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1 Environmental Biology

Adiabatic magnetization – a process of cooling – not for biological samples

Allelopathy - a biological phenomenon by which an organism produces one or more biochemicals that influence the germination, growth, survival, and reproduction of other organisms. These biochemicals are known as allelochemicals and can have beneficial (positive allelopathy) or detrimental (negative allelopathy) effects on the target organisms and the community. For example, Australian pine tree litter completely suppresses germination of understory plants despite the relative openness of the canopy and ample rainfall (>120 cm/yr) at the location. https://en.wikipedia.org/wiki/Allelopathy

Allen's rule - an ecogeographical rule formulated by Joel Asaph Allen in 1877 broadly stating that animals adapted to cold climates have shorter limbs and body appendages than animals adapted to warm climates.

Allochthonous - denoting a deposit or formation that originated at a distance from its present position. (remember *al*ien and *al*loch.)

Alpine timberline – that line in any biosphere beyond which trees do not form a canopy and are scattered, due to climatic conditions.

Amensalism - Amensalism is any relationship between organisms of different species in which one organism is inhibited or destroyed while the other organism remains unaffected

Arbuscules - are the sites of exchange for phosphorus, carbon, water, and other nutrients. https://en.wikipedia.org/wiki/Arbuscular_mycorrhiza.

Aspergillosis is an infection caused by a type of mold (fungus). The illnesses resulting from aspergillosis infection usually affect the respiratory system, but their signs and severity vary greatly.

Autochthonous – indigenous

Benthos – the community of organisms that live on, in, or near the seabed, river, lake or stream bottom i.e. benthic zone.

Bermuda grass allergy – a kind of airborne allergy from pollen

Bilirubin - is a yellowish substance in your blood.

Bioaugmentation – the addition of bacterial cultures required to speed up the rate of degradation of a contaminant. https://en.wikipedia.org/wiki/Bioaugmentation.

Biodegradation - is the breakdown of organic matter by microorganisms, such as bacteria and fungi. https://en.wikipedia.org/wiki/Biodegradation.

Biodiversity hotspot - a biogeographic region that is both a significant reservoir of biodiversity and is threatened with destruction. The term biodiversity hotspot specifically refers to 25 biologically rich areas around the world that have lost at least 70 percent of their original habitat. India has 5 biodiversity hotspots: **E Himalaya**, **W Himalaya**, **W Ghats**, **A&N Islands**, **Indo-Burma region** (although according to some sources, there are only

three: W Ghats, E Himalayas and Indo-Burma region).
https://en.wikipedia.org/wiki/Biodiversity_hotspot#Distribution_by_region,
https://en.wikipedia.org/wiki/Wildlife_of_India.

Biogenetic nutrients - They are inorganic substances provided by the earth which are required by organisms for their body building and metabolism.
https://www.toppr.com/ask/question/what-are-biogenetic-nutrients/.

Biomagnification - also known as bioamplification or biological magnification, is any concentration of a toxin, such as pesticides, in the tissues of tolerant organisms at successively higher levels in a food chain

Biomineralization - is the process by which living organisms produce minerals, often to harden or stiffen existing tissues. https://en.wikipedia.org/wiki/Biomineralization.

bioremediation - the use of either naturally occurring or deliberately introduced microorganisms to consume and break down environmental pollutants, in order to clean a polluted site. https://en.wikipedia.org/wiki/Bioremediation.

Biostimulation - involves the modification of the environment to stimulate existing bacteria capable of bioremediation. This can be done by addition of various forms of rate limiting nutrients and electron acceptors, such as phosphorus, nitrogen, oxygen, or carbon (e.g. in the form of molasses). https://en.wikipedia.org/wiki/Biostimulation.

Biotransformation - chemical alteration of chemicals such as nutrients, amino acids, toxins, and drugs in the body. The term is also used to refer to the degradation of pesticides by soil microorganisms.

Bohr's hypothesis – something related to quantum physics; states that in an atom, the energy is transferred only in certain well defined quantities.

CAM plants – succulent plants that grow in arid regions e.g. cacti.

Chaparral forest – shrublands/woodlands in a Mediterranean climate (i.e. wet winters and dry summers). These forests are largely fire adapted.

Chitin - a fibrous substance consisting of polysaccharides, which is the major constituent in the exoskeleton of arthropods and the cell walls of fungi.

Chronobiology - the branch of biology concerned with cyclical physiological phenomena.

Climax community/stage aka steady state – in any ecosystem, climax stage is that stage in ecological succession which displays equilibrium. The composition of species is suited to the average conditions of the area. This equilibrium is marked by rate of photosynthesis (P) = rate of respiration (R).

Collagen - Collagen is the most abundant protein in the human body, found in the bones, muscles, skin, and tendons. It is the substance that holds the body together. Collagen forms a scaffold to provide strength and structure

Commensalism - an association between two organisms in which one benefits and the other derives neither benefit nor harm.

Corticated – having a cortex, bark or rind

Cryopreservation - a process that preserves organelles, cells, tissues, or any other biological constructs by cooling the samples to very low temperatures. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5395684/.

Curve, rank abundance - A rank abundance curve or Whittaker plot is a chart used by ecologists to display relative species abundance, a component of biodiversity. It can also be used to visualize species richness and species evenness.

Curve, sigmoid or 'S' curve - is a mathematical function having a characteristic "S"-shaped curve or sigmoid curve. https://en.wikipedia.org/wiki/Sigmoid_function.

Curve, species accumulation or species discovery curve- is a graph recording the cumulative number of species of living things recorded in a particular environment as a function of the cumulative effort expended searching for them. https://en.wikipedia.org/wiki/Species_discovery_curve.

Curve, survivorship - a graph showing the number or proportion of individuals surviving to each age for a given species or group (e.g. males or females). https://en.wikipedia.org/wiki/Survivorship_curve.

Cycling rate – the turnover rate* of nutrients per unit time.

Cyclomorphism/cyclomorphosis – name given to the occurrence of cyclic or seasonal changes in the phenotype of an organism through seasonal changes.

Cytology - the branches of biology and medicine concerned with the structure and function of plant and animal cells.

Daphnia – a small planktonic crustacean. (Crustaceans are arthropods like crabs, lobsters, crayfish etc. that have a thick chitinous exoskeleton)

Deep ecology - an ecological and environmental philosophy promoting the inherent worth of living beings regardless of their instrumental utility to human needs, plus a restructuring of modern human societies in accordance with such ideas. This is in contrast to shallow ecology, which simply promotes conservations strategies against pollution and the depletion of resources.

Detritivore – heterotrophs that obtain nutrients by consuming detritus (decomposing plant and animal parts as well as faeces). https://en.wikipedia.org/wiki/Detritivore.

Detritus – waste, decomposed matter.

Dianoflagellates – a kind of algae, plankton

Diapause – suspension of development at some stage in the lifecycle of an organism

Diatomaceous earth - is a naturally occurring, soft, siliceous sedimentary rock that is easily crumbled into a fine white to off-white powder. Used as a nonchemical insecticide. https://en.wikipedia.org/wiki/Diatomaceous_earth.

Diauxic growth - any cell growth characterized by cellular growth in two phases, and can be illustrated with a diauxic growth curve. A diauxic growth curve refers to the growth curve generated by an organism which has two growth peaks.
https://en.wikipedia.org/wiki/Diauxic_growth.

Diversity, alpha – refers to the average species diversity in a habitat or specific area. Alpha diversity is a local measure.

Diversity, beta – ratio between local or alpha diversity and regional diversity. This is the diversity of species between two habitats or regions

Diversity, biological or biodiversity – all of the different kinds of life on earth or the total number of species in any area

Diversity, ecological - Ecosystem diversity deals with the variations in ecosystems within a geographical location and its overall impact on human existence and the environment. Ecosystem diversity is a type of biodiversity. It is the variation in the ecosystems found in a region or the variation in ecosystems over any region.
https://en.wikipedia.org/wiki/Ecosystem_diversity.

Diversity, gamma – is the total diversity of a landscape and is a combination of both alpha and beta diversity. Also, a change in diversity between different ecosystems.

Diversity, genetic - the total number of genetic characteristics in the genetic makeup of a species. It is distinguished from genetic variability, which describes the tendency of genetic characteristics to vary. Genetic diversity serves as a way for populations to adapt to changing environments.

Diversity, species – the number of species and their abundance in a particular location

Dollo's law of irreversibility - an organism never returns exactly to a former state, even if it finds itself placed in conditions of existence identical to those in which it has previously lived ... it always keeps some trace of the intermediate stages through which it has passed (Dollo, 1893)

Dominance effect - the phenomenon of one variant (allele) of a gene on a chromosome masking or overriding the effect of a different variant of the same gene on the other copy of the chromosome. The first variant is termed dominant and the second recessive.

Dot hybridization - is a technique where single-stranded DNA labeled with a fluorescent or radioactive probe is used to identify the presence of its complementary sequence.
https://www.sciencedirect.com/topics/medicine-and-dentistry/dot-hybridization.

Ecesis - the process by which a plant or animal becomes established in a new habitat.

Ecological equivalence - Unrelated organisms that occupy similar habitats and resemble each other. Ecological equivalents result from convergent evolution. For example, sharks (fish) and dolphins (mammals) live in a marine habitat and superficially resemble each other.

Edaphic – of, produced by or influenced by the soil

Edge effect - edge effects are changes in population or community structures that occur at the boundary of two or more habitats.

Emasculation – removal of reproductive parts of an animal/plant.

Endoparasite - a parasite, such as a tapeworm, that lives inside its host.

Endosperm - a tissue produced inside the seeds of most of the flowering plants following fertilization. It is triploid in most species. It surrounds the embryo and provides nutrition in the form of starch, though it can also contain oils and protein. This can make endosperm a source of nutrition in animal diet. https://en.wikipedia.org/wiki/Endosperm

Epiphyte – a plant that uses another plant for physical support but does *not* draw nourishment from it e.g. orchidaceae, bromiliaceae

Estuary – the mouth of a large river, where the river meets the stream. It is an ecotone rich in biodiversity.

Ethylene – hydrocarbon, plays a role in fruit ripening.

Extrinsic allergic alveolitis is a lung disorder resulting from repeated inhalation of organic dust, usually in a specific occupational setting. In the acute form, respiratory symptoms and fever begin several hours after exposure to the dust.

Farmer's lung disease (FLD) is a form of hypersensitivity pneumonitis (HP) caused by inhaling microorganisms from hay or grain stored in conditions of high humidity in the agricultural workplace.

Food chain, auxiliary - In addition to grazing and detritus food chains there are other auxiliary food chains operated through parasites and scavengers. Some parasitic food chains may be quite complex and may involve unrelated organisms.
https://brainly.in/question/7370171#readmore

Food chain, detritus - begins from the dead organic matter or decomposed material, which is usually present in the soil. *Nothing known as predator food chain.*
https://www.difference.wiki/grazing-food-chain-vs-detritus-food-chain/.

