Incandescent

What are they?

The incandescent light bulb or lamp is a source of electric light that works by incandescence, which is the emission of light caused by heating the filament. They are made in an extremely wide range of sizes, wattages, and voltages.

Where did they come from?

Incandescent bulbs are the original form of electric lighting and have been in use for over 100 years. While Thomas Edison is widely considered to be the inventor of the incandescent bulb, there are a number of people who invented components and prototypes of the light bulb well before Edison did.

One of those people was British physicist Joseph Wilson Swan, who actually received the first patent for a complete incandescent light bulb with a carbon filament in 1879. Swan's house was the first in the world to be lit by a light bulb. Edison and Swan merged their companies and together they were the first to design a bulb that was commercially viable.

How do they work?

An incandescent bulb typically consists of a glass enclosure containing a tungsten filament. An electric current passes through the filament, heating it to a temperature that produces light.

Incandescent light bulbs usually contain a stem or glass mount attached to the bulb's base which allows the electrical contacts to run through the envelope without gas/air leaks. Small wires embedded in the stem support the filament and/or its lead wires.

The enclosing glass enclosure contains either a vacuum or an inert gas to preserve and protect the filament from evaporating.

1. Glass bulb
2. Inert gas
3. Tungsten filament
4. Contact wire (goes to foot)
5. Contact wire (goes to base)
6. Support wires
7. Glass mount/support
8. Base contact wire
9. Screw threads
10. Insulation
11. Electrical foot contact

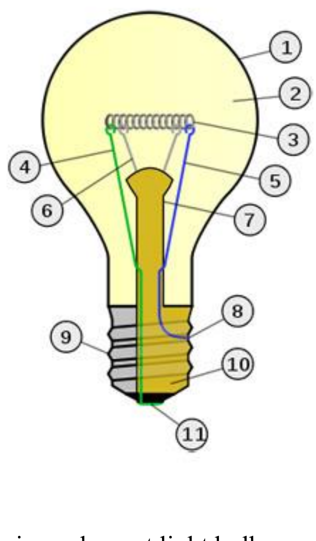


Diagram showing the major parts of a modern incandescent light bulb.

Incandescent lamps

by Chris Woodford. Last updated: October 25, 2017.

No more candles, no more gas lamps—just imagine how amazing people found the very first practical electric lamps toward the end of the 19th century. Incandescent lamps (ones that make light by making heat) are getting something of a bad press these days because they waste so much energy, but they've long been considered among the greatest inventions of all time and a burning-bright light bulb is still widely used as the symbol of a great idea. Let's take a look at these marvels of technology and find out how they work!

Why hot things give off light

Set fire to a big bunch of logs and you'll get a nice red glow as well as a warm feeling. People have known that hot things give off light ever since the discovery of fire, somewhere between one and two million years ago. But just why do hot things give off light?

When things burn, what's actually happening is a chemical reaction called combustion in which a fuel (such as the wood in the logs) reacts with oxygen in the air to produce carbon dioxide gas, water (in the form of steam), and a great deal of energy. Some of that energy is heat, some is light, and there's even a bit of sound energy produced too (in the crackling and hissing of the logs). Hot things give off light when the atoms they're made of gain energy and become excited. That makes them unstable and, to become stable again, they give off the energy they gained as particles of light called photons. (Read more and see a diagram of this in our main article on light.)

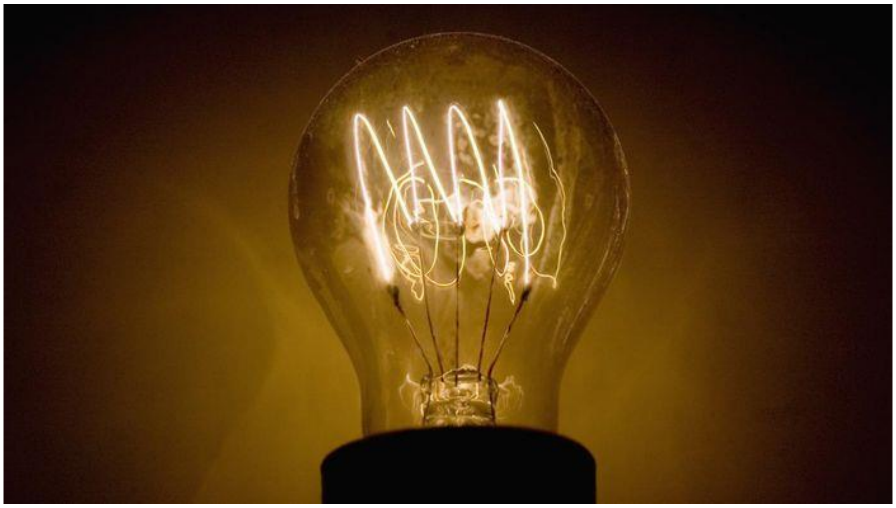
Candles used to be our main way of making light from heat. A candle is a mini-chemical factory that produces a continuous flame by slowly converting the energy stored in its oily wax into heat and light. A basic law of physics called the conservation of energy tells us exactly why candles always burn out eventually: all the energy we need to make continuous candlelight has to come from the wax, which must slowly burn away. Now just imagine if you could make a candle that never burned out—one that never needed replacing. You'd need a flame that never died and an endless supply of energy. And that's pretty much what you have in an incandescent electric light.

How incandescent lights work

Why do incandescent lamps glow when electricity flow through them? Electricity flows better through some materials than others. Metals that let electricity flow easily are good conductors that have low electrical resistance; plastics, wood, and other insulators have a high resistance. Some metals are better conductors than others: silver is better than gold, gold is better than copper, and copper is better than aluminum. Not all conductors are metals, however. Carbon is a good conductor and it has little in common with most metals.

