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V-I-B-G-Y-O-R of chemistry: A journey from micro to macro world

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Abstract: The word 'colour' originates from chemistry. The seven different colours V: Violet, I: Indigo, B: Blue, G: Green, Y: Yellow, O: Orange and R: Red unite to form a single colour which is totally white and fragmentation of this white colour through prism again gives the spectrum of seven colours having different wavelength (λ) which is in visible range (400-750nm). The colourful chemistry plays a role within the visible range in small scale to large scale. There is not a single element in the world, which is free from chemistry. This is embedded throughout the world in high extent. Either it is biochemistry or photochemistry or physical chemistry or organic chemistry or bioorganic chemistry or inorganic chemistry or analytical chemistry or combinatorial chemistry or environmental chemistry or computational chemistry or supramolecular chemistry or nanochemistry, each and everything is related with chemical science. Even physics is also based on the properties of matter, which also plays the role of chemistry: light, magnetism, electricity all are enlightened with the electronic behavior of the elements of periodic table. Light is free energy of photons, which is the multiplication of hν (h: Max Plank's constant and ν: Wave number) this can do the phosphorescence and fluorescence. It can also do the photolysis as well as photosynthesis, the destructive as well as creative matters! Material chemistry is build up by the chemical bonding between the elements of the building block. This bonding could be broken by the chemical reaction to form some another compound by four parameters: reactants, reagents, +ve or -ve heat and time. This can be done in laboratory and in environment also. There are huge number of chemical compounds in the world which are used as fine chemicals, reagents, drugs, pharmaceuticals, biochemicals, dyes, petrochemicals, pesticides, explosives, household appliances, domestic purpose, metallurgy and so many things. This chemistry is used as in nano to micro scale and in macro to mega scale but the chemical entity for a specific unit is same and joined by catenation property in which only three major bonding are there: ionic, covalent and coordinate bonds. Biomolecules under this heading is a big chapter under the receptor chemistry, enzyme chemistry, peptide chemistry, hormone chemistry, carbohydrate chemistry, lipid chemistry, vitamins all are chemical entity have definite functional activity in the living beings. The macro unit of chemical substance is based on the micro unit and the infrastructure is build up by elements of periodic table for inorganic chemistry and organic chemistry. A creation of God is a mega unit of genome (macro unit of chromosome which is a micro unit of polypeptides) can enjoy the chemistry in life to a full extent and especially for human who can play with chemistry from micro level to macro level.
So we cannot forget the existence of chemistry in our life because this is an endless journey with full of mystery as this is the history of chemistry.

Keywords: Colourful chemistry, Visible range, Physics, Periodic table, Material chemistry, Micro-Macro-Mega, Bonding, Genome.

Introduction

Color or colour (see spelling differences) is the visual perceptual property corresponding in humans to the categories called **violet**, **indigo**, **blue**, **green**, **yellow**, **orange** and **red** (i.e. **VIBGYOR**). Colour derives from the spectrum of light (distribution of light power versus wavelength) interacting in the eye with the spectral sensitivities of the light receptors. Colour categories and physical specifications of colour are also associated with objects, materials, light sources, etc., based on their physical properties such as light absorption, reflection, or emission spectra. By defining a colour space, colours can be identified numerically by their coordinates.[1]

Colour	Wavelength Interval (nm)	Frequency Interval (THz)
Violet	~ 430-380	~ 700-790
Indigo	~ 500-430	~ 600-700
Blue	~ 520-500	~ 580-600
Green	~565-520	~ 530-580
Yellow	~ 590-565	~510-530
Orange	~625-590	~ 480-510
Red	~ 740-625	~ 405-480

Table1: Wavelength and frequency profile of colours

Because perception of colour stems from the varying spectral sensitivity of different types of cone cells in the retina to different parts of the spectrum, colours may be defined and quantified by the degree to which they stimulate this cells.[2] These physical or physiological quantifications of colour, however, do not fully explain the psychophysical perception of colour appearance. The science of colour is sometimes called chromatics, chromatography (Greek: Chroma-colour), colourimetry, or simply colour science. It includes the perception of colour by the human eye and brain, the origin of colour in materials, colour theory in art, and the physics of electromagnetic radiation in the visible range (that is, what we commonly refer to simply as light).[3]

Electromagnetic radiation is characterized by its wavelength (or frequency) and its intensity. When the wavelength is within the visible spectrum (the range of wavelengths humans can perceive, approximately from 390 nm to 700 nm), it is known as "visible light". Most light sources emit light at many different wavelengths; a source's spectrum is a distribution giving its intensity at each wavelength. Although the spectrum of light arriving at the eye from a given direction determines the colour sensation in that direction, there are many more possible spectral combinations than colour sensations. In fact, one may formally define a colour as a class of spectra that give rise to the same colour sensation, although such classes would vary widely among different species, and to a lesser extent among individuals within the same species. In each such class the members are called metamers of the colour in question.

