Ocushield

Blue light. How does it affect us?

Welcome to your one-stop-shop for all-things blue light and eye health. This report has been created to help you understand the science behind blue light, and why it is a rising concern across the globe.

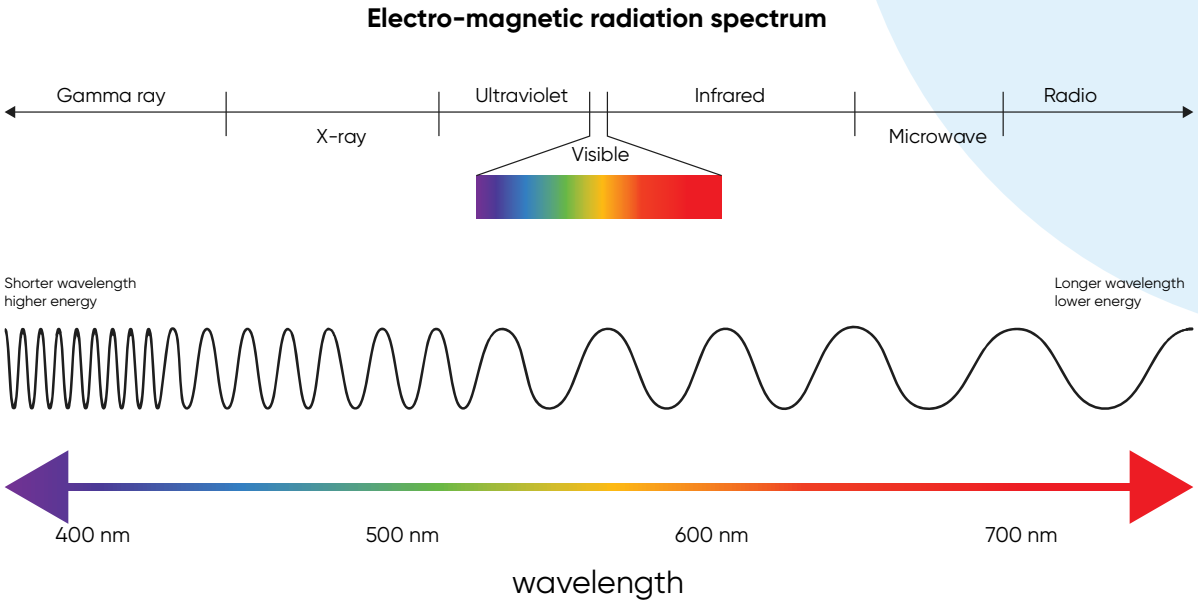
We have tried to keep it as simple as possible, but there may be points where it gets a little technical, and for some of us, those days of studying science were a long time ago! So, if there's anything you don't understand just shoot us an email and we'll be happy to help.

azulOptics

Inform Empower Protect

The dark truth about blue light

Light - how does it work?



Light can be represented as a wave, part of the continuous electromagnetic radiation (EMR) spectrum (above). We all know X-rays and ultraviolet (UV) radiation are very dangerous. As you can see in the diagram, blue light (380 - 500 nm, which includes violet and blue) is very close to these hazardous types of waves. A misconception is that there's a magic cut-off once you pass from UV into the visible spectrum of light. However, light is continuous; there is still danger in the kinds of light you can see.