Take a piece of a conducting material and you can make electricity flow through it a little bit better by doing two things: first, by making it shorter (the longer your conductor, the more work electricity has to do to get through it); second, by making it thicker (the fatter the conductor, the easier it is for the electric current to flow). Now suppose you could make a conductor that's both short and thin and pass electricity through it. Fashion it just right and it'll have enough resistance to make the current work hard and not so much that it stops the current completely. Switch on the electric current and your conductor (which is usually called a filament) will heat up. Use enough electricity and the filament will heat up so much that it'll glow red or white hot and give off light. That's the basic idea behind the incandescent electric light.

The only trouble is that an incandescent lamp has to produce an incredible amount of heat to make a decent amount of light. Roughly 95 percent of the electricity you feed into a lamp like this is wasted as heat. That's why people are now so keen on switching away from incandescent technology to energy-saving lamps (compact fluorescent lamps, also known as CFLs, or LEDs), which last several times longer and save roughly 80 percent of the energy (a typical incandescent lasts only about 1000 hours—from a few months to a year or two depending on how much you use it).



Incandescent Lamps

Incandescent lamps are often considered the least energy efficient type of electric lighting commonly found in residential buildings. Although inefficient, incandescent lamps possess a number of key advantages--they are inexpensive to buy, turn on instantly, are available in a huge array of sizes and shapes and provide a pleasant, warm light with excellent color rendition. However, because of their relative inefficiency and short life spans, they are more expensive to operate than newer lighting types such as compact fluorescent lamps (CFLs) and light-emitting diodes (LEDs).

Energy-Saving Incandescent (or Halogen) Lightbulbs

A halogen lamp is a type of incandescent lamp with a capsule that holds a special halogen gas composition around the heated filament to increase the efficacy of the incandescence. They are more energy efficient than standard incandescent bulbs but somewhat more costly. Halogen lamps may also have a special inner coating that reflects heat back into the capsule to further improve efficacy by “recycling” the otherwise wasted heat. Together, the filling and coating recycle heat to keep the filament hot with less electricity. They also provide excellent color rendition.

Halogens are a little more expensive than standard incandescent lamps, but are less expensive to operate because of their higher efficacy and longer life expectancy. They are commonly used in reflector lamps such as indoor and outdoor flood or spot lighting, indoor recessed and track fixtures, and floor and desk lamps.

Some halogen bulbs are dimmable, as indicated on the package, and are compatible with timers and other lighting controls.

Advantages:
*Great for small area lighting
*Good color rendering: CRI of 100 which is the best possible
*Cheap to produce
*No quantity of toxic materials to dispose of (like mercury, toxic alloys, or semiconductors)
*Is easily used in strobe or dimming circuits

Disadvantages:
*Not energy efficient (95% of energy goes to heat, 5% makes visible light)
*Traditional incandescent light bulbs are not useful for lighting large areas. It takes many to light a large area where as only one HID lamp can light a large open area. Halogen incandescent is useful for this purpose but it is not covered on this page.

Who invented the electric lamp?

Joseph Swan (1828–1914) was a British physicist and chemist. In 1850, he began working with carbonized paper filaments in an evacuated glass bulb. By 1860, he was able to demonstrate a working device but the lack of a good vacuum and an adequate supply of electricity resulted in a short lifetime for the bulb and an inefficient source of light. By the mid-1870s better pumps became available, and Swan returned to his experiments.

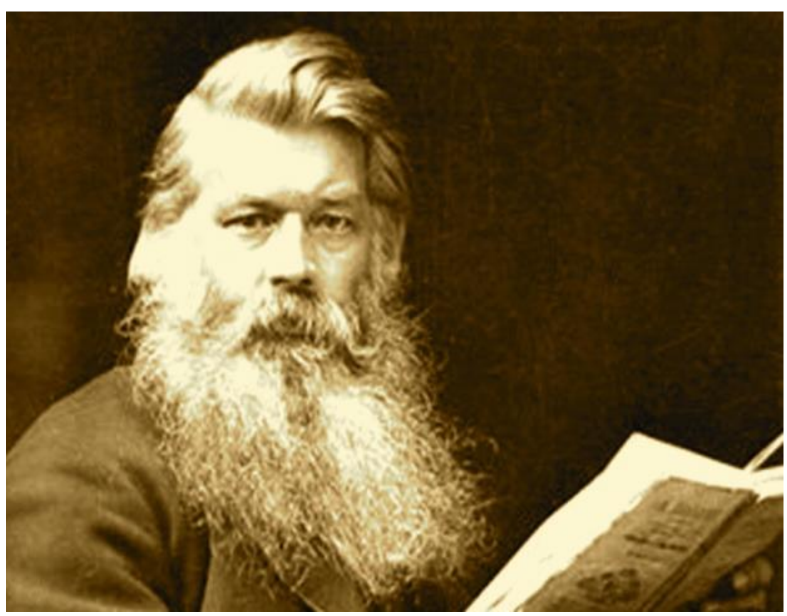
With the help of Charles Stearn, an expert on vacuum pumps, in 1878, Swan developed a method of processing that avoided the early bulb blackening. This received a British Patent in 1880. This bulb lasted about 40 hours.

Swan then turned his attention to producing a better carbon filament and the means of attaching its ends. He devised a method of treating cotton to produce 'parchmentised thread' in the early 1880s and obtained British Patent 4933 that same year.

From this year he began installing light bulbs in homes and landmarks in England. His house, Underhill, Low Fell, Gateshead, was the first in the world to be lit by a lightbulb and also the first house in the world to be lit by hydroelectric power.