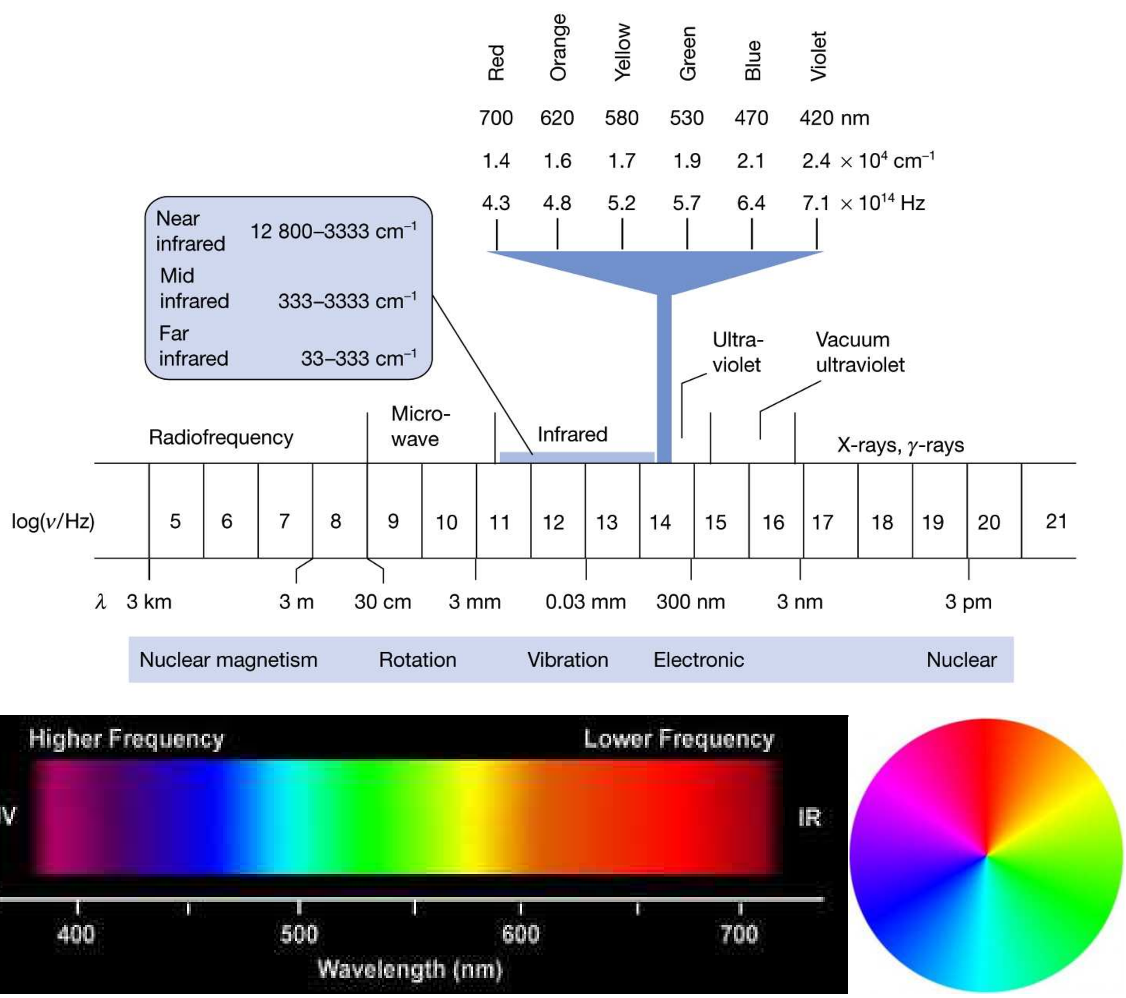

Figure1: Colour Spectrum

The colour of an object depends on both the physics of the object in its environment and the characteristics of the perceiving eye and brain. Physically, objects can be said to have the colour of the light leaving their surfaces, which normally depends on the spectrum of the incident illumination and the reflectance properties of the surface, as well as potentially on the angles of illumination and viewing. Some objects not only reflect light, but also transmit light or emit light themselves, which contribute to the colour also. A viewer's perception of the object's colour depends not only on the spectrum of the light leaving its surface, but also on a host of contextual cues, so that colour differences between objects can be discerned mostly independent of the lighting spectrum, viewing angle, etc. This effect is known as "colour constancy."

