Unit 1: Introduction

* Humans are incredibly reliant on vision. Almost 1/3 of the brain is devoted to processing visual cues
* People trust their sense of vision over other senses. For a lot of people, seeing truly is believing. For example, considering watching a movie in a theatre. The audio is coming from the speakers but you perceive it as coming from the actors’ mouths on the screen. The visual cues help enforce this idea
* Technically, we see with our brain, not our eyes. The eyes are an instrument to collect, focus, and sense the stimulus. The bulk of the process occurs in the brain
* The visual system, processes, and interprets visual information to give us a rich experience

Unit 2: The Stimulus – Light

* Eyes process light to visualize the world. Light is an important factor when it comes to vision
* Light travels as a wave and can vary in two respects: the height of each wave, called the amplitude, and the distance between the peaks of successive waves, called the wavelength
* Amplitude is an indication of perceived brightness. Variations in amplitude affect the perception of brightness. Generally, the greater the amplitude of the light wave, the more light is being reflected or emitted by that object, and so that object appears brighter or more intense to us.
* Wavelength is an indication of perceived colour. Variations in wavelength affect the perception of colour. Wavelength is measured in nanometers, or millionths of a millimetre. Smaller wavelengths refer to light waves with a higher frequency, because there is less distance between successive peaks. Larger wavelengths refer to light waves with a lower frequency.
* Humans are only sensitive to a tiny portion of the total range of wavelengths of electromagnetic radiation. This tiny portion is referred to as the visible spectrum, and is species dependant. The shortest wavelength that we can see is around 360 nanometers, which looks violet, and the longest wavelength that we can see is around 750, which looks red.
* The visible spectrum is human oriented, and there are other species that can see outside our visible spectrum. i.e. Bees can see wavelengths shorter than 360nm in the ultraviolet spectrum, and perceive differences in the colours of flowers that all look the same to us. Some species like snakes can see light made up of wavelengths longer than 750nm in the infrared spectrum, which allows them to find prey in the dark by being able to see the body heat that is emitted by the prey
* Amplitude and wavelength translate into our perceptions of brightness and colour, respectively. Purity is an indication of colour saturation, or the richness of colors
* A light that is made up of a single wavelength is a pure light, and the perceived colour would be described as completely saturated. However, natural light will more likely be a combination of many wavelengths, and be described as de-saturated. Most of the colours we see in our everyday life are not pure but a mixture of wavelengths and thus are less intense than pure colours.

Unit 3: The Eye

* Light passes through a series of focusing structures in the eye. First, light passes through the curved cornea, which begins the focusing process. The cornea is a transparent window at the front of the eye.
* The rest of the eye is covered by the white part of the eye called sclera, a tougher membrane.
* After the cornea, light passes through the pupil, which is the round window that you see as a black dot in the middle of your eye. The iris, or the colour part of your eye, controls the size of the pupil.
* The iris consists of a band of muscles that is controlled by the brain; if not enough light is reaching the retina, these muscles cause the pupil to dilate into a larger opening, where as if too much light is entering the eye then these muscles cause the pupil to constrict into a tiny opening.
* After passing through the pupil, light passes through the lens, a transparent structure that does the final focusing of light onto the retina at the back of the eye.
* Interestingly, the curvature of the lens causes images to land on the retina upside-down and reversed from left to right. However, the final perceived image is a product of brain activity, and is corrected.
* The lens is a flexible piece of tissue, the shape of which can be altered by surrounding muscles, allowing it to focus on objects that are close or far away
* If the object is close, the lens of your eye gets fatter or rounder to produce a clear image, but if the object is far away, the lens of your eye gets elongated to focus the image on the back of your eye
* This change in the shape of the lengths to focus on objects that vary in distance is accommodation
* After traveling through the lens, light passes through the vitreous humor, which is the clear, jelly-like substance that comprises the main chamber inside the eyeball. The light finally lands on the retina, which is the neural tissue that lines the back of the eye
* The cornea is responsible for roughly 80% of the focusing power of the eye
* In conclusion: Cornea > Pupil > Lens > Vitreous Humour > Retina

Unit 4: The Retina

* The retina begins the initial translation (physical stimulus) of light into neural impulses.
* The retina is a paper-thin sheet that covers the back of the eye, and is made up of a complex network of neural cells arranged in three layers with an “inside-to-out” arrangement
* The first layer, which is at the back of the eye, is furthest away from the light, and is where the photoreceptors are located. Photoreceptors are cells in the retina that are responsible for translating the physical stimulus of light into a neural signal that the brain can understand. To reach the photoreceptors, light must pass through the other 2 layers of retinal tissue which are transparent
* The neural cells are arranged in an “inside-out” pattern is because the photoreceptors get their nutrients from the retinal pigment epithelium [RPE] which is located at the very back of the eye
* Photoreceptors would die without access to the RPE cells, and if the photoreceptors were located at the front of the retina, facing the light, then they would not have access to RPE; that they need to live
* There are two different types of photoreceptors, called rods and cones. They specialize in high-light and low-light conditions, respectively. Humans have about 125 million rods and 6 million cones.
* Cones are designed to operate at high light intensities and are primarily used for day vision. The cones provide us with sensation of colour and provide good visual acuity, or sharpness of detail. Cones become more concentrated towards the fovea; a tiny spot in the middle of the retina
* Rods are designed to operate at low light intensities, and are primarily used for night vision. They provide no colour information and offer poor visual acuity. There are no rods in the fovea itself, but are highly concentrated in the area around the fovea. This arrangement makes rods very useful for peripheral vision, and explains why it is better to look slightly to one side of an object as opposed to staring at it in a dimly light environment. Cones do not work well in dimly light areas.
* The photoreceptors send information to the next layer of cells called the bipolar cells. In turn, the bipolar cells send their information on to the next layer of cells in the retina, called the ganglion cells
* The ganglion cells collect information from a larger segment of the retina, and the axons of these cells all converge onto one point in the eye called the optic disc, when then leave the eye to join the optic nerve, and travel to the brain. The optic disc is like an exit hole in the eye for the ganglion axons, this small area contains no photoreceptors at all, and so it constitutes our blind spot
* Cells in the retina that allow areas within a retinal layer to communicate with each other are called horizontal cells and amacrine cells. These cells allow information from adjacent photoreceptors to combine their information
* Information from over 130 million rods and cones in the retina converge to travel along only 1 million axons in the optic nerve. This means that some amount of visual processing is done in the retina, before the signal is sent on to the brain

Unit 5: Visual Pathways

Unit 6: Evolution Of The Eye

Unit 7: Developmental Of Visual Architecture

Unit 8: Conclusion