Food chain, grazing - a food chain in which the energy in the lowest trophic level is derived from photosynthesis. In grazing food chains the first energy transfer is from plants to herbivores

Gaia hypothesis - proposes that living organisms interact with their inorganic surroundings on Earth to form a synergistic and self-regulating, complex system that helps to maintain and perpetuate the conditions for life on the planet.
https://en.wikipedia.org/wiki/Gaia_hypothesis.

Gauss exclusion principle – states that two species that compete for the same resources cannot stably coexist.

Genetic drift – changes in allele frequency in a population because of any selection pressure or genetic bottleneck.

Hardening (plant sciences) – a phenomenon whereby a plant prepares itself for cold weather. They do so by relocating nutrients from roots and shoots to storage organs.

Hartig Net - is a network of inward growing hyphae, that extends into the root, penetrating between the epidermis and cortex of ectomycorrhizal plants. This network is a site of nutrient exchange between the fungus and the host plant. https://en.wikipedia.org/wiki/Hartig_net. https://www.britannica.com/science/fungus explains fungi very well.

Parts of a Fungus

Hedgerow – a line of closely spaced shrubs (hedge) that marks the boundary of an area

Heleoplankton – plankton that lives in freshwater lakes and ponds etc. plankton are algae/plants but some planktons like rotifers are considered animals (?!).

Heterosis – when two unrelated individuals/lines are crossed, the performance of the F1 hybrid is superior to both parents. This is heterosis.

Homeostasis - the tendency towards a relatively stable equilibrium between interdependent elements, especially as maintained by physiological processes.

homoparasite – an animal parasite (as a hemoflagellate or a filarial worm) living in the blood of a vertebrate.

Hydrilla – a submerged perennial herb aka water thyme.

Hydrophyte – a plant that grows in or on water

Hyperoxia – a state where oxygen supply is excessive. (opposite: hypoxia).

Hypothalamus and thalamus – hypothalamus is a small region at the base of the brain that regulates body temperature etc., thalamus is just above the brain stem and is related to relaying motor and sensory signals to the cerebral cortex

Inoculation – injecting sth

Isidia - idia are outgrowths of the thallus surface, and are corticated. https://en.wikipedia.org/wiki/Isidium.

Jatropha sp. – a Euphorbiaceae, its seeds are a popular source of biodiesel. https://www.biooekonomie-bw.de/en/articles/news/jatrosolutions-jatropha-oil-for-biofuel-and-more.

Kepler's law – no need to know in detail, something related to the motion of planets.

Kranz anatomy – a structure in the leaves of many C4 plants that allows for its photosynthesis

Lacustrine – lake-like or formed by a lake. Usually marked by slow velocity of water.

Lake, amictic - Amictic lakes are "perennially sealed off by ice from most of the annual seasonal variations in temperature."[1] Amictic lakes exhibit inverse cold water stratification whereby water temperature increases with depth below the ice surface 0 °C (less-dense) up to a theoretical maximum of 4 °C (at which the density of water is highest).

Lake, dystrophic – having brown acidic water that is low in oxygen and supports little life, owing to low pH and high levels of dissolved humus.

Lake, eutrophic – lake with high concentration of nutrients

Lake, holomictic - lakes that have a uniform temperature and density from top to bottom at a specific time during the year, which allows the lake waters to completely mix.

Lake, monomictic – they are holomictic lakes that mix from top to bottom during one mixing period each year. Monomictic lakes may be subdivided into cold and warm types.

Lake, oligomictic – subset of holomictic lakes; oligomictic lakes are generally stable and shallow low-altitude lakes and reservoirs with a very slow or rare mixing.

Lake, oligotrophic - An oligotrophic lake is a lake with low primary productivity, as a result of low nutrient content. These lakes have low algal production, and consequently, often have very clear waters, with high drinking-water quality.

Lake, polymictic - Polymictic lakes are holomictic lakes that are too shallow to develop thermal stratification; thus, their waters can mix from top to bottom throughout the ice-free period.

Legionnaires disease, also known as legionellosis, is a form of atypical pneumonia caused by any type of Legionella bacteria. Signs and symptoms include cough, shortness of breath, high fever, muscle pains, and headaches

Lentic ecosystem - A lentic ecosystem entails a body of standing water, ranging from ditches, seeps, ponds, seasonal pools, basin marshes and lakes. Deeper waters, such as lakes, may have layers of ecosystems, influenced by light. https://sciencing.com/lentic-lotic-ecosystems-7355077.html.

Lentic ecosystem – still water ecosystem (e.g. lake) https://sciencing.com/lentic-lotic-ecosystems-7355077.html

Limnion, epi – the upper layer of water in a stratified lake

Limnion, hypo - the lower layer of water in a stratified lake, typically cooler than the water above and relatively stagnant.

Limnion, meta – aka thermocline is a thin layer in a large water body where the temperature changes rapidly with depth than in the layers above or below. Nothing known as midlimnion, oligolimnion and dystrolimnion.

Lincoln Index – used in animals to estimate total population density

Lotic ecosystem – riverine ecosystem (lentic ecosystem is lake ecosystem)

Macrophyte - an aquatic plant large enough to be seen by the naked eye.

Mark-Recapture method – used to estimate the size of a population where it is impractical to count every individual.

Medulla – long stem like structure which makes up part of the brainstem. Responsible for autonomic (involuntary) functions ranging from vomiting to sneezing.

Miller's hypothesis - The Miller-Urey experiment provided the first evidence that organic molecules needed for life could be formed from inorganic components.

Molasses – a black viscous substance released from refining sugarcane or sugar beets into sugar.

Most Probable Number (MPN) test - is a method used to estimate the concentration of viable microorganisms in a sample by means of replicate liquid broth growth in ten-fold dilutions. https://microbeonline.com/probable-number-mpn-test-principle-procedure-results/.

Natural selection, convergent - the process by which unrelated or distantly related organisms evolve similar body forms, coloration, organs, and adaptations.

Natural selection, directional - or positive selection is a mode of natural selection in which an extreme phenotype is favoured over other phenotypes, causing the allele frequency to shift over time in the direction of that phenotype.

Natural selection, diversifying aka disruptive - describes changes in population genetics in which extreme values for a trait are favored over intermediate values. https://en.wikipedia.org/wiki/Disruptive_selection.

Natural selection, stabilising - is a type of natural selection in which the population mean stabilizes on a particular non-extreme trait value. This is thought to be the most common mechanism of action for natural selection because most traits do not appear to change drastically over time. Instead of favouring individuals with extreme phenotypes, it favours the intermediate variants.

Nektons - are living organisms that are able to swim and move independently of currents. Nekton are heterotrophic and have a large size range, such as fish, squid, octopus, sharks, and marine mammals.

Nematodes – phylum that includes roundworms. Can be found in different environments from marine to terrestrial.

Neustons - group of organisms found on top of or attached to the underside of the surface film of water e.g. whirligig beetles and water striders, some spiders and protozoans, and occasional worms, snails, insect larvae, and hydras.
https://www.britannica.com/science/neuston.

Niche, fundamental – a niche for a species where there is no competition from other species

Niche, realised – a subset of fundamental niche; the part of fundamental niche that an organism occupies as a result of limiting factors present in its habitat.

Nitrification – conversion of NH4 to NO2 (nitrite), and then NO2 to NO3 (nitrate)

Non-halogenated – not treated or combined with a halogen

Nudation - The initiation of a new plant succession by a major environmental disturbance (e.g. a volcanic eruption).

Oligotrophic – water bodies low in nutrition and net primary productivity

Oxygen demand, biochemical (BOD) - the amount of dissolved oxygen needed (i.e. demanded) by aerobic biological organisms to break down organic material present in a given water sample at certain temperature over a specific time period.
https://en.wikipedia.org/wiki/Biochemical_oxygen_demand.

Oxygen demand, chemical (COD) - In environmental chemistry, the chemical oxygen demand (COD) is an indicative measure of the amount of oxygen that can be consumed by reactions in a measured solution. https://en.wikipedia.org/wiki/Chemical_oxygen_demand.

Pappus - The pappus is the modified calyx, the part of an individual floret, that surrounds the base of the corolla tube in flower heads of the plant family Asteraceae.
https://en.wikipedia.org/wiki/Pappus_(botany).

Phagus, phyto – organisms that consume living plant material

Phagus, sapro – organisms that consume dead plant material

Photoperiod - the period of time each day during which an organism receives illumination; day length.

Phyte, crypto - These plants have subterranean or under water resting buds

Phytes, chamae - These plants have buds on persistent shoots near the soil surface; woody plants with perennating buds borne close to the soil surface, a maximum of 25 cm above the soil surface, e.g., bilberry and periwinkle. *See Raunkiaer's lifeforms*.

Phytes, halo - a salt-tolerant plant that grows in soil or waters of high salinity, coming into contact with saline water through its roots or by salt spray, such as in saline semi-deserts, mangrove swamps, marshes and sloughs and seashores.
https://en.wikipedia.org/wiki/Halophyte.

Phytes, helio - sun-loving plants, are those that require for their optimum growth full exposure to the sun.

Phytes, hemicrypto – plants that have buds near the base

Phytes, phanero – usually trees/woody perennials; they grow their stems in the air with buds being more than 50 cms above the soil surface.

Phytes, thero - These are annual plants that complete their lives rapidly in favorable conditions and survive the unfavorable cold or dry season in the form of seeds. Many desert plants are by necessity therophytes.

Pioneer species – hardy and resilient plants first to colonise an area after disturbances e.g. fire.

Plankton – aquatic organisms that drift with water movements, generally having no locomotive organs e.g. phytoplankton, zooplankton, protozoans etc.

Pneumatophore - (in mangroves and other swamp plants) an aerial root specialized for gaseous exchange.

Population model, exponential growth - When resources are unlimited, populations exhibit exponential growth, resulting in a J-shaped curve. When resources are limited, populations exhibit logistic growth. See https://www.dummies.com/education/science/environmental-science/the-environmental-science-of-population-growth-models/.

Population model, linear – straight line, essentially. Linear growth witnesses the same amount added to the population each year.

Population model, Lotka Volterra – a model that deals with prey-predator or herbivore-plant or parasite-host interactions

Population model; Leslie-matrix – a model that explains the growth of the population, deceasing trend in the population and stable condition. It does not deal with prey-predator interactions (Rupendra Singh P566)

Population model; logistic – a model used to predict population growth for a single species in an ecosystem.

Population, meta – a set of local populations connected by dispersing individuals

Population, super or infinite or mega – a population which is uncountable, such as the number of cells in one's body

Propagules - a vegetative structure that can become detached from a plant and give rise to a new plant, e.g. a bud, sucker, or spore. https://en.wikipedia.org/wiki/Propagule.