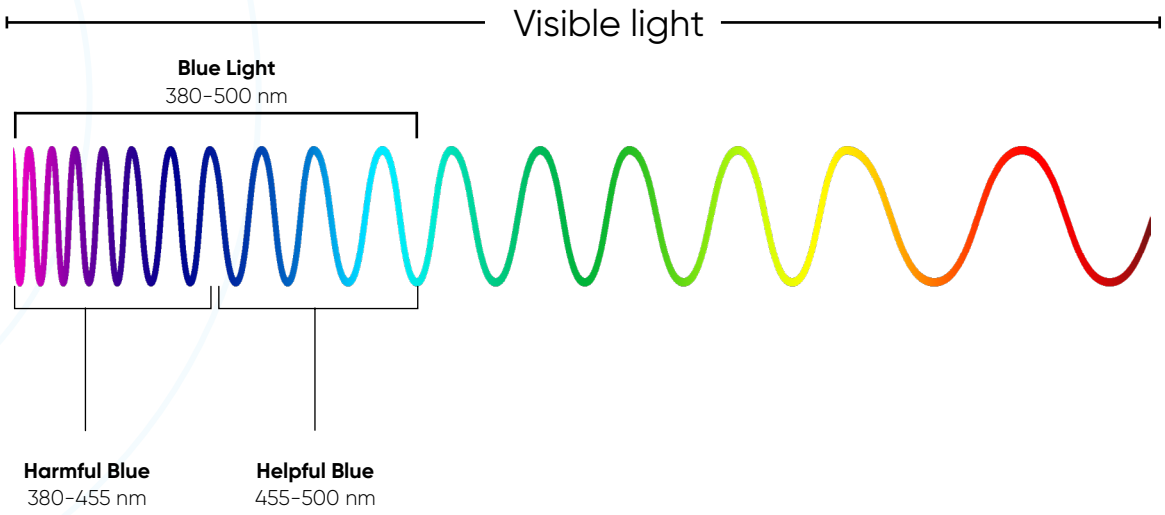
The further left you get along the spectrum (the bluer you go!), the smaller the gaps between the waves become, because these waves have shorter wavelengths. Short wavelengths of light carry more energy because they vibrate faster.

Why are shorter wavelengths harmful?

Short-wavelength light causes photochemical damage to cells and their DNA. So, every time you are exposed to blue light your cells/tissues are at risk of being damaged. Every minute you spend exposing your eyes to blue light increases the chances that you will do damage to your eye.

So, you either need to decrease the time spent being exposed to blue light, or reduce the intensity of the blue light.

Where does blue light sit on the spectrum?



Light between 380-500 nm is the blue part of the spectrum. It is thought that this part of the spectrum may contribute towards visual stress, eye strain and headaches.

Harmful Blue

Light between 380-455 nm is known as high energy visible (HEV) light. This is the blue light that can cause photochemical damage, eventually leading to cell death and induce retinal damage in the eye.

Helpful Blue

Light between 455-500 nm is the part of the spectrum that supports our sleep/wake cycle. If we are exposed to helpful blue light when we first wake up it helps set our internal clock and can help us to be more alert throughout the day and get a better night's sleep. Conversely, if we are exposed to too much blue light before going to bed it can make it difficult to fall asleep.

Where does blue light come from?

The sun is the biggest source of blue light.

LED lighting around our homes and offices.