In the early 1880s he had started his company. In 1881, the Savoy Theatre in the City of Westminster, London was lit by Swan incandescent lightbulbs, which was the first theatre, and the first public building in the world, to be lit entirely by electricity. The first street in the world to be lit by an incandescent lightbulb was Mosley Street, Newcastle upon Tyne, United Kingdom. It was lit by Joseph Swan's incandescent lamp on 3 February 1879.

Joseph Swan ->



Thomas Alva Edison

Thomas Edison began serious research into developing a practical incandescent lamp in 1878. Edison filed his first patent application for "Improvement In Electric Lights" on 14 October 1878.[40] After many experiments, first with carbon in the early 1880s and then with platinum and other metals, Edison and his team later discovered that a carbonized bamboo filament could last more than 1200 hours.

In 1880, the Oregon Railroad and Navigation Company steamer, *Columbia*, became the first application for Edison's incandescent electric lamps.

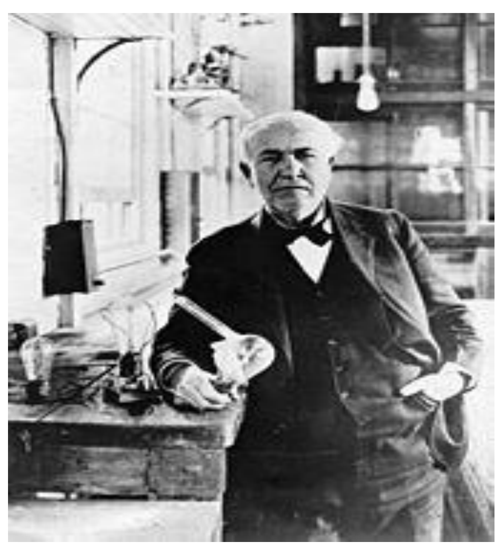
In Britain, the Edison and Swan companies merged into the Edison and Swan United Electric Company. Edison was initially against this combination, but after Swan sued him and won, Edison was eventually forced to cooperate, and the merger was made. Eventually, Edison acquired all of Swan's interest in the company.

The United States Patent Office gave a ruling 8 October 1883, that Edison's patents were based on the prior art of William Sawyer and were invalid. Litigation continued for a number of years. Eventually on 6 October 1889, a judge ruled that Edison's electric light improvement claim for "a filament of carbon of high resistance" was valid.[

In 1896 Italian inventor Arturo Malignani (1865–1939) patented an evacuation method for mass production, which allowed obtaining economic bulbs lasting 800 hours. The patent was acquired by Edison in 1898.[

In 1897, German physicist and chemist Walther Nernst developed the Nernst lamp, a form of incandescent lamp that used a ceramic globar and did not require enclosure in a vacuum or inert gas.[56][57] Twice as efficient as carbon filament lamps, Nernst lamps were briefly popular until overtaken by lamps using metal filaments.

Thomas Edison ->



How Fluorescent Lamps Work

by Tom Harris

The central element in a fluorescent lamp is a **sealed glass tube**. The tube contains a small bit of **mercury** and an inert gas, typically **argon**, kept under very low pressure. The tube also contains a **phosphor powder**, coated along the inside of the glass. The tube has two **electrodes**, one at each end, which are wired to an electrical circuit. The electrical circuit, which we'll examine later, is hooked up to an alternating current (AC) supply.

When you turn the lamp on, the current flows through the electrical circuit to the electrodes. There is a considerable voltage across the electrodes, so electrons will migrate through the gas from one end of the tube to the other. This energy changes some of the **mercury** in the tube from a liquid to a gas. As electrons and charged atoms move through the tube, some of them will **collide** with the gaseous mercury atoms. These collisions excite the atoms, bumping electrons up to higher energy levels. When the electrons return to their original energy level, they release light photons.

The electrons in mercury atoms are arranged in such a way that they mostly release light photons in the **ultraviolet** wavelength range. Our eyes don't register ultraviolet photons, so this sort of light needs to be converted into visible light to illuminate the lamp.

This is where the tube's phosphor powder coating comes in. **Phosphors** are substances that give off light when they are exposed to light. When a photon hits a phosphor atom, one of the phosphor's electrons jumps to a higher energy level and the atom heats up. When the electron falls back to its normal level, it releases energy in the form of another photon. This photon has less energy than the original photon, because some energy was lost as heat. In a fluorescent lamp, the emitted light is in the visible spectrum -- the phosphor gives off **white light** we can see. Manufacturers can vary the color of the light by using different combinations of phosphors.

How a Basic Fluorescent Lamp Works

By: Jonathan Z. Kremer

General Design
The general design of a simple fluorescent lamp consists of a sealed glass tube. The tube contains a small bit of mercury and a gas (usually argon) kept under very low pressure. The tube also contains a phosphor powder, coated along the inside of the glass. The tube has two electrodes, one at each end, which are wired to an electrical circuit. The electrical circuit, which includes a starter and ballast, is hooked up to an alternating current (AC) supply.

General Operation:
When the lamp is first turned on, the current travels through the path of least resistance, which is through the bypass circuit, and across the starter switch. This current then passes through the circuit heating up the filament in each electrode, which are located at both ends of the tube (these electrodes are simple filaments, like those found in incandescent light bulbs). This boils off electrons from the metal surface, sending them into the gas tube, ionizing the gas. The mercury vapor becomes "excited" and it generates radiant energy, mainly in the ultraviolet range. This energy causes the phosphor coating on the inside of the tube to fluoresce, converting the ultraviolet into visible light.

In Conclusion:
There are many different types of fluorescent lamps but they all work in the same basic way: An electric current stimulates mercury atoms, which causes them to release ultraviolet photons. These photons in turn stimulate a phosphor, which emits visible light photons.

Fluorescent light ballasts

What about fluorescent ballasts? How do fluorescent lights work with their ballasts to provide an even lighting?