Psammosere - A psammosere is a seral community, an ecological succession that began life on newly exposed coastal sand. Most common psammoseres are sand dune systems.

Ptilophyllum flora – characteristic of hot and humid climate (that's all I know about it).

Pyramid of biomass - It is a graphical representation of biomass (total amount of living or organic matter in an ecosystem) present in unit area in different trophic levels.

Pyramid of energy is a graphical representation of the amount of energy at each trophic level of a food chain.

Pyramid of numbers – a graphical representation of the number of individual organisms/species involved at each trophic level https://en.wikipedia.org/wiki/Ecological_pyramid. There is probably nothing known as pyramid of dry weight.

Quinolone - A quinolone antibiotic is a member of a large group of broad-spectrum bacteriocidals that share a bicyclic core structure related to the substance 4-quinolone. They are used in human and veterinary medicine to treat bacterial infections, as well as in animal husbandry.

Raunkiaer's lifeforms – a system of classifying plants on the basis of the distance of the buds from the roots.

Red tide – algal bloom, where an upwelling of nutrients brings microorganisms like protozoa and algae to the surface.

Reed Swamp Stage – in an ecological succession, 'reed swamp stage' is the stage where plants have tall, flexible spear shaped leaves. This allows them to cope with large fluctuations in water level; always retaining some portion of the leaves above the water for effective photosynthesis. By this stage, the water may be too shallow to support fully submerged plants. Also called amphibious stage and plants like Typha, Sagittaria, Scripus, etc., replace the floating plants. http://www.biologydiscussion.com/plants/8-main-stages-of-hydrosere-plants-botany/75454.

Rotifera – a phylum in Animalia kingdom, contains near microscopic pseudocoelomate animals. https://www.britannica.com/animal/rotifer.

RuBisCo – an enzyme used by plants to fix atmospheric CO2. Most abundant protein in biosphere.

Saprophyte/saprotroph/saprophagus – plant, fungus or microorganism that lives on dead organic matter

Sclerophyllous vegetation/leaves - Typically scrub, but also woodland, in which the leaves of the trees and shrubs are evergreen, small, hard, thick, and leathery. https://en.wikipedia.org/wiki/Sclerophyll.

Sedge – any plant of the genus Carex

Seral community – in any ecosystem, a seral community is an intermediate stage when the ecosystem is advancing towards climax community.

Shannon index – an index to measure species diversity. It assumes that all species have been sampled randomly. On the other hand, the Simpson Index gives more weight to common species.

Speciation, allopatric - also referred to as geographic speciation, vicariant speciation, or its earlier name, the dumbbell model is a mode of speciation that occurs when biological

populations of the same species become isolated from each other to an extent that prevents or interferes with gene flow.

Speciation, sympatric - Sympatric speciation is the evolution of a new species from a surviving ancestral species while both continue to inhabit the same geographic region. In evolutionary biology and biogeography, sympatric and sympatry are terms referring to organisms whose ranges overlap so that they occur together at least in some places.

Species abundance – the number of individuals in a given species

Species evenness - refers to how close in numbers each species in an environment is.

Species richness – the number of species in a community

Species, flagship – a species selected to represent an environmental cause and symbol for a defined habitat

Species, indicator - An indicator species is an organism whose presence, absence or abundance reflects a specific environmental condition. Indicator species can signal a change in the biological condition of a particular ecosystem, and thus may be used as a proxy to diagnose the health of an ecosystem.

Species, keystone - A species whose presence and role within an ecosystem has a disproportionate effect on other organisms within the system. A keystone species is often a dominant predator whose removal allows a prey population to explode and often decreases overall diversity.

Species, monocarpic – species that flower, set seeds and die.

Species, monotypic - one that does not include subspecies or smaller, infraspecific taxa.

Species, umbrella - Umbrella species are species selected for making conservation-related decisions, typically because protecting these species indirectly protects the many other species that make up the ecological community of its habitat.

Standing state - the amount of nutrients like calcium,nitrogen,phosphorous present in the soil of the ecosystem.

Strategist, k- or k-selected species – fewer offspring, high survivability.

Strategist, r- or r-selected species – those species that produce many offspring quickly, each of whom have a low survivability. E.g. bacteria, diatoms, insects and grasses. *There is no such thing as c-selection*!

Streeter-Phelps model - The model describes how dissolved oxygen (DO) decreases in a river or stream along a certain distance by degradation of biochemical oxygen demand (BOD).

Subculture – a microbial culture made by transferring some or all cells from a previous culture to a fresh growth medium.

Succession, allogenic – succession in an ecosystem driven by abiotic components

Succession, autogenic – succession in an ecosystem driven by biotic components

Succession, ecological – the successive stages whereby an ecosystem can restore itself after a disturbance such as fire

Succession, hydrarch – succession in a wet or humid ecosystem

Succession, polyclimax – a theory that says that many different sets of species can be recognised as climax communities for a niche

Succession, xerarch – succession in a dry ecosystem

Sulphur cycle - https://en.wikipedia.org/wiki/Sulfur_cycle

telic, ammono - organisms which excrete nitrogenous waste substances in the form of ammonia, e.g., Octopus, Sepia and bony fishes.

Telic, ureo - are the organism which excretes the nitrogenous waste as urea. For example, bony fish.

Telic, urico - organisms which excrete nitrogenous waste substances in the form of uric acid, e.g., Lizard, some insects and birds.

Tetracyclins – an antibiotic

Thallus - a plant body that is not differentiated into stem and leaves and lacks true roots and a vascular system. Thalli are typical of algae, fungi, lichens, and some liverworts.

Threshold of security or ecological threshold - Ecological threshold is the point at which a relatively small change or disturbance in external conditions causes a rapid change in an ecosystem. When an ecological threshold has been passed, the ecosystem may no longer be able to return to its state by means of its inherent resilience. https://en.wikipedia.org/wiki/Ecological_threshold.

Turbid – cloudy

Turnover rate – a measure of the movement of an element in a biogeochemical cycle. It is calculated as the rate of flow into and out of a particular nutrient pool, divided by the quantity of the nutrient in the pool. It measures the importance of a particular nutrient flux in relation to the pool size (Oxford Dictionary of Plant Sciences: 546).

Vermiculture – the cultivation of earthworms to use them to convert organic waste to fertiliser.

Vernalization – the cooling of seed during germination in order to accelerate flowering when it's planted

Vesicles – a small bladder like structure containing a fluid (Oxford dictionary of plant sciences: 557).

Weismann's theory aka germplasm theory - that heritable information is transmitted only by germ cells in the gonads (ovaries and testes), not by somatic cells.

Zone in a biosphere, Buffer – surrounds the core area and dedicated to research and educational activity

Zone in a biosphere, Core – undisturbed zone, protected entirely and kept free of experimentation and research.

Zone in a biosphere, transition – outer most region where inhabitation, agriculture and recreational activity occurs.

Zone, benthic - The benthic zone is the ecological region at the lowest level of a body of water such as an ocean, lake, or stream, including the sediment surface and some sub-surface layers. https://en.wikipedia.org/wiki/Benthic_zone.

Zone, hyporheic - hyporheic zone is the region of sediment and porous space beneath and alongside a stream bed, where there is mixing of shallow groundwater and surface water. https://en.wikipedia.org/wiki/Hyporheic_zone.

Zone, limnetic – The open and well-lit area of a freestanding body of freshwater

Zone, neritic - the region of shallow water (200 meters depth) above the continental shelf where light penetrates to the sea floor. https://www.thoughtco.com/neritic-zone-4767613.

Zone, Pelagic – the water column of an ocean. It has further subdivisions. https://en.wikipedia.org/wiki/File:Pelagiczone.svg.

Zone, Photic – the uppermost layer of a waterbody that received sunlight. Opposite: aphotic zone.

Zone, Profundal – that part of a water body where sunlight does not penetrate

zooparasites – any parasite that is parasitic to an animal

species, least concern – an IUCN category for.

Species, conservation dependent – an IUCN category for

1.1 Environmental Biology Factfile

Table 1 Terrestrial Biome Characteristics

Biome	Plant Life	Annual Rainfall	Annual Temp	Soil Quality	Uses
Tundra	Low-growing plants, no trees	Low	Cold	Frozen	
Boreal	Evergreen trees	Low	Cold	Poor	Logging
Temperate grassland	Grasses	Low	Hot summer, cold winter	Highly productive	Grazing, farming
Woodland/chaparral	Woody shrubs, oak	Low	Hot summer, cool winter	Low in nutrients	Grazing, grape, agriculture
Temperate deciduous	Deciduous trees	High	Warm summer, cold winter	Rich in nutrients	Agriculture
Temperate rainforest	Large conifers, ferns	High	Mild year round	Low in nutrients	Logging
Tropical rainforest	Large tropical trees	High	Warm year round	Low in nutrients	Logging/agriculture
Savannah	Grasses, shrubs, trees	Low	Warm	Rich in nutrients	Agriculture, grazing
Subtropical desert	Cacti, other succulents	Very low	Hot	Very poor	

From Spooner 2012: 102

Table 2 IUCN Red List Category

Broad Category	Category	Definition
Extinct	Extinct (EX)	A species whose last known living member has died.
	Extinct in the wild (EW)	A species known only by living members kept in captivity or as a naturalized population outside its historic range due to massive habitat loss.
Threatened	Critically Endangered (CR)	A species facing an extremely high risk of extinction in the wild.
	Endangered (EN)	A species that is very likely to become endangered in the future
	Vulnerable (VU)	A species that is likely to become endangered unless the circumstances that are threatening its survival and reproduction improve.
Lower Risk	Near threatened (NT)	A species that may be considered threatened with extinction in the near future, although it does not currently qualify for the threatened status.
	Conservation dependent (CD)	species dependent on conservation efforts to prevent it from becoming threatened with extinction.
	Least concern (LC)	species that are not threatened or conservation dependent

Table 3 Important hormones and chemicals

Abcissic acid (ABA)	ABA functions in many plant developmental processes, including seed and bud dormancy, the control of organ size and stomatal closure.
Auxin	plant hormone produced in the stem tip that promotes cell elongation.
Chlorophyll-a	a specific form of chlorophyll used in oxygenic photosynthesis. It absorbs most energy from wavelengths of violet-blue and orange-red light. It also reflects green-yellow light, and as such contributes to the observed green color of most plants. https://en.wikipedia.org/wiki/Chlorophyll_a.
Cytokinin	phytohormone that promotes cell division aka cytokinesis.
Flavonoid	are a class of polyphenolic plant and fungus secondary metabolites. Closely associated with Nod D gene.
Gibberellin	plant hormones that regulate various developmental processes, including stem elongation, germination, dormancy, flowering, flower development, and leaf and fruit senescence.
Globulin	are a group of proteins in your blood. They are made in your liver by your immune system.
Glycoprotein	any class of proteins that have carbohydrate groups attached to a polypeptide chain
Indole-3-acetic acid (IAA, 3-IAA)	a plant hormone responsible for, among other things, curling of root hair in legumes
Leghaemoglobin	is an oxygen carrier protein which is found in the nitrogen-fixing root nodules of a leguminous plant. It is produced by the legumes in respond to roots being colonized by nitrogen-fixing bacteria, termed rhizobia, as a part of symbiotic interaction between plant and bacterium. Also responsible for giving root nodules in leguminous plants a red/pink colour.
Lignin	class of complex organic polymers that form key structural materials in the support tissues of vascular plants and some algae.
Lignocellulose	plant dry matter (biomass), so called lignocellulosic biomass. Found in the cell walls of woody plants. An abundant source of biofuels esp. bioethanol. https://en.wikipedia.org/wiki/Lignocellulosic_biomass.
Methanogens	bacteria that produce methan as a metabolic by-product in hypoxic conditions. They are obligate, anaerobic bacteria. https://en.wikipedia.org/wiki/Methanogen.