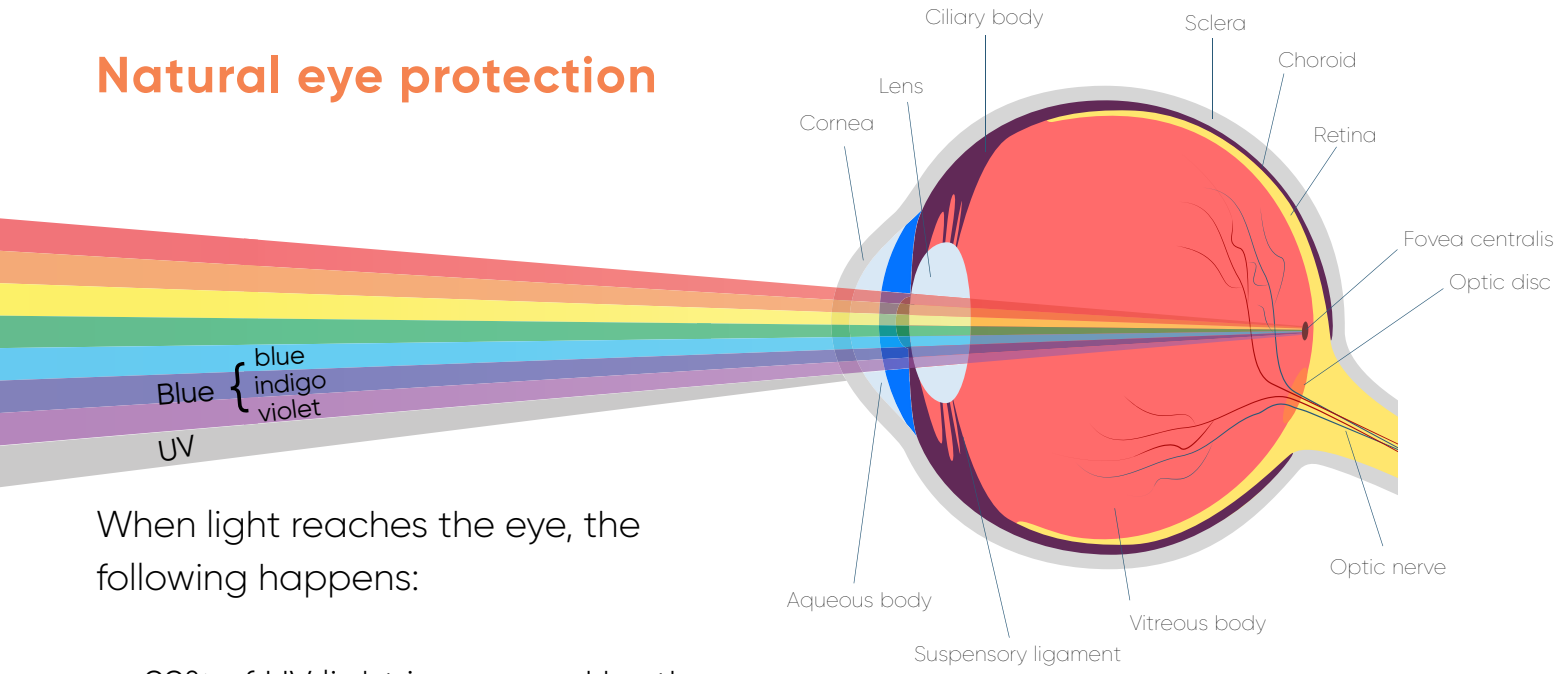
Digital devices such as smartphones, tablets & monitors.

It is not all about intensity

Even though LEDs and digital devices are not as bright as the sun, they still emit photons of light with the same wavelengths (energy). And those photons can cause photochemical damage to the cells in your retina no matter how intense the source is.

If there are fewer photons (less intense) the probability of damage is lower and that just means it takes longer for the damage to accumulate. However, many of us spend an awful lot of time on digital devices.

Natural eye protection



When light reaches the eye, the following happens:

- 99% of UV light is removed by the cornea and lens*, but can damage these structures in turn - this is why it's important to wear sunglasses.
- This leaves visible light (380-700 nm) to reach the back of the eye.

Digging deeper into blue light

Okay - let's get scientific!

When we consider light as a particle, the smallest unit of light is the photon. Each photon has an amount of energy that is inversely related (the opposite) to its wavelength. Meaning, the shorter the wavelength of light, the higher the photon energy it possesses.

