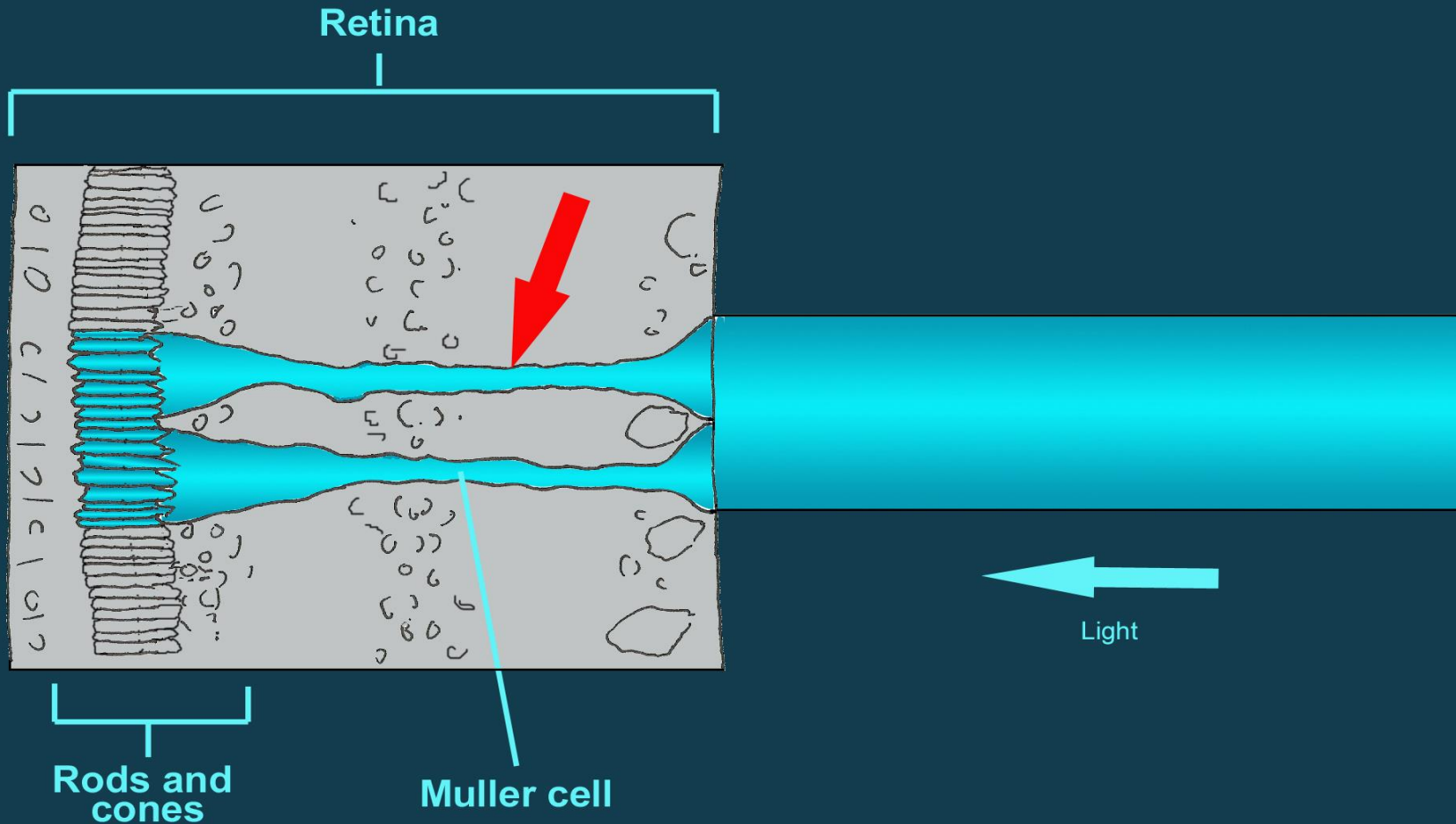
3. THE INVERTED RETINA

CRITICISMS ABOUT INVERTED RETINA ARE NOT VALID

d. Müller cells transmit light directly through the retina.

Recently (2007, Franze K et al. *Proceedings of the National Academy of Sciences* 104:8287-8292) it has been discovered that special cells called **Müller cells**, that span across most of the thickness of the retina, have a refractive index that is higher than that of the surrounding tissue and thus serve as conduits to transmit light directly through the layer of nerve cells of the retina that lie between the incoming light and the rods and cones. As illustrated in the next slide, the blue light coming in from the right is transmitted to the rods and cones by the elongated Müller cells (red arrow) in the retina.