Table 4 Important microorganisms

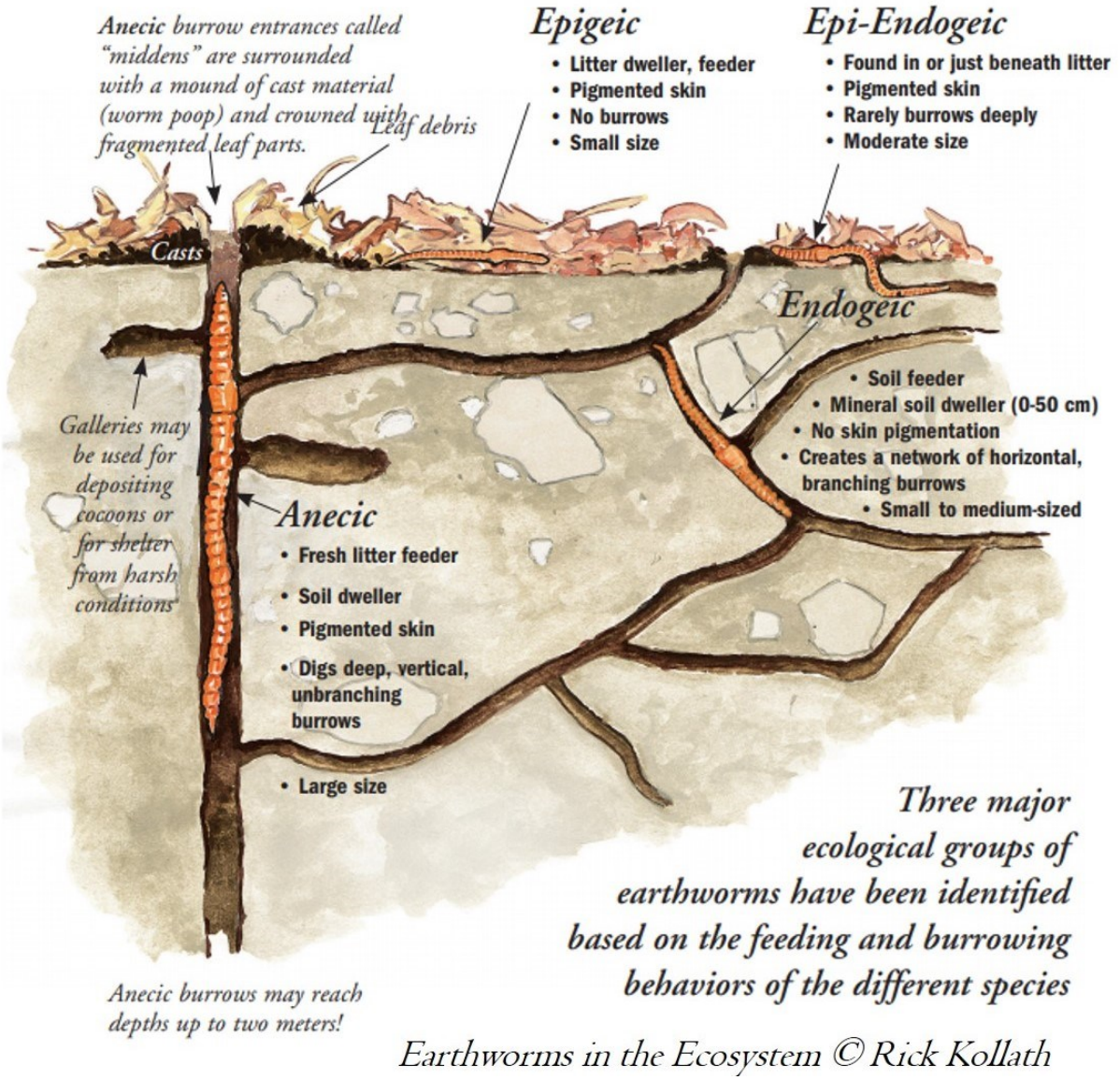
Acidithiobacillus thiooxidans	a bacteria that uses sulphur as its primary energy source. Used in a mining technique called bioleaching, where metals are extracted from their ores using microbes
Actinomycetes	gram positive bacteria, known to produce a wide variety of industrially and medically relevant compounds (antibiotics, chemotherapeutics, fungicides, herbicides and immunosuppressants). https://www.sciencedirect.com/topics/earth-and-planetary-sciences/actinomycete.
Aminoglycocides	Aminoglycoside is a medicinal and bacteriologic category of traditional Gram-negative antibacterial medications that inhibit protein synthesis and contain as a portion of the molecule an amino-modified glycoside.
Anabaena	Anabaena is a genus of filamentous cyanobacteria that exist as plankton. They are known for nitrogen-fixing abilities, and they form symbiotic relationships with certain plants, such as the mosquito fern. https://en.wikipedia.org/wiki/Anabaena.
Auxotroph	a mutant organism (especially a bacterium or fungus) that requires a particular additional nutrient which the normal strain does not.
Azospirillum	a Gram-negative, microaerophilic, non-fermentative and nitrogen-fixing bacterial genus from the family of Rhodospirillaceae. Azospirillum bacteria can promote plant growth.
Beta-lactams	drugs that prevent the formation of a bacterial cell wall
Clostridium	genus of rod-shaped, usually gram-positive bacteria, members of which are found in soil, water, and the intestinal tracts of humans and other animals.
Frankia	Frankia lives in symbiotic relationship with actinorhizal plants, like Alder, Bayberry etc. These bacteria convert atmospheric nitrogen into ammonia using enzyme nitrogenase. The Frankia symbiosis is often utilised in land reclamation and restoration process using Casuarinales trees to hold soil.
Microcystis	is a genus of freshwater cyanobacteria which includes the harmful algal bloom Microcystis aeruginosa. The cyanobacteria

	can produce neurotoxins and hepatotoxins, such as microcystin and cyanopeptolin. https://en.wikipedia.org/wiki/Microcystis.
Mycorrhizae	fungi that dwell in a plant's root system and have a symbiotic relationship with the plant.
Nitrobacter	a genus comprising rod-shaped, gram-negative, and chemoautotrophic bacteria.
Nitrosomonas	a genus of Gram-negative rod-shaped chemoautotrophic bacteria. This organism oxidizes ammonia into nitrite as a metabolic process, known as nitritation (a step of Nitrification)
Nostoc	an important cyanobacteria composed of beaded filaments which aggregate to form a gelatinous mass, growing in water and damp places and able to fix nitrogen from the atmosphere. https://en.wikipedia.org/wiki/Nostoc.
Peptidoglycan (murein)	is a polymer consisting of sugars and amino acids that forms a mesh-like layer outside the plasma membrane of most bacteria, forming the cell wall.
Pseudomonas	a common bacteria found in soils etc. that fixes nitrogen.
Pseudomonas putida	Aka 'superbug' cleans up oil spills
Rhizobium	a genus of bacteria associated with the formation of root nodules on plants. These bacteria live in symbiosis with legumes. They take in nitrogen from the atmosphere and pass it on to the plant, allowing it to grow in soil low in nitrogen.

Table 5 Earthworms

Ecotype	**Description**	**Major species**
anecic	make permanent vertical burrows in soil. They feed on leaves on the soil surface that they drag into their burrows. https://www.earthwormsoc.org.uk/earthworm-ecology.	***Lumbricus terrestris***, *Lumbricus friend, Aporrectodea longa, Aporrectodea nocturna,*
endogeic	They form shallow semi-permanent burrows and sometimes come to the surface to search for food. Feed primarily on decomposed organic matter that is already incorporated in the soil. Assist in soil comminution i.e. breaking down of soil into finer structures.	*Lampito mauritii, Octochaetona serrata, Pontoslex carethrurus, Octochaetona thurstoni*

	https://www.sciencelearn.org.nz/resources/7-niches-within-earthworms-habitat.	
Epigeic	Inhabitants of the organic layer of the soil (o-horizon) and not common in most agricultural soils. In organic farming practices, mulching is highly recommended as it provides food and shelter for surface dwelling earthworms.	*Perionyx excavatus, Eisenia fetida* (red wigglers), *Eudrilus eugeniae, Lumbricus rubellus*
Compost	These are most likely to be found in compost, or areas very rich in rotting vegetation. They prefer warm and moist environments with a ready supply of fresh compost material. They can very rapidly consume this material and also reproduce very quickly. Compost earthworms tend to be bright red in colour and stripy. It seems there are earthworms from all the above three categories here.	***Eisina fetida*** (aka tiger worm), *Dendrobaena veneta,* Major endemic Indian composting earthworms: ***Perionyx excavatus***, *Lampito mauritii*, *Octochaetona serrata* (lives in red acidic laterite soil), *Eudrilus eugeniae*



https://www.earthwormsoc.org.uk/earthworm-ecology

2 Environmental Pollution and Control

Acid mine drainage – or acid and metalliferous drainage (AMD), or acid rock drainage (ARD) is the outflow of acidic water from metal mines or coal mines. There is nothing known as gold mine drainage. https://en.wikipedia.org/wiki/Acid_mine_drainage.

Aeration – a process by which air is circulated through or dissolved in a liquid

Aerosol Impaction – the process in which particles are removed from an air stream by forcing the gases to make a sharp bend. Particles above a certain size possess so much momentum that they cannot follow the air stream and strike a collection surface which is available for later analysis of mass and composition. https://en.wikipedia.org/wiki/Aerosol_impaction.

Aerosol interception - is the mechanism by which particles, while following the mainstream flow, come into contact with an airway wall because of their shape and size. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3417302/?report=classic.