Without a fluorescent light ballast, your fluorescent tube would have two problems.

1) First of all, there would not be enough of an initial surge of current to excite the mercury atoms enough to ionize some of the atoms and start the light shining.
2) Second, once electricity does start to pass through the tube and begins to vaporize mercury atoms, the electrical conductivity of the tube increases (because the mercury vapor becomes more conductive the more it conducts).

In other words, the more electricity is flowing through the tube, the easier it is for electricity to flow through the tube. This means that if we didn’t limit the current flow, it would soon reach a level dangerous for the stability of the bulb, or for the circuit to which the light is connected.

A fluorescent ballast works around both of these problems. Early ballasts and those on some existing four-foot and eight-foot tube fluorescents were magnetic ballasts; they are bulky devices that provide the initial surge of high voltage current to get the ball rolling, and then slowly reduce the current as conductivity increased.

Modern, electronic ballasts do the same thing but generally start the bulb faster, with less flickering, less noise, and significantly less energy overhead, making them even more efficient than older, mechanical ballast fluorescent lights.

The Development of Fluorescent Lights

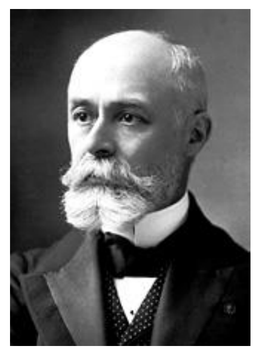
In 1857, the French physicist Alexandre E. Becquerel who had investigated the phenomena of fluorescence and phosphorescence theorized about the building of fluorescent tubes similar to those made today. Alexandre Becquerel experimented with coating electric discharge tubes with luminescent materials, a process that was further developed in later fluorescent lamps.

American Peter Cooper Hewitt (1861-1921) patented (U.S. patent 889,692) the first mercury vapor lamp in 1901. The low-pressure mercury arc lamp of Peter Cooper Hewitt is the very first prototype of today's modern fluorescent lights.

Hewitt didn't think people would want lamps with blue-green light in their homes, so he looked for other applications for it in photographic studios and industrial uses. George Westinghouse and Peter Cooper Hewitt formed the Westinghouse-controlled Cooper Hewitt Electric Company to produce the first commercial mercury lamps.

Marty Goodman in his History of Electric Lighting cites Hewitt as inventing the first enclosed arc-type lamp using metal vapor in 1901. It was a low-pressure mercury arc lamp.

Alexandre E. Becquerel



Edmund Germer, Friedrich Meyer, Hans Spanner, Edmund Germer - Fluorescent Lamp Patent U.S. 2,182,732

Edmund Germer (1901 - 1987) invented a high-pressure vapor lamp, his development of the improved fluorescent lamp and the high-pressure mercury-vapor lamp allowed for more economical lighting with less heat. Together with Friedrich Meyer and Hans Spanner, Edmund Germer patented an experimental fluorescent lamp in 1927.

In 1934, Edmund Germer created a high-pressure arc lamp that could handle a lot more power in a smaller space. Hewitt's low-pressure mercury arc lamp put off a large amount of ultraviolet light. Germer and others coated the inside of the light bulb with a fluorescent chemical that absorbed UV light and re-radiated that energy as visible light. In this way, it became an efficient light source.

Edmund Germer is credited by some historians as being the inventor of the first true fluorescent lamp. However, it can be argued that fluorescent lamps have a long history of development before Germer.

Edmund Germer ->

George Inman and Richard Thayer - The First Commercial Fluorescent Lamp

George Inman led a group of General Electric scientists researching an improved and practical fluorescent lamp. Under pressure from many competing companies the team designed the first practical and viable fluorescent lamp (U.S. Patent No. 2,259,040) that was first sold in 1938. It should be noted that General Electric bought the patent rights to Edmund Germer's earlier patent.

GE paid $180,000 for U.S. Patent No 2,182,732 that had been issued to Friedrich Meyer, Hans J. Spanner, and Edmund Germer. While one might argue the real inventor of the fluorescent lamp, it is clear that GE was the first to introduce it."

George Inman and Richard Thayer ->

Chemiluminescence in forensics

Forensic scientists use the reaction of luminol to detect blood at crime scenes. A mixture of luminol in a dilute solution of hydrogen peroxide is sprayed onto the area where the forensic scientists suspect that there is blood. The iron present in the haem unit of haemoglobin (see Figure 4) in the blood acts as a **catalyst** in the reaction described in Box 1. The room must be dark and if blood is present, a blue glow, lasting for about 30 seconds, will be observed. The forensic investigators can record this glow by using photographic film, which can be used as evidence in court for the presence of blood at the scene.

Because the iron acts as a catalyst, it is only required in trace amounts, therefore only a tiny amount of blood is required to produce a positive result. This means that blood can be detected even when it is not visible to the naked eye.