LIGHT TRANSMITTED THROUGH RETINA BY MULLER CELLS



Based on Franze K, et al. 2007. PNAS 104: 8287-8292

MULLER CELLS OF THE INVERTED RETINA. Cross section of a small part (gray area) with Muller cells (red arrow) that transmit light right through the nerve cells.

3. THE INVERTED RETINA

CRITICISMS ABOUT INVERTED RETINA ARE NOT VALID

Hence, all the terrible problems that the inverted retina is supposed to cause, do not appear to be significant.

Organisms such as the squid that have a inverted retina do not keep replacing discs. They have no discs at all, but have long microvilli with light sensitive molecules that apparently do not undergo constant rapid replacement.

3. THE INVERTED RETINA

REVERSING THE INVERTED RETINA

Should we reverse the retina, as some evolutionists suggest that God should have done, it seems likely that we would have a visual disaster. The discs of the rods and cones would face into the light, but what would perform the essential function of the pigment epithelium in absorbing the old discs? Rods and cones are constantly at work and produce some ten billion discs per day in each of our eyes. These would accumulate in the transparent **vitreous humor** of the eye (see part A in the figure of the details of the vertebrate eye a few slides back), and their great numbers would soon impair our ability to see. Also, the rods and cones would be without the necessary pigment epithelium and the nearby blood supply of the choroid layer needed to replace the discs, so the disc replacing system would likely work poorly or not at all.

3. THE INVERTED RETINA

REVERSING THE INVERTED RETINA

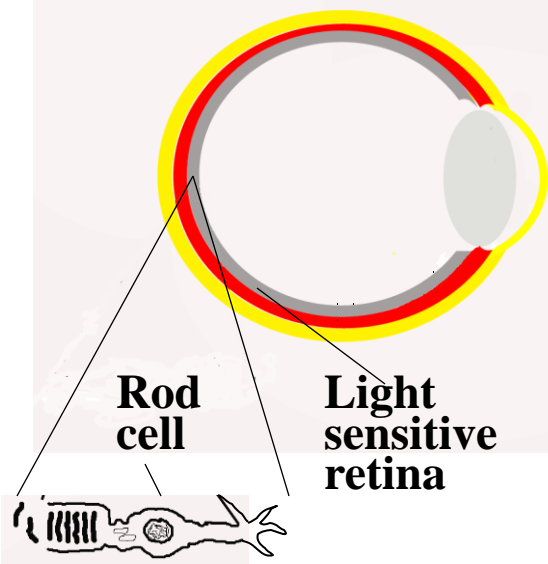
If under this reversal of the inverted retina we should then try to provide the disc ends of the rods and cones, pointed towards the light, as some evolutionists suggest they should be, with their necessary pigment epithelium and choroid blood supply layer, these layers would have to lie on the inside of the layer of rods and cones. In other words, they would lie closer to the middle of the eye and the source of light than the rest of the retina. As a result the light coming into the eye would first have to try and get through the blood-supplying choroid layer and pigment epithelium before reaching the light sensitive discs. A blood hemorrhage in the retina is extremely debilitating and illustrates how disruptive blood can be to the visual process. The pigment in the pigment epithelium that absorbs light would also be in the way and would contribute further to complete blindness. Like trying to play tennis with ripe tomatoes instead of tennis balls, this is not a great idea!

The next slide illustrates this. Note that the grey layer is the retina, the red layer the blood choroid, and yellow the outer sclera.

REVERSING THE “INVERTED” RETINA

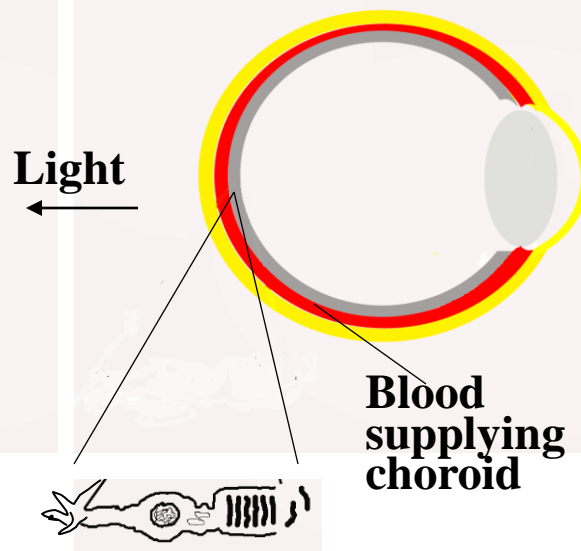
Some evolutionists suggest that the eye was not designed, because the light sensitive disc ends of the rods and cones point away from the light. The retina is said to be “inverted.” However if these light sensitive cells were reversed towards the light it appears that we would have a visual disaster.