Aerosol optical depth - Aerosol optical depth is a measure of the extinction of the solar beam by dust and haze. In other words, particles in the atmosphere (dust, smoke, pollution) can block sunlight by absorbing or by scattering light. AOD tells us how much direct sunlight is prevented from reaching the ground by these aerosol particles. It is a dimensionless number that is related to the amount of aerosol in the vertical column of atmosphere over the observation location. https://www.esrl.noaa.gov/gmd/grad/surfrad/aod/.

Aldicarb - is a carbamate insecticide. It is effective against thrips, aphids, spider mites, lygus, fleahoppers, and leafminers, but is primarily used as a nematicide. https://en.wikipedia.org/wiki/Aldicarb.

Alpha particle – a particle consisting of two protons and neutrons bound by electromagnetic forces, identical to a Helium nucleus. It has no electrons.

Apatite - a widely occurring pale green to purple mineral, consisting of calcium phosphate with some fluorine, chlorine, and other elements. It is used in the manufacture of fertilizers. https://en.wikipedia.org/wiki/Apatite.

Bacteroids - a differentiated symbiotic form of the nitrogen-fixing bacteria, Rhizobia.

Bioaccumulation - is the gradual accumulation of substances, such as pesticides or other chemicals, in an organism. https://en.wikipedia.org/wiki/Bioaccumulation.

Bioprecipitation - is the concept of rain-making bacteria and was proposed by David Sands from Montana State University in 1982. The formation of ice in clouds is required for snow and most rainfall. Dust and soot particles can serve as ice nuclei, but biological ice nuclei are capable of catalyzing freezing at much warmer temperatures. https://en.wikipedia.org/wiki/Bioprecipitation but also see https://link.springer.com/10.1007/978-3-642-11274-4_189.

Biosorption - Biosorption can be defined as the ability of biological materials to accumulate heavy metals from wastewater through metabolically mediated or physico-chemical pathways of uptake. https://en.wikipedia.org/wiki/Biosorption

Black body - is an idealized physical body that absorbs all incident electromagnetic radiation, regardless of frequency or angle of incidence. https://en.wikipedia.org/wiki/Black_body.

Blue baby syndrome - can refer to a number of conditions that affect oxygen transportation in the blood, resulting in blueness of the skin in babies.

Box model – See Masters and Ela (2014: 468).

Bronchitis - is an inflammation of the lining of your bronchial tubes, which carry air to and from your lungs. People who have bronchitis often cough up thickened mucus, which can be discoloured. https://www.mayoclinic.org/diseases-conditions/bronchitis/symptoms-causes/syc-20355566.

Buoyancy flux parameter – something to do with stack height.

Carbamate – any chemical compound that is derived from NH_2COOH. They are almost always organic.

Carotenoids - any of a class of mainly yellow, orange, or red fat-soluble pigments, including carotene, which give colour to plant parts such as ripe tomatoes and autumn leaves. https://www.livescience.com/52487-carotenoids.html.

Cascade impactor - are strictly measurement-related devices. In addition to measuring the range of substances moved through an opening by aerosol, the impactor can also be used to determine the particle size of the distributed substance. https://en.wikipedia.org/wiki/Cascade_impactor

Chloropyrifos – organophosphate pesticide used on crops, animals and buildings. https://en.wikipedia.org/wiki/Chlorpyrifos.

Coagulant – a substance that gets coagulated. The substance that causes coagulation is called procoagulant.

Coliforms - bacteria are defined as Rod shaped Gram-negative non-spore forming and motile or non-motile bacteria which can ferment lactose with the production of acid and gas when incubated at 35–37°C. https://en.wikipedia.org/wiki/Coliform_bacteria.

Colloidal form - a colloid is a mixture in which one substance of microscopically dispersed insoluble or soluble particles is suspended throughout another substance. https://en.wikipedia.org/wiki/Colloid

Conductivity bridge - Conductivity Bridge is lab equipment designed for precise, direct measurement of electrical resistance.

Curie – a unit of radioactivity. https://whatis.techtarget.com/definition/curie.

Cyclone separation - is a method of removing particulates from an air, gas or liquid stream, without the use of filters, through vortex separation. https://en.wikipedia.org/wiki/Cyclonic_separation.

Damping of waves – a damped wave is one whose amplitude decreases with time. https://en.wikipedia.org/wiki/Damped_wave.

Diffraction of waves – is defined as the bending of waves around the corners of an obstacle or through an aperture into the region of geometrical shadow of the obstacle/shadow.

Ekman dredge – an apparatus for bringing up objects or mud from a river or seabed by scooping or dragging.

Electrostatic precipitator (ESP) - is a filtration device that removes fine particles, like dust and smoke, from a flowing gas using the force of an induced electrostatic charge minimally impeding the flow of gases through the unit.
https://en.wikipedia.org/wiki/Electrostatic_precipitator

Emission, positron or β+ decay - is a subtype of beta decay, in which a proton inside a radionuclide nucleus is converted into a neutron while releasing a positron and an electron neutrino. https://en.wikipedia.org/wiki/Positron_emission.

Emission, α - is a type of radioactive decay in which an atomic nucleus emits an alpha particle (helium nucleus) and thereby transforms or 'decays' into a different atomic nucleus, with a mass number that is reduced by four and an atomic number that is reduced by two.

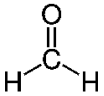
Emission, β or beta decay- a high-energy, high-speed electron or positron emitted by the radioactive decay of an atomic nucleus during the process of beta decay. A positron is the anti-particle of an electron. https://en.wikipedia.org/wiki/Beta_particle.

Emission, γ - a penetrating electromagnetic radiation arising from the radioactive decay of atomic nuclei. It consists of the shortest wavelength electromagnetic waves and so imparts the highest photon energy. https://en.wikipedia.org/wiki/Gamma_ray.

Fabric filters – aka baghouse is an air pollution control device and dust collector that removes particulates or gas released from commercial processes out of the air.

Floc - a loosely clumped mass of fine particles. The process by which fine particulates are caused to clump together into a floc is called flocculation.
https://en.wikipedia.org/wiki/Flocculation.

Folin-Wu method – a method of estimating sugar content.

Formaldehyde (CH_2O) -  it is the simplest of aldehydes. It is an important precursor to many other materials and chemical compounds. It's also a popular biocide.
https://en.wikipedia.org/wiki/Formaldehyde.

Gaussian plume model – a model for air pollution monitoring. See Masters and Ela (2014: 451-454).

Haemoglobin - a protein found in the red blood cells that carries oxygen in your body and gives blood its red colour.

Imhoff tank - is a chamber suitable for the reception and processing of sewage. It may be used for the clarification of sewage by simple settling and sedimentation, along with anaerobic digestion of the extracted sludge. https://en.wikipedia.org/wiki/Imhoff_tank.

Immiscible liquids – not forming a homogeneous mixture when mixed.

Interference of waves - is a phenomenon in which two waves superpose to form a resultant wave of greater, lower, or the same amplitude.
https://en.wikipedia.org/wiki/Wave_interference

Ionising radiation - ionizing radiation is radiation with enough energy so that during an interaction with an atom, it can remove tightly bound electrons from the orbit of an atom, causing the atom to become charged or ionized.
https://www.who.int/ionizing_radiation/about/what_is_ir/en/.

IS 3307 (1965) – an indian document on the standard of tolerance limits for various polluting characteristics of wastewater.

Kjeldahl's flask – a method for the quantitative determination of nitrogen contained in organic substances plus the nitrogen contained in the inorganic compounds ammonia and ammonium (NH_3/NH_4^+). https://en.wikipedia.org/wiki/Kjeldahl_method.

Leq - Leq (equivalent continuous sound level) is the preferred method to describe sound levels that vary over time, resulting in a single decibel value which takes into account the total sound energy over the period of time of interest. http://www.gracey.co.uk/basics/leq-b1.htm.

Lysimeter - is a measuring device which can be used to measure the amount of actual evapotranspiration which is released by plants (usually crops or trees).
https://en.wikipedia.org/wiki/Lysimeter.

Magnetite - is a rock mineral and one of the main iron ores, with the chemical formula Fe_3O_4.
https://en.wikipedia.org/wiki/Magnetite.

Malathion - is a pesticide that is widely used in agriculture, residential landscaping, public recreation areas, and in public health pest control programs such as mosquito eradication.
https://en.wikipedia.org/wiki/Malathion.

Millirads – an angular measurement, 10^{-3} of a radian

Millirems – unit of absorbed radiation dose.

Monazite - a reddish-brown phosphate mineral containing rare-earth metals.
https://en.wikipedia.org/wiki/Monazite.

Myeloproliferative neoplasms (MPN) - a group of disorders in which the bone marrow stem cells grow and reproduce abnormally. https://www.leukaemia.org.au/disease-information/myeloproliferative-disorders/.

Non-ionizing electromagnetic radiation – any electromagnetic radiation that is too weak to remove or add an electron to an atom/molecule. https://en.wikipedia.org/wiki/Non-ionizing_radiation.

Obligate anaerobes - are microorganisms killed by normal atmospheric concentrations of oxygen (20.95% O2). Oxygen tolerance varies between species, some capable of surviving in up to 8% oxygen, others losing viability unless the oxygen concentration is less than 0.5%. https://en.wikipedia.org/wiki/Obligate_anaerobe.

Organochlorine - any of a large group of pesticides and other synthetic organic compounds with chlorinated aromatic molecules. https://en.wikipedia.org/wiki/Organochloride.

Organophosphate – phosphoric acid esters that are highly toxic to mammals. Often used as insecticides today. https://dhss.delaware.gov/dhss/dph/files/organophospestfaq.pdf.

Oxidation ponds - Oxidation ponds, also called lagoons or stabilization ponds, are large, shallow ponds designed to treat wastewater through the interaction of sunlight, bacteria, and algae. https://www.britannica.com/technology/wastewater-treatment/Oxidation-pond.

Parathion - It is an organic phosphate insecticide.

Partition coefficient (K_{ow}) aka Distribution coefficient - the ratio of the concentrations of a solute in two immiscible or slightly miscible liquids, or in two solids, when it is in equilibrium across the interface between them. This ratio is therefore a comparison of the solubilities of the solute in these two liquids. https://en.wikipedia.org/wiki/Partition_coefficient.

Percolating filter aka trickling filter - A bed of broken rock or other coarse aggregate onto which sewage or industrial waste is sprayed intermittently and allowed to trickle through, leaving organic matter on the surface of the rocks, where it is oxidized and removed by biological growths. https://en.wikipedia.org/wiki/Trickling_filter.

Peroxyacetyl nitrate (PAN) - It is a secondary pollutant present in photochemical smog. It is thermally unstable and decomposes into peroxyethanoyl radicals and nitrogen dioxide gas. ... Peroxyacetyl nitrate, or PAN, is an oxidant that is more stable than ozone. https://en.wikipedia.org/wiki/Peroxyacetyl_nitrate.