The upper disk and the lower disk have exactly the same objective colour, and are in identical gray surroundings; based on context differences, humans perceive the squares as having different reflectances and may interpret the colours as different colour categories; see checker shadow illusion.[4]

Some generalizations of the physics can be drawn, neglecting perceptual effects for now:

Light arriving at an opaque surface is either reflected "specularly" (that is, in the manner of a mirror), scattered (that is, reflected with diffuse scattering), or absorbed – or some combination of these. Opaque objects that do not reflect specularly (which tend to have rough surfaces) have their colour determined by which wavelengths of light they scatter strongly (with the light that is not scattered being absorbed). If objects scatter all wavelengths with roughly equal strength, they appear white. If they absorb all wavelengths, they appear black. Opaque objects that specularly reflect light of different wavelengths with different efficiencies look like mirrors tinted with colours determined by those differences. An object that reflects some fraction of impinging light and absorbs the rest may look black but also be faintly reflective; examples are black objects coated with layers of enamel or lacquer.

Objects that transmit light are either translucent (scattering the transmitted light) or transparent (not scattering the transmitted light). If they also absorb (or reflect) light of various wavelengths differentially, they appear tinted with a colour determined by the nature of that absorption (or that reflectance). Objects may emit light that they generate from having excited electrons, rather than merely reflecting or transmitting light. The electrons may be excited due to elevated temperature (incandescence), as a result of chemical reactions (chemo luminescence), after absorbing light of other frequencies ("fluorescence" or "phosphorescence") or from electrical contacts as in light emitting diodes (see list of light sources).[5] That's why only even various spectroscopical methods are given their respective names depending upon nature/type of response of light like ultra violet spectroscopy, visible spectroscopy, infrared spectroscopy and also turbidimetry, nephlometry, fluorimetry, etc.

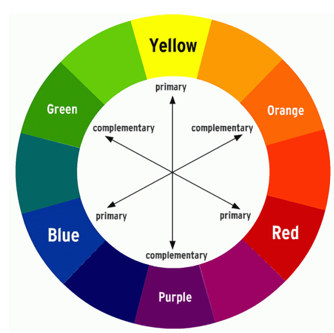

Figure 2: Colour chart

To summarize, the colour of an object is a complex result of its surface properties, its transmission properties, and its emission properties, all of which contribute to the mix of wavelengths in the light leaving the surface of the object. The perceived colour is then further conditioned by the nature of the ambient illumination, and by the colour properties of other objects nearby, and via other characteristics of the perceiving eye and brain.

Visible light (commonly referred to simply as light) is electromagnetic radiation that is visible to the human eye, and is responsible for the sense of sight. Visible light has a wavelength in the range of about 380 nanometers (nm), or 380×10^{-9} m, to about 740 nanometers – between the invisible infrared, with longer wavelengths and the invisible ultraviolet, with shorter wavelengths. Primary properties of visible light are intensity, propagation direction, frequency or wavelength spectrum, and polarization, while its speed in a vacuum, 299, 792, 458 meters per second, is one of the fundamental constants of nature.

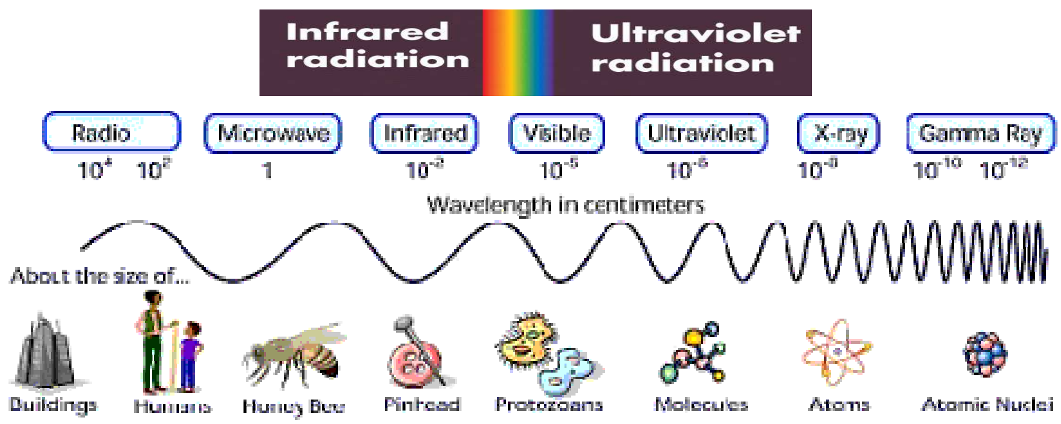

Figure 3: Chemistry of Waves

Visible light, as with all types of electromagnetic radiation (EMR), is experimentally found to always move at this speed in vacuum. In common with all types of EMR, visible light is emitted and absorbed in tiny "packets" called photons, and exhibits properties of both waves and particles. This property is referred to as the wave–particle duality. The study of light, known as optics, is an important research area in modern physics. A famous scientist Albert Einstein has invented "photo electric effect" on these criteria only.

