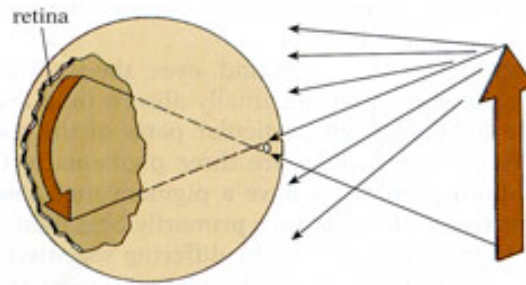


COMPLEX BUT CRISP: CAMERA EYES

There are two versions of the **camera eye**, the strategy employed by vertebrates and some molluscs. By far the rarer is the **pinhole eye** of organisms such as the chambered nautilus. The pinhole eye is simply a covered eye cup with a tiny opening in its surface. Light from the world outside passes through the hole and is projected onto the array of receptors (the **retina**) at the back. Very little light can enter, and if the opening were widened to admit more light, the image, which is surprisingly sharp, would become blurred.



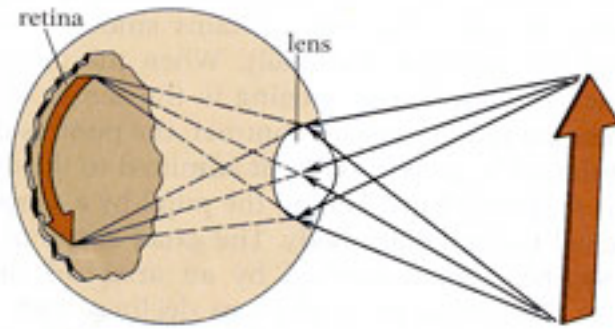
Cephalopods, with pinhole eyes –
Cephalopods such as these chambered nautili, are the only organisms with pinhole eyes



How the pinhole eye works – Light reflected from objects in the environment passes through the pinhole and projects a precise (though inverted) image on the retina. The main disadvantage of this eye is that the image is relatively dim, since very little light is admitted.

The **lens eye**, on the other hand, can have a far larger opening for light, since the images are focused by a lens rather than a pinhole on the retina. This more elaborate approach, however, is not without its problems. Unlike a pinhole eye, a lens eye can focus on objects at only one distance at any one time. Mammals and some birds and reptiles have muscles to change the shape (and thus the focus) of their lenses, while fish, amphibians, and other reptiles move the whole lens toward or away from the retina in the manner of a true camera. (Birds can also alter the shape of their cornea, the transparent structure through which light must pass to reach the lens.)

In addition, the retina and lens must have just the right spatial relationship: if the retina is too close to the lens, the animal will have difficulty seeing nearby objects (that is, it will be farsighted), whereas if the retina is too far away, distant objects cannot be brought into focus (the animal is nearsighted). In addition, irregularities in the lens itself may give rise to astigmatism, in which images of objects at the same distance from the lens but in different parts of the visual field come into focus at different distances. An insuperable disadvantage of the camera eye for many creatures is its bulk: a camera eye large enough to provide the same visual resolution as the compound eye of a honeybee would weigh more than the bee itself.



How the lens eye works. Light reflected from objects in the environment arrives at a lens and is focused on the retina. The lens eye admits much more light than the pinhole eye, but has great constraints on its focusing ability.