Phon - a unit of the perceived loudness of sounds.

photo-bioreactors - refers to any manufactured device or system that supports a biologically active environment. A photobioreactor (PBR) is a bioreactor that utilizes a light source to cultivate phototrophic microorganisms. https://en.wikipedia.org/wiki/Bioreactor.

Photochemical smog aka Los Angeles smog - haze in the atmosphere accompanied by high levels of ozone and nitrogen oxides, caused by the action of sunlight on pollutants. https://www.britannica.com/science/photochemical-smog.

Photosystem 1 and 2 – the two main multi-subunit membrane protein complexes responsible for photosynthesis. https://biodifferences.com/difference-between-photosystem-i-and-photosystem-ii.html.

Plume rise – the rise of a 'plume' of a gas/smoke. A plume is an area in air or water or rock containing pollutants released from a single source. https://www.dictionary.com/browse/plume.

Pollutant, primary – is an air pollutant emitted directly from a source.

Pollutant, secondary – is not directly emitted as such, but forms when other pollutants (primary pollutants) react in the atmosphere. Examples of a secondary pollutant include ozone, which is formed when hydrocarbons (HC) and nitrogen oxides (NOx) combine in the presence of sunlight; NO2, which is formed as NO combines with oxygen in the air; and acid rain, which is formed when sulphur dioxide or nitrogen oxides react with water. https://www.greenfacts.org/glossary/pqrs/primary-pollutant-secondary-pollutant.htm.

Polychlorinated biphenyls – are a group of manmade chemicals. PCBs are very stable mixtures that are resistant to extreme temperature and pressure. PCBs were used widely in electrical equipment like capacitors and transformers. PCBs have been released into the environment through spills, leaks from electrical and other equipment, and improper disposal and storage. http://www.idph.state.il.us/envhealth/factsheets/polychlorinatedbiphenyls.htm.

Pulmonary – anything related to lungs.

Radioactivity – in simple terms, radioactivity is when particles emit energy or smaller particles.

Rain gauge - a device for collecting and measuring the amount of rain which falls.

Recalcitrant – a pollutant in the atmosphere which is hard to flush out.

Recarbonation - (a) the process of introducing carbon dioxide, CO_2, as a final stage in the lime-soda ash softening process in order to convert carbonates to bicarbonates and thereby stabilize the solution against precipitation of carbonates, (b) the diffusion of carbon dioxide gas through liquid to replace the carbon dioxide gas removed by the addition of lime, or (c) the diffusion of carbon dioxide through a liquid to render the liquid stable with respect to precipitation or dissolution of alkaline constituents.

Rotating biological contractor - A rotating biological contactor or RBC is a biological treatment process used in the treatment of wastewater following primary treatment. The RBC process involves allowing the wastewater to come in contact with a biological medium in order to remove pollutants in the wastewater before discharge of the treated wastewater to the environment, usually a body of water (river, lake or ocean). https://en.wikipedia.org/wiki/Rotating_biological_contactor.

Rutile - is a mineral composed primarily of titanium dioxide (TiO_2).

Secchi disc - is a plain white, circular disk 30 cm (12 in) in diameter used to measure water transparency or turbidity in bodies of water. Secchi disk

Sedimentation of aerosols – the deposition of aerosol particles on solid surfaces.

Septic tank - is an underground chamber made of concrete, fiberglass, or plastic through which domestic wastewater (sewage) flows for basic treatment. https://en.wikipedia.org/wiki/Septic_tank.

Settling chambers – a simple dust collector meant to reduce air pollution.

Sewage treatment plant cycle – basically, in the primary stage, the sewage is separated according to physical properties. Heavy matter settles down, while oil and lighter solids float on the surface. In the secondary treatment, dissolved and suspended biological matter are removed. In tertiary treatment, water is disinfected before being released into a water body like a lake or a river. https://en.wikipedia.org/wiki/Sewage_treatment#Process_steps.

Sludge digester – in wastewater treatment, sludge digestion is a biological process in which organic solids are decomposed into stable substances. Digestion reduces the total mass of solids, destroys pathogens, and makes it easier to dewater or dry the sludge.

Sludge process - is a type of wastewater treatment process for treating sewage or industrial wastewaters using aeration and a biological floc composed of bacteria and protozoa. https://en.wikipedia.org/wiki/Activated_sludge.

Soil moisture meter – measures water content in soil by indirect proxy like electrical resistance and does not require removing/drying/weighing samples. https://en.wikipedia.org/wiki/Soil_moisture_sensor.

Soil porosity meter – there is no such thing as soil porosity meter. Soil porosity is measured indirectly by, for e.g., how much water does it take to fill the little pores. https://socratic.org/questions/how-do-scientists-measure-the-porosity-of-soil.

Solubilization - Solubilization is the increase in solubility of a poorly water–soluble substance with surface-active agents. The mechanism involves entrapment (adsorbed or dissolved) of molecules in micelles and the tendency of surfactants to form colloidal aggregations at critical micelle concentration levels.

Spectrophotometer – an instrument that measures the reflection or transmission properties of a material as a function of wavelength. https://en.wikipedia.org/wiki/Spectrophotometry.

Stoke's law – a law on the frictional force exerted on solids passing through a column of fluid (liquid or gas). The *constant* velocity with which the object moves after a certain point is called it terminal velocity or settling velocity.

Substrate, in wastewater treatment – usually refers to the organic matter or nutrient in wastewater, which is converted during biological treatment.

Sulphide drainage – *see* acid mine drainage

Traffic Noise Index (TNI) - Traffic levels are monitored over a 24-hour period and TNI is derived by combining the noise levels exceeded in dBA 10 per cent and 90 per cent of the time. This considers the very noisy vehicles weighted against the general traffic noise. https://www.sfu.ca/sonic-studio-webdav/handbook/Traffic_Noise_Index.html.

Tropical cyclone - is a rapidly rotating storm system characterized by a low-pressure center, a closed low-level atmospheric circulation, strong winds, and a spiral arrangement of thunderstorms that produce heavy rain or squalls.

Venturi scrubbers – an instrument used to reduce air pollution. The input gas, consisting of particulate matters, is passed through a scrubbing solution and clean air is released. https://www.youtube.com/watch?v=m2Q4W3LCvtg.

Volatile organic compounds (VOCs) - are organic chemicals that have a high vapor pressure at ordinary room temperature. Their high vapor pressure results from a low boiling point, which causes large numbers of molecules to evaporate or sublimate from the liquid or solid form of the compound and enter the surrounding air, a trait known as volatility. https://en.wikipedia.org/wiki/Volatile_organic_compound.

2.1 Ambient air quality monitoring methods

Sulphur dioxide (SO_2)	Improved West-Gaeke, UV fluorescence
Nitrogen Oxides	Jacob and Hochheiser (Na-Arsenite), Chemiluminescence
PM2.5 and PM10	Gravimetry, TOEM, Beta attenuation
Ozone (O_3)	UV photometry, chemiluminescence
Lead (Pb)	AAS/ICP method after sampling on EPM 2000
Carbon monoxide (CO)	Non dispersive infrared spectroscopy
Ammonia (NH_3)	Chemiluminescence, Indophenols Blue Method
Benzene	Gas chromatography based continuous analyser, Adsorption and desorption followed by GC
Benzo[a]pyrene particulate phase only	Solvent extraction followed by HPLC/GC
Arsenic and Nickel	AAS/ICP method after sampling on EPM 2000 of equivalent

2.2 Major air pollutants

Carbon monoxide (CO)

- Properties
  - Colourless, odourless, tasteless
- Source
  - <1% - stationary sources
  - 80% - non-stationary sources
- Cause
  - Incomplete combustion of carbonaceous fuels
- Effects
  - Major asphyxiant. Readily binds to haemoglobin in the bloodstream to form **carboxyhaemoglobin (COHb)**.
  - Common symptoms: affects brain function and leads to an increase in the heart rate, dizziness, headache, fatigue, impaired judgement. Above 60% → unconsciousness and death.
  - COHb is quickly removed from the bloodstream once clean air is breathed.

Oxides of Nitrogen (NO_x)

- Source
  - Dominant source: Fuel NO_x, which results from the oxidation of nitrogen compounds that are chemically bound in the fuel molecules themselves
  - Other source is Thermal NO_x, which is created when nitrogen and oxygen in the combustion air are heated to a high enough temperature to oxidise the nitrogen
- Effects
  - NO_x can react with volatile organic compounds in the presence of sunlight to form photochemical oxidants that have adverse health consequences as well.

- **Oxides of nitrogen: nitric Oxide (NO)**
  - Properties
    - Colourless
  - Source
    - Constitutes a majority of anthropogenic NO_x emissions. NO_x is produced mainly by transportation sector.
  - Effects
    - No known adverse health effects. However, NO readily oxidises to NO_2, which in turn has severe consequences for human health and environment (see below).

- **Oxides of Nitrogen: nitrogen dioxide (NO_2)**
  - Effects
    - Can irritate lungs, cause bronchitis and pneumonia, lower resistance to respiratory infections.
    - Reacts with OH- radical in the atmosphere to form nitric acid (HNO3) that corrodes metal surfaces, damages terrestrial plants.
    - Is a significant cause of eutrophication.

        - Responsible for the reddish-brown colour in smog in cities like Los Angeles.