**NORMAL
EYE**



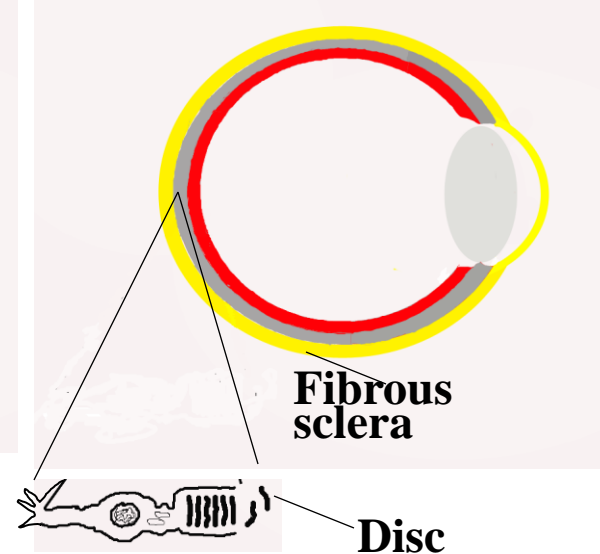
Light goes through transparent nerve cells. It works very well. There are fewer nerve cells in central fovea.

**REVERSED
RETINA**



Discs pointed towards light, but what would absorb the billions produced each day. They would eventually fill the eye.

**REVERSED RETINA
AND CHOROID**



If pigment epithelium and choroid were placed on the inside to absorb discs, light could not get through to the light sensitive discs.

3. THE INVERTED RETINA

CONCLUSIONS

- 1. While some leading evolutionists propose that the inverted retina is a terrible design a few evolutionists think it is a good design.**
- 2. The blind spot is far to the side and barely noticeable. One eye compensates for the other.**
- 3. In the area of acute vision (fovea), the nerve cells are small and radiate away from the region, resulting in a thin nerve cell layer. Rare small blood vessels in the retina avoid this area.**
- 4. Except for the pigment epithelium, the retina is a very transparent organ allowing light to reach the rods and cones. Furthermore, Müller cells transmit light directly through the retina.**

3. THE INVERTED RETINA

CONCLUSIONS

5. The inverted retina seems necessary to provide the interaction that the very active rods and cones require from the choroid's blood supply. Reversal would be detrimental to the ability to see.

6. If, as some evolutionists claim, the eye is so badly designed, and if as some other evolutionists claim, the eye can evolve "in a twinkling"; one can wonder why didn't natural selection produce a better eye for vertebrates a long time ago!

7. The inverted retina works very well. If it didn't you would not be able to read all this. It is hard to argue against success!

3. THE INVERTED RETINA

CONCLUSIONS

8. Inversion does not follow an evolutionary pattern. Vertebrates have an inverted retina, while in general invertebrates have a verted retina. But several invertebrates have an inverted retina. Examples include a snail, a cockle (bivalve mollusk), and several spiders and scorpions.

It would be a complicated process to change from one type to another, involving reorientation of light sensitive cells and nerve fibers, and then reconnection. Sudden change of several parts is implausible, and gradual change, while parts are not functional, would not be favored by natural selection of the fittest. Design of the various kinds of eyes seems a more plausible explanation.

4. CONCLUSIONS
DARWIN AND THE
EYE, PART 2

4. SUMMARY AND CONCLUSIONS

DARWIN AND THE EYE, PART 2.

- a.** Advanced optical systems, such as lenses that correct for spherical aberration, **appear very early** in the animal fossil record, without appropriate ancestors.

- b.** The eyes provide many illustrations of complex systems. The problem of the evolution of complex systems in the eye, with interdependent parts that have no evolutionary survival value until all necessary parts are there so they can function, **is not seriously considered** by evolutionists.

- c.** The Nilsson-Pelger model for rapid eye evolution is **extremely incomplete**.

- d.** The **inverted retina** appears to be a very good design for the needs of the vertebrate eye.