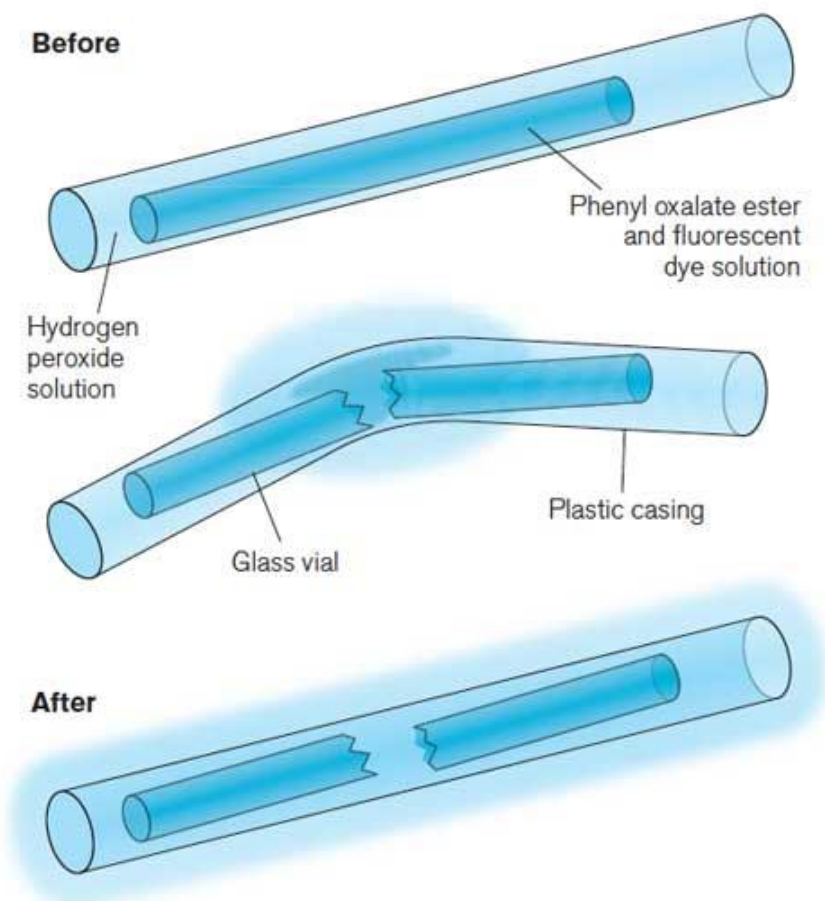
Using luminol at the scene of a crime

One of the drawbacks of using luminol is that the reaction can be catalysed by other chemicals that may be present at the crime scene, for example, copper-containing alloys, some cleaning fluids such as bleach, and even horseradish. Clever criminals can clean up the blood with bleach, which destroys the evidence of the blood, but bleaching the carpet may alert people to the crime sooner. Urine also contains small amounts of blood, which can be enough to catalyse the reaction of luminol. Once luminol has been applied to the area, it may prevent other tests from being performed there. However, despite these drawbacks, luminol is still used by forensic scientists as a tool to solve crime.

Glow Sticks

When you snap a glow stick and it begins to glow, the light produced is an example of chemiluminescence (see Figure 5). Glow sticks comprise a plastic tube containing a mixture including diphenyl oxalate and a dye (which gives the glow stick its colour). Inside the plastic tube is a smaller glass tube containing hydrogen peroxide. When the outer plastic tube is bent, the inner glass tube snaps, releasing the hydrogen peroxide and starting a chemical reaction that produces light (see Box 2). The colour of light that a glow stick produces is determined by the dye used (see Box 3).

Chemiluminescence reactions, such as those in glow sticks, are temperature-dependent. The reaction speeds up as the temperature rises – snapping your glow stick in hot water will produce a fantastic glow, but it will not last as long as it would at room temperature. Conversely, the reaction rate slows down at low temperature; this is why keeping your glow stick in the freezer for several hours can allow the stick to glow brightly again when it is removed and warmed up, long after it would otherwise have stopped glowing. The reaction does not stop completely in the freezer, but it does slow down so that the glow is barely detectable.



Chemiluminescence

When two molecules react chemically so that there is a release of energy (an exothermic reaction), that energy sometimes manifests itself not as heat but as light.

This occurs because the energy excites the product molecules into which it has been funneled. A molecule in this excited state either relaxes to the ground state, with the direct emission of light, or transfers its energy to a second molecule, which becomes the light emitter. This process is referred to as chemiluminescence.

The originally green, now multicolored, commercially made "light sticks" (often in the form of bracelets and necklaces) work in this way, utilizing the (exothermic) reaction of hydrogen peroxide with an oxalate **ester**. This **oxidation** reaction produces two molecules of carbon dioxide (CO_2) and the released energy is transferred to a fluorescent dye molecule, usually an anthracene derivative.

Light sticks were developed by the U.S. Navy as an inconspicuous and easily shielded illumination tool for special operations forces dropped behind enemy lines. Besides their use as children's toys, they are also used extensively as a navigation aid by divers searching in muddy water.

Chemiluminescence

Chemiluminescence is the term for light that's emitted as a product of chemical reactions. Chemiluminescent reactions produce unstable products, which then decay in order to form more stable products. In the process, energy is emitted in the form of light.

One of the earliest observed examples of chemoluminescence was the emission of a greenish glow when elemental phosphorus was exposed to damp air. Phosphorus vapor absorbed into the air around the solid is oxidized, producing HPO and $(PO)_2$ in their excited states. Green light is emitted as the molecules return to their stable, lower energy states.

Light sticks (also known as glow sticks) utilize chemoluminescence, and are used by everyone from emergency workers and military personnel to rave dancers and Halloween trick-or-treaters. While they do not provide bright illumination, they are perfect for highlighting someone's position in the dark. They are particularly useful in situations (such as the aftermath of an earthquake or nighttime scuba diving) where it is dangerous or impractical to use electricity.

Chemoluminescence spectroscopy is an important tool in chemical analysis. The emissions from excited molecules, either in the gas phase or in solution, are measured using a photomultiplier or similar light-sensitive instrument, possibly in combination with a chromatograph. Measurement of the light emitted through chemoluminescence is used to determine the concentration of the excited chemical reagent.

Bioluminescence - Living glow sticks

Have you ever walked along a beach at night and seen sparks of light around your feet? Or been in the countryside at night and seen fireflies flitting about? These are examples of bioluminescence, and around 90% of deep-sea life also exhibits this strange phenomenon. These organisms have evolved to produce light because it has many useful functions. Glowing can be used as a lure to catch prey, as camouflage or to attract potential mates. Some bacteria even use bioluminescence to communicate.