Volatile Organic Compounds (VOCs) aka Total Non Methane Organic Compounds (TNMOC)

- Sources
    - Anthropogenic sources: transportation sector, <2% from power plants and industrial boilers
    - Natural sources: wildfires, reactive hydrocarbons such as oaks, spruce, eucalyptus, and citrus trees that emit isoprene; and maple, hickory, pine, spruce, and fir trees that emit monoterpenes
- Cause
    - These enter the atmosphere when solvents, fuels and other organics evaporate, along with unburned and partially burned hydrocarbons that are emitted from tailpipes and smoke stacks when fossil fuels are not.
- Effect
    - Greatest risk comes from these compounds inside our buildings

Photochemical smog

- Source
    - Automobiles
- Composed of
    - Complex chemistry involving NO, O_3, Peroxyacetyl Nitrate (PAN)
- Effects
    - annoying respiratory effects, such as coughing, shortness of breath, airway constriction, headache, chest tightness, and eye, nose, and throat irritation can lead to permanent scarring of lung tissue.
    - cause damage to tree foliage and to reduce growth rates of certain sensitive tree species

Oxides of sulphur

- Source
    - ~95% from fossil fuel combustion in stationary sources e.g. coal fired power plants. (Coal contains 1-6% sulphur).
    - ~5% from highway vehicles
    - Others:
        - petroleum refining
        - copper smelting
        - cement manufacture
- Cause:
    - Fuel combustion, that results in SO2, SO3 and SO4
- Effects
    - SO2 can convert to SO3; SO3 reacts very quickly with water to form sulphuric acid.
    - Sulfuric acid molecules rapidly become particles by either condensing on existing particles in the air or by merging with water vapor to form H2O-H2SO4 droplets. This leads to acid rain (pH < 5.6)
    - Acid Deposition

        - Since SO2 to SO4 (sulphate) conversion is gradual, SO2/SO4 can be deposited back onto land/water through precipitation. This is called **wet deposition**.
        - It can be deposited sans precipitation via a slow process called **dry deposition** as well.
    - Damages trees, when they are bathed in acid fog
    - Soils leach out nutrients more readily in acidic conditions. Allows aluminium to solubilise, which interferes with uptake of nutrients.
    - Sulphurous pollutants can discolour paint, corrode metals and cause organic fibres to weaken.
    - Sulphates weaken marble, limestone, mortar by replacing carbonates (CaCO3) with sulphates (CaSO4 aka gypsum). CaSO4 produced by this reaction is water soluble and easily washes away, leaving a pitted, eroded surface
    - SO2 is more water soluble than many other criteria pollutants and can be absorbed in the upper respiratory system. As an aerosol, sulphur can reach far deeper into the lung. Does long term damage.
    - Particulate matter + sulphur can be deadlier than either of them separate
    - Affects visibility

Lead

- Source
    - Emissions from leaded gasoline i.e. gasoline that contains the antiknock additive tetraethyllead (Pb(C2H5)4)
        - Leaded gasoline fuels have been largely phased out
- Effects
    - Lead is emitted into the atmosphere primarily in the form of inorganic particulates and often settles in the vicinity. Therefore, despite leaded fuels being phased out, the soil in these areas is still contaminated.
    - Lead contamination in soil and water finds its way in leafy fruits and vegetables.
    - Lead contaminated water can be ingested.
    - Lead contaminated soil becomes airborne when disturbed.
    - Airborne lead can get lodged in home carpeting.
    - Lead can be inhaled
        - Indoors – from lead-based paints used in the past. Are sweet in taste and often eaten by children.
        - In areas near highways and metal processing plants.
    - Lead poisoning can cause
        - Destructive behaviour
        - Learning disabilities
        - Permanent brain damage
        - Seizures
        - Death
    - However, lead has been successfully phased out of gasoline, and is considered a significant environmental achievement.

Particulate matter

- Characteristics
    - any dispersed matter, solid or liquid, in which the individual aggregates range from molecular clusters of 0.005-100 µm.
    - PM2.5 = Particles <2.5 µm; PM10 = particles greater than 2.5 µm and smaller than 10 µm.
    - Sizes determined by their aerodynamic diameter, which is ascertained by comparing the particulate matter in question with a perfect sphere having the same settling velocity
- Sources
    - Tobacco smoke
    - Motor vehicle exhaust
    - Char on charcoal broiled food
    - Smoke from wood and coal combustion
- Cause
    - carbonaceous soot particle emissions from incomplete combustion
    - Transformation of SO_2 emissions into liquid droplets of sulphates (e.g. sulphuric acid)
    - Transformation of NOx emissions into liquid droplets of nitrates (e.g. nitric acid).
- Composed of
    - Black soot emitted from diesel engines and smokestacks. This black soot is formed when:
        - Carbon containing materials are not completely oxidised
        - This results in vast numbers of carbon atoms fused together in benzene rings called Polynuclear Aromatic Hydrocarbons or Polycyclic Aromatic Hydrocarbons (PAH).
        - PAH is released as gas but quickly condenses into particles of soot.
        - Major examples are naphthalene and benzo[a]pyrene (BaP)
- Effects
    - BaP causes lung and kidney cancer
    - Our respiratory system can effectively stop particles larger than 10 µm in the nose itself.
    - Smaller particles can settle in lungs.
    - Respiratory symptoms like upper respiratory
    - infections, cardiac disorders, bronchitis, asthma, pneumonia, and emphysema, and increased mortality rates have been observed

2.3 Major air pollution remediation technologies for stationary sources

1. Common approaches to reduce emissions

    1.1. Precombustion
        1.1.1. Increase conversion efficiency from fuel to energy
        1.1.2. Reduce emission potential of the fuel itself by switching to fuels with less N or S or by treating fuels physically/chemically.

    1.2. Combustion
        1.2.1. reduce emissions by improving the combustion process itself. Examples:
            1.2.1.1. New burners that reduce NOx
            1.2.1.2. Fluidized bed boilers that reduce NOx and SOx

    1.3. Post-combustion
        1.3.1. Increase efficiency of energy consumption (post production)
        1.3.2. capture emissions after they have been formed but before they are released to the air.

2. Coal-Fired Power Plants (P427)
    2.1. Responsible for emitting
        2.1.1. great quantities of sulphur oxides
        2.1.2. great quantities of nitrogen oxides
        2.1.3. twice as much CO_2 as natural gas fired power plants

3. Precombustion Controls (P428-9)

    3.1. Fuel switching – substituting high sulphur coal with low sulphur coal
    3.2. Coal cleaning
        3.2.1. If sulphur is bound into organic coal molecules → chemical or biological treatment
        3.2.2. If sulphur is present as inorganic pyrite (FeS_2) → simple physical separation aka 'washing' This physical treatment not only reduces sulphur treatment but also reduces the ash content, increases the energy per unit weight of fuel (which reduces coal transportation and pulverization costs), and creates more uniform coal characteristics that can increase boiler efficiency

4. Combustion Controls

    4.1. Fluidized-Bed Combustion (FBC) (P429)
        4.1.1. In an FBC boiler, crushed coal mixed with limestone is held in suspension (fluidized) by fast-rising air injected from the bottom of the bed. Sulphur oxides formed during combustion react with the limestone (CaCO3) to form solid calcium sulphate (CaSO4), which falls to the bottom of the furnace and is removed.
        4.1.2. Sulphur removal rates can be higher than 90 percent
        4.1.3. Higher heat transfer efficiency, allowing boilers to work at lower temperatures ~800 C, which is lower than 1400 C at which NOx is formed. This allows FBCs to use coal with high ash content since its temperature is below the melting point of ash.

4.1.4. Can also burn solid fuel, municipal solid waste (MSW), cow manure, tree bark etc.

4.2. Integrated Gasification Combined Cycle (P429-30)

4.2.1. Offers increased combustion efficiency, up to 45%
4.2.2. Coal water slurry comes in contact with steam → forms a fuel gas called syngas, consisting of CO and H2 (C + H2O → CO + H2)
4.2.3. Syngas is cleaned up, removing particulates, mercury and sulphur.
4.2.4. Carbon can be extracted at this stage, before combustion. Offers potential to sequester carbon.
4.2.5. Burned in high efficiency gas turbine. N2 is provided to cool the gas turbine, O2 to increase syngas combustion efficiency.
4.2.6. Waste heat generates more electricity
4.2.7. There are losses in the gasification process, but they are offset by a combination of gas + turbine (I don't know what this actually means)
4.2.8. However, IGCC is more expensive.

4.3. Combustion controls for NO_x Emissions (P431)

4.3.1. Low Excess Air – air is kept at the minimum amount required for complete combustion. Cheap technology. 15-20% lower NOx emissions.
4.3.2. Low NOx Burner
4.3.2.1. Stage 1: Fuel burns in an air-starved environment, causing the fuel-bound nitrogen to be released as nitrogen gas, N_2, rather than NOx.
4.3.2.2. Stage 2: introduction of more air to allow complete combustion
4.3.3. Limestone Injection Multistage Burner (LIMB)
4.3.3.1. Similar to Low NOx Burner. Added limestone injection for sulphur control.

5. Post combustion controls

5.1. Selective Catalytic Reduction (SCR) – ammonia (NH_3) is injected into boiler flue gas, and the mix is passed through a catalyst bed in which the NOx and NH_3 react to form nitrogen and water vapor. 90% NOx removal efficiency.

5.2. Flue Gas Desulphurization (Scrubbers) (P431-2)
5.2.1. Flue gas is the gas exiting to the atmosphere via a flue, which is a pipe or channel for conveying exhaust gases
5.2.2. Wet scrubbers
5.2.2.1. Finely pulverized limestone ($CaCO_3$) is mixed with water to create a slurry.
5.2.2.2. Slurry is sprayed on flue gas.
5.2.2.3. The flue gas SO_2 is absorbed by the slurry.
5.2.2.4. This forms calcium sulphite ($CaSO_3$) and sulphate ($CaSO_4$) precipitate/sludge, which is then removed from the scrubber.
5.2.2.5. Up to 90% sulphur can be removed by this method.

5.2.2.6. Sometimes scrubbers use lime (CaO) instead of limestone, but this is an expensive method although more efficient (up to 95% sulphur removed).

5.2.3. Dry scrubbers

5.2.3.1. Uses lime – which is more expensive and hence rarely used.

5.2.4. Throwaway scrubbers (where sulphur from the flue gas is discarded)

5.2.5. Regenerative scrubbers (where sulphur from the flue gas is recovered in a usable form)

6. Particulate Control (P432-7)

6.1. Cyclone Collectors

6.1.1. Gas enters at the top; spins; centrifugal forces cause dust to settle down; clean air exits from top

6.1.2. V efficient for large particles, not particles smaller than 5 µm

6.1.3. Inexpensive and low maintenance

6.2. Electrostatic Precipitators

6.2.1. For really small particles

6.2.2. Two electric plates, where wires are charged up to -100 kV

6.2.3. This creates a strong electric field

6.2.4. This, in turn, creates corona discharge

6.2.5. Ionises gas molecules in air stream

6.2.6. The free electrons move towards grounded plates

6.2.7. They attach themselves to particulate matter

6.2.8. The now-charged particles move towards the grounded collecting surface

6.2.9. These charged particles are then removed

6.3. Baghouses or fabric filtration

6.3.1. V high efficiency for particles as small as 1-0.01 µm

6.3.2. Dust bearing gases are passed through fabric filter bags which are suspended upside-down in a large chamber, called a baghouse. A baghouse contains thousands of bags.

6.3.3. Large, expensive, cannot operate in moist environments, easily harmed by corrosive chemicals in flue gas.

6.3.4. Risk of fire if dust is combustible.

7. Combined Heat and Power (CHP) Systems

7.1. These are smaller, cleaner alternatives to large power plants. Examples are:

7.1.1. Fuel cells

7.1.1.1. Strips hydrogen from natural gas

7.1.1.2. This is transmitted to the fuel cell stack

7.1.1.3. The power conditioner converts DC to AC

7.1.1.4. can power a small laptop. Efficiency of up to 85%.