**THE EYE
VERY
MUCH
LOOKS
LIKE IT
WAS
DESIGNED
BY GOD**

5. REVIEW QUESTIONS

REVIEW QUESTIONS - 1

(Answers given later below)

- 1. When we examine the fossil record we find trilobite eyes that have sophisticated aplanatic lenses that correct for spherical aberration. What is the significance of the fact that these trilobite eyes are among the very lowest eyes found as we examine the fossils in the rock layers?**
- 2. The optical system of the copepod *Copilia* consists of several lenses; the focusing system of the vertebrate eye consists of a number of parts; the same is the case for the system that controls the amount of light that enters the eye. What problem do these complex systems pose for a suggested evolutionary origin?**

REVIEW QUESTIONS - 2

(Answers given later below)

- 3. Some evolutionists (i.e. Nilsson and Pelger, 1994) have proposed a model of how the eye could evolve very fast. In fact they suggest that the eye could have evolved 1500 times since the Cambrian. They propose 1% arbitrary steps in improvement, especially changes in the shape of the eye. What is the main problem with their model? Give details.**
- 4. A number of leading evolutionists claim that the retina of the vertebrate eye is very badly designed because the light sensitive parts of the rods and cones are directed away from the incoming light. What appears to be the purpose of the inverted retina? What would happen if it weren't inverted?**

REVIEW QUESTIONS AND ANSWERS - 1

- 1. When we examine the fossil record we find trilobite eyes that have sophisticated aplanatic lenses that correct for spherical aberration. What is the significance of the fact that these trilobite eyes are among the very lowest eyes found as we examine the fossils in the rock layers?**

It would take a lot of random evolutionary trials of mostly detrimental mutations to finally produce a sophisticated aplanatic lens that corrects for spherical aberration. These extended evolutionary trials would be expected to leave lots of fossils in the process of evolving aplanatic lenses, but they are not found, and it looks like the trilobite eye did not evolve.

REVIEW QUESTIONS AND ANSWERS - 2

2. The optical system of the copepod *Copilia* consists of several lenses; the focusing system of the vertebrate eye consists of a number of parts; the same is the case for the system that controls the amount of light that enters the eye. What problem do these complex systems pose for a suggested evolutionary origin?

It does not seem possible that a process of random mutations could gradually evolve these systems with so many interdependent parts that would be essentially useless until all the necessary parts were present so as to provide some evolutionary survival value. The evolutionary process of natural selection would have been expected to favor those organisms that did not have the extra encumbrance of parts of developing systems that would have been useless until the systems were complete enough to be functional.

REVIEW QUESTIONS AND ANSWERS - 3

3. Some evolutionists (i.e. Nilsson and Pelger, 1994) have proposed a model of how the eye could evolve very fast. In fact they suggest that the eye could have evolved 1500 times since the Cambrian. They propose 1% arbitrary steps in improvement, especially changes in the shape of the eye. What is the main problem with their model? Give details.

The main problem is that they did not include most of the essential parts of the eye in their estimates of the time required for an eye to evolve. Parts omitted include: 1. The retina (the most important and most complex part of the eye). 2. Brain parts needed to interpret what the eye sees. 3. Nerve connection between eye and brain. 4. Lens focusing mechanism. 5. Pupil size adjusting mechanism. 6. A functional lens (they make a vague suggestion). 7. New embryological process needed for vertebrates where the eye originates from the brain, not the skin, as they propose. 8. Muscles that move the eye.

REVIEW QUESTIONS AND ANSWERS - 4

4. A number of leading evolutionists claim that the retina of the vertebrate eye is very badly designed because the light sensitive parts of the rods and cones are directed away from the incoming light. What appears to be the purpose of the inverted retina? What would happen if it weren't inverted?

The inverted retina permits the absorption of the light sensitive discs that the rods and cones are constantly producing. Furthermore, it places the active disc-producing ends of the rods and cones close to the blood supply of the choroid layer.

If the retina were not inverted, and the light sensitive ends of the rods and cones were turned towards the light, what would perform the essential function of absorbing the discarded discs? These discs would eventually fill the eye and interfere with our ability to see.

ADDITIONAL REFERENCES

For further discussions by the author (Ariel A. Roth) and many additional references, see the author's books titled:

1. **ORIGINS: LINKING SCIENCE AND SCRIPTURE.** Hagerstown, MD. Review and Herald Publishing Association.
2. **SCIENCE DISCOVERS GOD: Seven Convincing Lines of Evidence for His Existence.** Hagerstown, MD. Autumn House Publishing, an imprint of Review and Herald Publishing Association.

Additional information is available on the author's Web Page: Sciences and Scriptures. www.sciencesandscriptures.com. Also see many articles published by the author and others in the journal **ORIGINS** which the author edited for 23 years. For access see the Web Page of the Geoscience Research Institute www.grisda.org.

Highly Recommended URLs are:

Earth History Research Center <http://origins.swau.edu>

Theological Crossroads www.theox.org

Sean Pitman www.detectingdesign.com

Scientific Theology www.scientifictheology.com

Geoscience Research Institute www.grisda.org

Sciences and Scriptures www.sciencesandscriptures.com

Other Web Pages providing a variety of related answers are: Creation-Evolution Headlines, Creation Ministries International, Institute for Creation Research, and Answers in Genesis.

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