The term 'glow worm' describes the larvae of several species of insect, including fireflies; some of them glow to scare off predators, whereas other species use their glow to attract prey. There are species of squid and crustacean that can release clouds of bioluminescent liquid to confuse predators while they make their escape. Creatures living deep in the ocean have evolved to produce mainly blue or green light because it transmits well through seawater. This is because blue light has a shorter wavelength than red light, which means it is absorbed less readily by particles in the water.

Bioluminescent reactions use ATP (adenosine triphosphate) as a source of energy. The structure of the light-producing molecules varies from species to species, but they are all given the generic name *luciferin*.

When fireflies glow, the luciferin is oxidised to produce an excited complex, which falls back down to the ground state, releasing a photon of light, just like the chemiluminescent reaction of luminol. However, fireflies do not use hydrogen peroxide and potassium hexacyanoferrate(III) to oxidise luciferin; instead they use molecular oxygen and an enzyme called luciferase (this is also a generic name – luciferases vary from species to species).

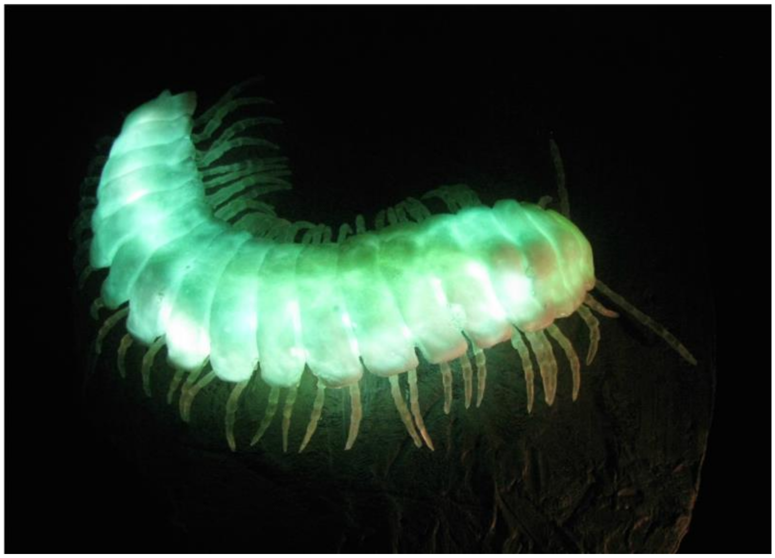
$$\text{Luciferin} + O_2 \xrightarrow{\text{Luciferase}} \text{Oxyluciferin} + \text{Light}$$

Fireflies

Fireflies, also known as lightning bugs, are one of the most common examples of bioluminescence. They have a special organ that produces light through a chemical reaction. Fireflies use flashing light to attract mates, but begin emitting light even as larvae, as you can see in the image below. They belong to the Lampyridae family, and there are 2000 species around the world, many of which have distinct flashing patterns.

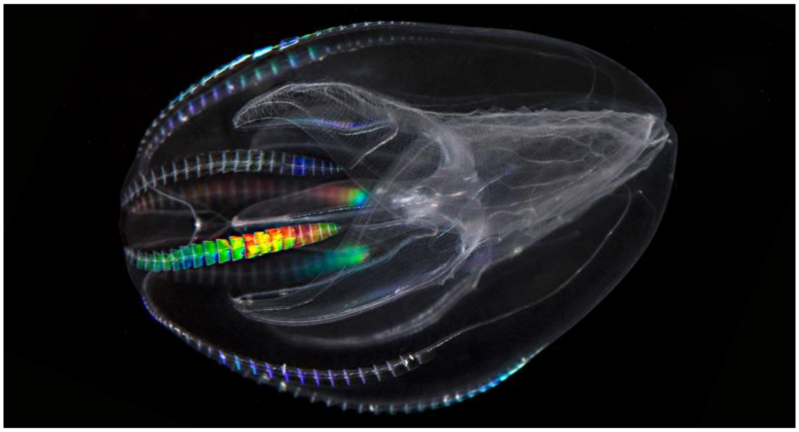
Millipedes

The Motyxia millipede, also commonly known as the Sierra luminous millipede, is another bioluminescent invertebrate. In a paper published in Current Biology, researchers report that this millipede's bright light is a warning to predators that it's highly toxic. Motyxia defends itself by oozing cyanide, but the light tells predators to stop before they take a bite.



Comb jellies

Most bioluminescent creatures are found in the ocean, often at depths below the reach of sunbeams. Some species of comb jellies, or Ctenophora, are an example of this. The comb jelly produces blue or green light, but the movement of its combs can scatter the light, producing a rainbow effect (see top image). Researchers think the lights may serve to confuse predators.



Anglerfish

The long protrusion on anglerfish's head is called a lure, and it does exactly what it sounds like. The light on the tip of the lure attracts prey right to the fish's toothy mouth, just like in "Finding Nemo." It's no wonder Jeff Kart called this predator a fish to inspire nightmares.