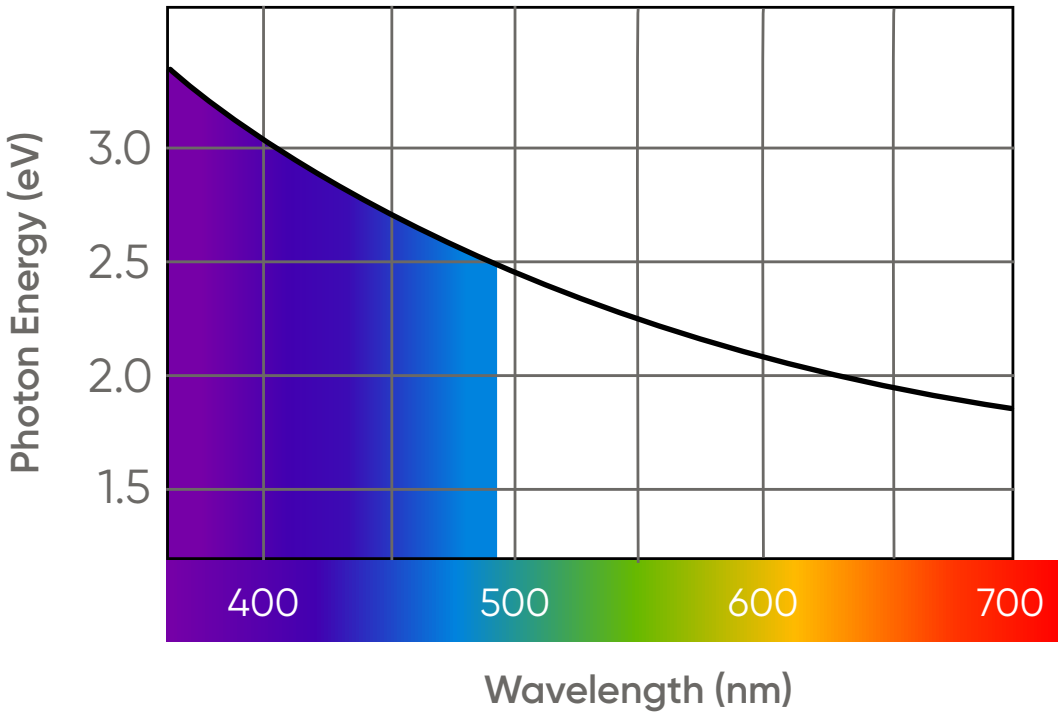
Food for thought

Did you know most sunglasses only block (reflect/absorb) up to 400 nm of light? That's why you can find a UV 400 sticker on most sunglasses. As mentioned before, there is no magic cut-off. To keep our eyes healthy, we should also limit our exposure to blue light (up to 455 nm) that can be harmful over the long-term.

*Children under 10 are at greater risk than adults to UV because their lens and cornea do transmit a considerable amount of UV).

As you can see in the diagram below, blue light carries 2.5 electron-Volts (eV) or more. Above 2.5 eV, blue photons have enough energy to create free radicals (reactive oxygen species) by ionizing a molecule. Free radicals are highly reactive molecules that cause oxidative stress and have the power to cause cell damage (e.g. damage to your cells DNA), some of which the body can not repair.

Lucky for us, we have natural sunglasses built into our eyes. The antioxidants, lutein and zeaxanthin (macular pigments) work by blocking some of the blue light entering our eyes and neutralising free radicals. The amount of macular pigment is dependent on several factors - such as genetics, diet and lifestyle. Ask your optometrist to see if they can assess your macular pigment levels during your next eye exam.



Top tip

To support your eye health and reduce the negative effect of blue light, everyone should be including more foods in their diet that contain lots of lutein and zeaxanthin like dark and brightly coloured fruits and vegetables such as:

- **Kale**
- **Spinach**
- **Parsley**
- **Green peas**
- **Squash**
- **Broccoli**
- **Red peppers**
- **Corn**
- **Carrots**

Types of light damage

Type 1

Type 2

Type 1 damage

Type 1 damage is low intensity over a long period of time (or repeated exposures) and is cumulative over time.

Type 2 damage

Type 2 damage is high intensity over a short period of time, and it is this type of damage that has been well studied and shows that blue light is 20 times more damaging than green light.

Key takeaways

- **Damage is caused by exposure to short wavelength (blue) light**
- **Exposure = time x intensity**
- **Blue light damage is cumulative through life**
- **Every blue photon has a probability of damage**

Let's weigh up your chances of damage

Low probability of damage

Type 1 damage can occur with every short-wavelength photon. This is unlike heat damage, where the number of photons needs to be very high to raise the temperature above the threshold for damage. In the case of Type 1 damage, the probability is low, but the damage is cumulative through life.

High probability of damage

With Type 2 damage, instead of increasing time, we increase intensity. For photochemical damage, time and intensity are interrelated and increasing either can increase the risk of retinal damage. Conversely, reducing either reduces the likelihood of damage.

How much blue light comes from digital devices?

Food for thought

The level of light intensity from digital devices is lower than that of the sun. You know this because it can be very hard to see your screen when you use your laptop or phone outside on a sunny day.