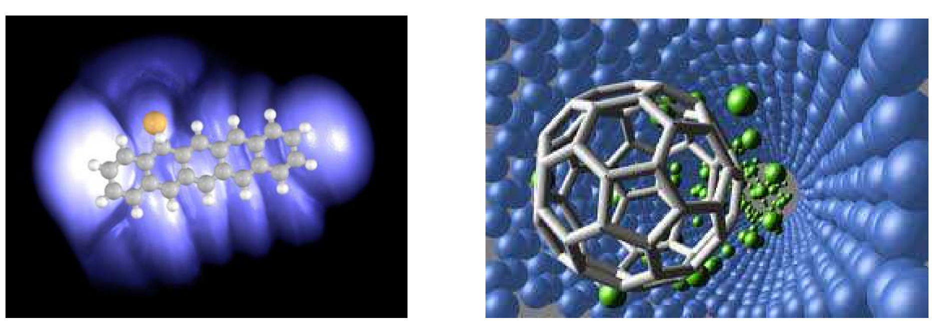

Figure 4: Nanotechnology

Nanochemistry or Nanotechnology related with the production and the reactions of nanoparticles and their compounds. It is concerned with the unique properties associated with assemblies of atoms or molecules on a scale between that of the individual building blocks and the bulk material (from 1 to 1000 nm). At this level, quantum effects can be significant, and also new ways of carrying out chemical reactions become possible. Professor Geoffrey Ozin of the University of Toronto is regarded as the father of nanochemistry. "His visionary paper "Nanochemistry - Synthesis in Diminishing Dimensions" (Advanced Materials, 1992, 4, 612) stimulated a whole new field: it proposed how the principles of chemistry could be applied to the bottom-up synthesis of materials "overall length scales" through "building block hierarchical construction principles": that is, by using molecular/nano-scale building blocks "programmed" with chemical information that will spontaneously self-assemble, in a controlled way, into structures that traverse a wide range of length scales. This was a whole new way of thinking at the time."[6]

This science use methodologies from the synthetic chemistry and the material's chemistry to obtain nanomaterials with specific sizes, shapes, surface properties, defects, self-assembly properties, designed to accomplish specific functions and uses.[7] The applications of nanochemistry have a wide range which covers from the semi-conductors electronics, to the medicine. Nanochemistry uses semi-conductors that only conduct electricity in specific conditions. As the semi-conductors are much smaller than normal conductors the product can be much smaller. There is evidence certain nanoparticles of silver are useful to inhibit some viruses and bacteria. Nanochemistry is being used to build high-tech armor and military weapons and for military uses. Nanochemistry could also be used for Chemical Warfare. Nanochemistry is also used to make windows that clean themselves, along with bicycles that are 1000 times stronger than steel but lighter than metal ones. The most productive piece of Nanochemistry is Carbon Nanotubes which are very dense and light when made into materials such as bicycles. Nanochemistry could be very useful in the future.[8]

In physics, the term light sometimes refers to electromagnetic radiation of any wavelength, whether visible or not. This article focuses on visible light. See the electromagnetic radiation article for the general term.[9]

A chemical bond is an attraction between atoms that allows the formation of chemical substances that contain two or more atoms. The bond is caused by the electrostatic force of attraction between opposite charges, either between electrons and nuclei, or as the result of a dipole attraction. The strength of chemical bonds varies considerably; there are "strong bonds" such as covalent or ionic bonds and "weak bonds" such as dipole–dipole interactions, the London dispersion force and hydrogen bonding. Since opposite charges attract via a simple electromagnetic force, the negatively charged electrons that are orbiting the nucleus and the positively charged protons in the nucleus attract each other. Also, an electron positioned between two nuclei will be attracted to both of them. Thus, the most stable configuration of nuclei and electrons is one in which the electrons spend more time between nuclei, than anywhere else in space. These electrons cause the nuclei to be attracted to each other, and this attraction results in the bond. However, this assembly cannot collapse to a size dictated by the volumes of these individual particles. Due to the matter wave nature of electrons and their smaller mass, they occupy a much larger amount of volume compared with the nuclei, and this volume occupied by the electrons keeps the atomic nuclei relatively far apart, as compared with the size of the nuclei themselves. In general, strong chemical bonding is associated with the sharing or transfer of electrons between the participating atoms. The atoms in molecules, crystals, metals and diatomic gases— indeed most of the physical environment around us— are held together by chemical bonds, which dictate the structure and the bulk properties of matter.[10]