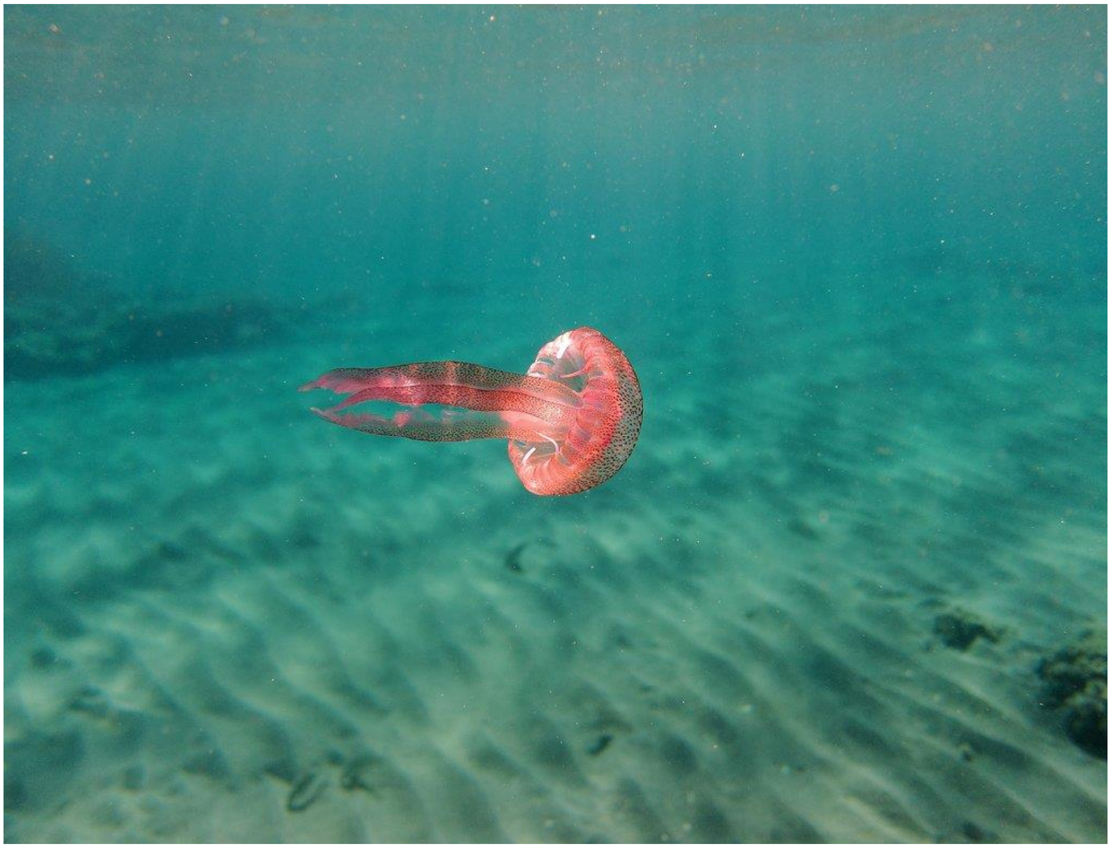
What Color is Bioluminescence?

Light travels in waves of different shapes—known as wavelengths—which determine the color of the light. When the waves hit our eyes, they are translated into colors by the brain depending on their wavelength.

The wavelengths that our eyes can see are known as the "visible light spectrum," and we can see all the colors on this spectrum as they travel through the air above land. But light travels differently underwater because longer wavelengths can't travel as far.

Most of the bioluminescence produced in the ocean is in the form of blue-green light. This is because these colors are shorter wavelengths of light, which can travel through (and thus be seen) in both shallow and deep water. Light traveling from the sun of longer wavelengths—such as red light—doesn't reach the deep sea. This is why many deep sea animals are red: it's effectively the same as being invisible. Moreover, because it's not present, many deep-water animals have lost the ability to see it altogether.

However, some animals evolved to emit and see red light, including the dragonfish (*Malacosteus*). By creating their own red light in the deep sea, they are able to see red-colored prey, as well as communicate and even show prey to other dragonfish, while other unsuspecting animals cannot see their red lights as a warning to flee.