Measurements of absolute intensity show that a 20 minute walk on a beach looking at reflected sunlight outdoors = 133 hours (5.5 days!) of looking at your phone.

However, you wouldn't stand in bright sunlight on a beach without sunglasses for 5 minutes, let alone 20 minutes. 😲

Numerous research studies highlight the benefits to health and wellbeing when blue light is reduced. Check out some examples!

Blue blocking glasses worn at night in first year higher education students with sleep complaints

Short-Wavelength Light-Blocking Eyeglasses Attenuate Symptoms of Eye Fatigue.

Effect of Blue Light-Reducing Eye Glasses on Critical Flicker Frequency.
Protective effect of blue-light shield eyewear for adults against light pollution from self-luminous devices used at night.

Visual function improvement using photocromic and selective blue-violet light filtering spectacle lenses in patients affected by retinal diseases.

Good news, there is something we can do about blue light!

Technology is getting brighter and we should be careful going forward. It's better to take a precautionary approach and limit our exposure to light. Prevention is always better than cure.

Reducing exposure by reducing either intensity or time can decrease the risk of retinal damage through life. Here are some steps you can take:

Use technology that filters out harmful blue light
Devices that filter out some of the blue light (screen filters, sunglasses, photochromics and blue filtering lenses in glasses, contacts and intraocular lens replacements) can reduce blue light reaching the retina.

Choose your light sources wisely
Using light sources (bulbs and screen settings) with lower kelvin rating e.g. 2700K will reduce the amount of blue light in your home and work environment.

Eat an eye-loving diet
Improving your natural protection (macular pigment density) by eating more dark and brightly coloured vegetables and fruits can reduce blue light reaching the central retina (macula).

Most importantly, reduce blue light!
Reducing blue light decreases the light that is scattered most, decreasing glare and increasing contrast, thereby improving image quality and reducing eye fatigue.

Who created this document?

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Dhruvin Patel, MCOptom - Ocushield

Dhruvin Patel is a qualified optometrist from the United Kingdom. He began researching the harmful effects of blue light to our circadian rhythms and eye physiology whilst undertaking an undergraduate degree at City University, London. In 2015, after receiving a development grant from City University in London, he developed the world's first medically-rated screen protector that absorbs blue light. Since doing so, he has held posts as a practicing Optometrist in Specsavers, Boots and Vision Express. He is now the clinical lead at Ocushield and was named a finalist for the Healthtech Innovator of the year award in 2018.

Ocushield has been featured in many publications, including - Forbes, USA Today, The Guardian and The Telegraph. Ocushield products are currently used by employees at organisations such as NHS, JP Morgan, HMRC and Barclays. Ocushield products are currently used by over 50,000 consumers and sold in over 68 countries. Ocushield also developed a range of products for living better in the digital age. These include the Oculamp, an all-day all-night desk lamp that reduces blue light through the use of a touch pad.

www.ocushield.com

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Dr Shelby Temple - Azul Optics

Dr Shelby Temple is a visual neuroscientist and holds a position as an Honorary Research Associate at University of Bristol and is also the Chief Science Officer at Azul Optics. His research into polarization vision led to the invention of a new ophthalmic instrument (MP-eye) that uses specially polarized light to to assess macular pigment density, a strong risk factor for age-related macular degeneration (AMD).
Dr Temple has received the Innovator of the Year Award from the Biotechnology and Biological Sciences Research Council.

Azul Optics develops screening tools for the detection and prevention of eye diseases. The company was started by Dr Shelby Temple and Mr Matt Evans to take a patent pending research idea developed at the University of Bristol and turn it into a market ready ophthalmic instrument for assessing a key risk factor for age-related macular degeneration. Azul's first product, the MP-eye, is a class I CE marked medical device that can be used by eye care providers to quickly and easily assess a patient's natural protection against phototoxic blue light. The MP-eye is available in countries around the globe and helps eye care providers identify people that will most benefit from protective products like blue filtering lenses, sunglasses and macular pigment supplements.

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