In the field of biochemistry, a receptor is a molecule usually found on the surface of a cell that receives chemical signals from outside the cell. When such external substances bind to a receptor, they direct the cell to do something, such as divide, die, or allow specific substances to enter or exit the cell. Receptors are proteins embedded in either the cell's plasma membrane (cell surface receptors), in the cytoplasm, or in the cell's nucleus (nuclear receptors), to which specific signaling molecules may attach. A molecule that binds to a receptor is called a ligand, and can be a peptide (short protein) or another small molecule such as a neurotransmitter, hormone, pharmaceutical drug, or toxin.[11-12]

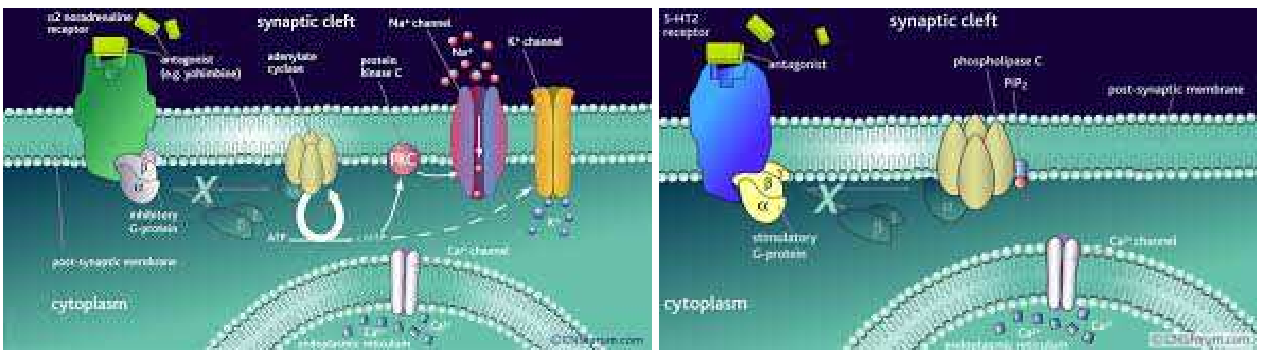

Figure 5: Bioreceptor Platform

Numerous receptor types are found in a typical cell. Each type is linked to a specific biochemical pathway, and binds only certain ligand shapes, similarly to how locks require specifically shaped keys to open. When a ligand binds to its corresponding receptor, it activates or inhibits the receptor's associated biochemical pathway. Ligand binding changes the conformation (three-dimensional shape) of the receptor molecule. This alters the shape at a different part of the protein, changing the interaction of the receptor molecule with associated biochemicals, leading in turn to a cellular response mediated by the associated biochemical pathway. However, some ligands called antagonists merely block receptors from binding to other ligands without inducing any response themselves.[13-16]

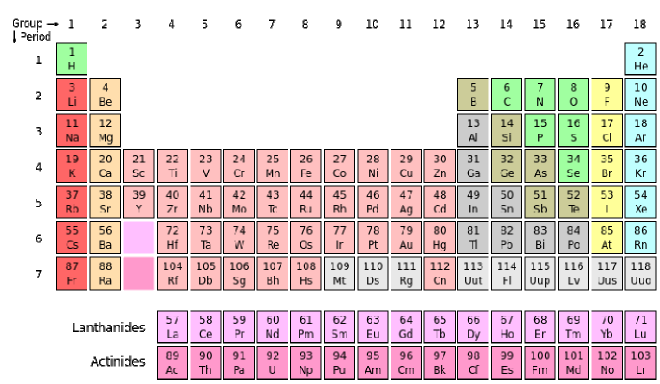

Figure 6: Periodic Table

Conclusion

There is nothing in this world which is free from chemistry. In a specific sense if it is seen, even physics and biology related inventions are also finally based on chemistry only. Both living and non-living beings are the structural network made by chemical entities. There are 118 elements in periodic table which has been categorized into metals and non-metals but they are single moieties, but when they join with each other by catenation property they can form nano level substance to micro level substance to mega level substance. This happens because "chemistry is a playground of functional groups". So many elements combine with each other to form inorganic or organic chemicals. Inorganic chemicals react with each other by ionic reactions and organic chemicals by functional groups to form small molecules to macromolecules. Chemistry is a reaction of colours and that colour can be identified by spectral parameters.

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