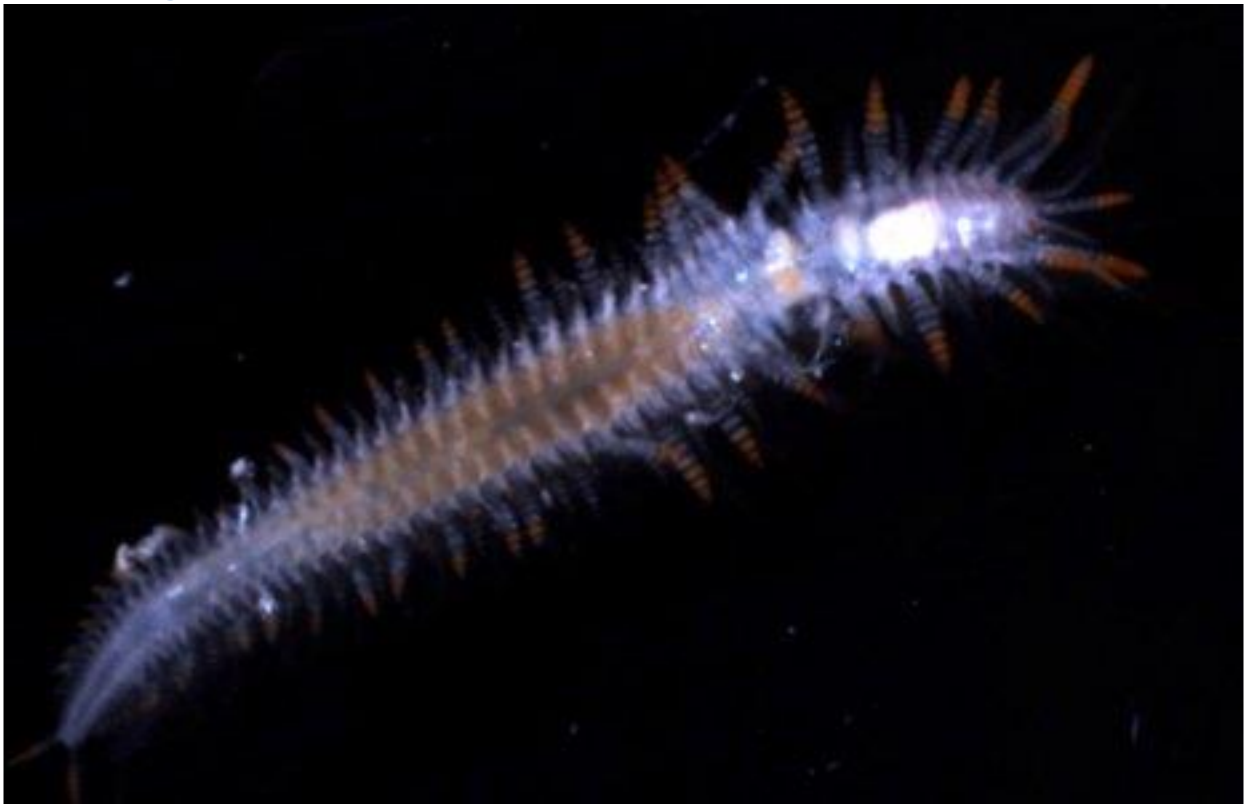
Why Animals Light Up

Feeding

The yellow bioluminescent ring on this female octopus may attract mates.

Animals can use their light to lure prey towards their mouths, or even to light up the area nearby so that they can see their next meal a bit better. Sometimes the prey being lured can be small plankton, like those attracted to the bioluminescence around the beak of the *Stauroteuthis* octopus. But the light can also fool larger animals. Whales and squid are attracted to the glowing underside of the cookie-cutter shark, which grabs a bite out of the animals once they are close. The deep-sea anglerfish lures prey straight to its mouth with a dangling bioluminescent barbel, lit by glowing bacteria.

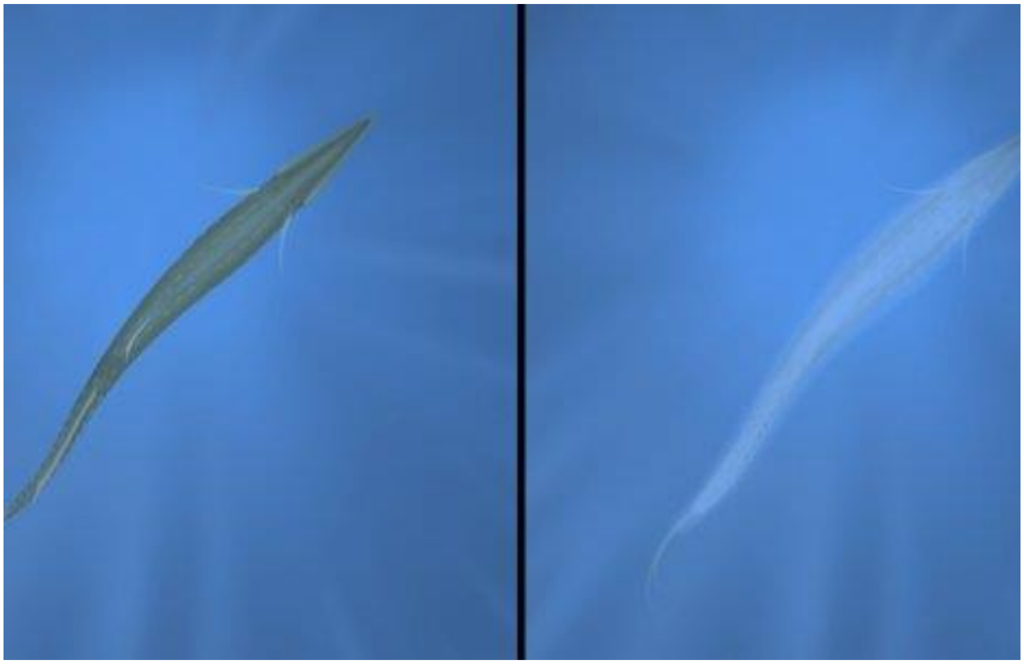
Attracting Mates



Syllid fireworms can be found mainly on the seafloor, but they switch to a planktonic form to reproduce, where the females use bioluminescent signals.

Animals don't only need to look for and attract food; bioluminescence can also play a part in attracting a mate. The male Caribbean ostracod, a tiny crustacean, uses bioluminescent signals on its upper lips to attract females. Syllid fireworms live on the seafloor, but with the onset of the full moon they move to the open water where the females of some species, like *Odontosyllis enopla*, use bioluminescence to attract males while moving around in circles. These glowing worms may have even helped to welcome Christopher Columbus to the New World. Anglerfish, flashlight fish and ponyfish all are thought to luminesce in order to tell the difference between males and females, or otherwise communicate in order to mate.

Protection



This fish is using counterillumination to disappear. At left it stands out against the light above it. At right, with bioluminescent structures lit, it blends in.

Often animals use a strong flash of bioluminescence to scare off an impending predator. The bright signal can startle and distract the predator and cause confusion about the whereabouts of its target. From small copepods to the larger vampire squid, this tactic can be very useful in the deep-sea. The "green bomber" worm (*Swima bombiviridis*) and four other similar worm species from the polychaete family release a bioluminescent "bomb" from their body when in harms way. These deep sea worms live close to the sea bottom and were only discovered in 2009. Some animals such as the deep-sea squid *Octopoteuthis deletron* even detach their bioluminescent arms, which stick to and probably distract their predators. All this commotion could also serve as a burglar alarm, attracting larger predators to the scene. In certain cases a predator might only get a bite of their prey, and the evidence will keep glowing from within its stomach.

Bioluminescence can also be used to help camouflage with the use of counterillumination. Photophores on the bottom side of an animal can match the dim light coming from the surface, making it harder for predators searching for prey from below to see what they are looking for.