7.1.1.5. Examples are solid oxide fuel cell (SOFC) and molten carbonate fuel cells (MCFC)

7.1.2. Stirling Engines

7.1.3. Reciprocating Engines

2.4 Major water pollutants

1. Pathogens

Table 6 Different categories of diseases caused by water contaminated by pathogens

Category	Cause	Example
Waterborne diseases	Ingestion of contaminated water	Cholera, typhoid
Water washed diseases	Lack of sufficient water to maintain cleanliness	Trachoma, scabia
Water based diseases	Involve water contact, but not ingestion	Schistosomiasis (caused by free swimming larvae *cercaria*), dracunculiasis
Water related diseases	Involve a host that depends on water for its habitat e.g. mosquitos	Malaria, dengue

2. Nutrients
   - 2.1. **nitrogen, phosphorus, carbon**, sulfur, calcium, potassium, iron, manganese, boron, and cobalt, that are essential to the growth of living things.
   - 2.2. Nutrients that is least available relative to plant's growth is called limiting nutrient. Carbon is usually abundantly available from the atmosphere, soil etc., but nitrogen and phosphorus are usually less abundant.
   - 2.3. Nutrient enrichment aka eutrophication leads to algal blooms on the surface, which prevent penetration of sunlight, which prevents photosynthesis of plants below the surface, creating hypoxic conditions. → the algae dies off, sinks the bottom, decomposes and further lowers the already low dissolved oxygen at the bottom.
   - 2.4. Decaying organic matter also adds to colour, turbidity, foul odour.
   - 2.5. Seawater is more limited by nitrogen, fresh water is more limited by phosphorus.
   - 2.6. Effects of nitrogen in water
     - 2.6.1. Major source: municipal wastewater discharges, runoff from animal feedlots, chemical fertilizers, and nitrogen-deposition from the atmosphere, especially in the vicinity of coal-fired power plants
     - 2.6.2. Nitrate (NO3) in water is not toxic in itself, but can be **converted to nitrite (NO2)** by bacteria. found in the alkaline digestive tract of infants but not later in adults as the digestive system becomes more acidic. Hemoglobin in the bloodstream is oxidized by nitrite to **methemoglobin**, which cannot carry oxygen. The oxygen starvation characteristic of **methemoglobinemia** causes a bluish discoloration of the infant; hence, it is commonly referred to as the **blue baby syndrome**.
     - 2.6.3. Eutrophication problems.
   - 2.7. Effects of phosphorus in water
     - 2.7.1. Phosphorus addition to water comes largely from detergents' surfactant. Since most freshwater lakes are P limited, addition of phosphorus led to algal blooms since P is the controlling nutrient.

2.7.2. Even with the phasing out of phosphorus in detergents, phosphorus is still used in fertilisers. Agricultural run off (a non-point source) still adds considerable amounts of P to water, resulting in eutrophication.

2.8. Point sources - This type of pollution originates at a specific and identifiable location, such as a drainage pipe

2.9. Non point sources - This type of pollution comes from a large area of polluted surface runoff with no specific origination point. The most common source of nonpoint source pollution is runoff from agricultural fields and urban areas. Difficult to manage and is the largest contributor to surface water pollution in the world.

3. Salts

3.1. Salts are, chemically speaking, dissolved solids in water. Water accumulates these solids as it passes through rocks etc.

3.2. Salinity is measured as total dissolved solids (TDS)

3.2.1. Fresh water – TDS <1500 mg/L or 1.5 g/L

3.2.2. Brackish water – TDS 1500-5000 mg/L or 1.5-5 g/L

3.2.3. Saline water – TDS >5000 mg/L or 5 g/L

3.3. Usual TDS values,

3.3.1. Seawater – 30-34 g/L

3.3.2. Drinking water – 0.5 g/L or 500 mg/L. Most people feel salinity in drinking water at TDS greater than 1 g/L, although livestock/poultry etc. can handle higher concentrations.

3.3.3. Irrigation – TDS usually < 2100 mg/L. Above this TDS, only very salt tolerant crops can survive

3.4. Salinity and agriculture

3.4.1. Salinity big threat in arid areas – soil becomes salty easily due to evaporation of water

3.4.2. Water can accumulate salts as it passes through/over soils. Each reuse increases salt concentration so irrigation water is always saltier than normal supply water.

3.4.3. This is a major problem in most countries, incl India.

3.4.4. Salt accumulation in soils is often controlled by flushing the salts away with additional amounts of irrigation water. This increases costs; wastes water, which may not be abundantly available in the first place.

3.4.5. Since irrigation return water contains not only salts but fertilizers and pesticides as well, finding an acceptable method of disposal is difficult

4. Thermal Pollution

4.1. Thermal pollution occurs when humans use water for industrial processes that heat it up and then return it to its source.

4.2. Increase in heat can be detrimental to some organisms like trout and salmon, but can be beneficial to others

4.3. Dissolved oxygen (DO) decreases because

4.3.1. High temperature → high metabolic rates of fish etc. → uses up more DO

4.3.2. Increase in metabolism → increase in waste → increase in decomposition activity → reduction in DO

4.3.3. Amount of DO water can hold decreases with temperature

5. Heavy metals
   5.1. Metals are, chemically speaking, elements that that will give up one or more electrons to form a cation in an aqueous solution (although metalloids like selenium, arsenic, phosphorus, silicon, boron exhibit both cationic and anionic properties)
   5.2. Almost complete non biodegradable, indestructible
   5.3. Toxic metals: aluminum, arsenic, beryllium, bismuth, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, strontium, thallium, tin, titanium, and zinc
   5.4. In terms of their environmental impacts, the most important heavy metals are mercury (Hg), lead (Pb), cadmium (Cd), and arsenic (As)
   5.5. Cadmium, lead, and mercury are examples of nephrotoxic (i.e. those that are toxic to kidneys) metals
   5.6. Metals can be inhaled or ingested
   5.7. Mercury
      5.7.1. Not v toxic in liquid form
      5.7.2. Highly toxic as vapour and damages central nervous system
   5.8. Lead
      5.8.1. Not much risk as vapour as it has low vapour pressure
      5.8.2. When dissolved into its ionic form (Pb^{2+}) in blood and can be passed from mother to foetus.

6. Pesticides
   6.1. Four categories: Pesticides can be delineated as insecticides, herbicides, rodenticides, and fungicides.
   6.2. Main synthetic organic insecticides are:
      6.2.1. Organochlorides aka chlorinated hydrocarbons
         6.2.1.1. Organochlorine insecticides are harmful to insects, but not very toxic to humans
         6.2.1.2. But they are persistent and last very long in envt, soluble in hydrocarbon solvents and bioaccumulate in fatty tissues, and they biomagnify. DDT (discussed below) was, therefore, harmful to birds atop the food chain.
         6.2.1.3. Best example dichlorodiphenyltrichloroethane (DDT), used to control insects that carry diseases like malaria (mosquito), typhus (lice), plague (flea)
         6.2.1.4. DDT metabolises to DDE (dichlorodiphenyldichloroethane) inside the bird's body. It interferes with calcium production in the body, as a result of which their eggs' shells are too thin to support the weight of the parent. This has affected a lot of bird species. Therefore it was banned.
         6.2.1.5. Other organochlorides are:

Dieldrin	Liver cancer, birth defects in mice + hamsters
Aldrin	Birth defects in mice + hamster
heptachlor	Liver cancer
chlordane	Liver cancer
Kepone	Neurological damage
Endosulphan	Tremors, seizures, death

6.2.1.6. Because of their harmful long term effects (e.g. cancer) and resistance most insects had developed to it, most organochlorides have been replaces by organophosphates and carbamates

6.2.1.7. Also used as herbicides

6.2.1.7.1. Chlorophenoxy compounds 2,4,5-T and 2,4,5-D aka 'Agent Orange' kill broad leaf plants without harming grasses. They were used in Vietnam War

6.2.1.7.2. It has been banned because it produces a toxic side product called dioxin which has high environmental persistence

6.2.1.7.3. Other herbicides

Paraquat	Used on: Marijuana
Metachlor	Used on: Soybeans and corn

6.2.2. Organophosphates

6.2.2.1. Not as persistent as organochlorides in envt

6.2.2.2. More toxic to humans than organochlorides and are rapidly absorbed through the skin, lungs and GI tract and adequate precautions must be taken

6.2.2.3. Symptoms include symptoms, including tremor, confusion, slurred speech, muscle twitching, and convulsions.

6.2.3. Carbamates

6.2.3.1. Is derived from carbamic acid (H_2NCOOH).

6.2.3.2. Low persistence in envt and therefore less bioaccumulation

6.2.3.3. High human toxicity. Symptoms include nausea, vomiting, blurred vision, and, in extreme cases, convulsions and death.

6.2.3.4. Examples: propoxur, carbaryl, and aldicarb

7. VOCs

7.1. Most commonly found groundwater contaminants. Surface concentrations are v low, but groundwater concentrations thousand times as much.

7.2. Solvents used widely in industries and suspected carcinogens and mutagens

7.3. Common VOCs are:

vinyl chloride (chloroethylene)	Human carcinogen	Used in the production of polyvinylchloride resins
Trichloroethylene (TCE)	Suspected carcinogen, most commonly found in groundwater	used to clean everything from electronics parts to jet engines and septic tanks
Tetrachloroethylene	Tumours in animals, suspected human carcinogen	solvent, as a heat transfer medium; manufacture of CFCs
Dichloroethane	Suspected carcinogen, causes injury to central nevous system, liver, kidney. Highly water soluble. Difficult to remove by 'air stripping' (see 7.4).	metal degreaser; used to make vinyl chloride, tetraethyllead, fumigants, varnish removers, and soap compounds

carbon tetrachloride	V toxic if ingested, can produce death, relatively insoluble in water and, therefore, only occasionally found in contaminated groundwater	common household cleaning agent, common household cleaning agent

7.4. Since they are 'volatile,' a common method of treatment is to heat water so that they evaporate into the atmosphere. But this does not destroy VOCs but only transfers it from water to air. Thus, VOC concentration in atmosphere is a cause for concern.

8. Emerging contaminants
   8.1. Substances are assessed on the basis of environmental persistence; relative toxicity or deleterious impact (both to humans and other biota); occurrence frequency and concentration; and immediacy of impact. Some examples are:
   8.2. endocrine disrupting chemicals (EDCs)
      8.2.1. interfere with hormones i.e. endocrine system
      8.2.2. results impaired reproductive system, offspring survival, development in frogs, salmon, oysters, newts, trout, and turtles. 84 percent of the female Chinook salmon in one Columbia River study were found to have undergone sex reversal early in development and were, in fact, chromosomally males
      8.2.3. 17β-estradiol (the natural female sex hormone) and ethinylestradiol (the analogue of 17β-estradiol that is in birth control pills) are prominent EDCs that affect reproduction and development in fish
      8.2.4. Probably human effects as well
   8.3. Polybrominated biphenyl ethers (PBDEs) and perflourocarboxylates (PFCAs)
      8.3.1. They bioaccumulate and possibly exhibit toxicity or endocrine disruption in wildlife and humans
   8.4. Pathogens
      8.4.1. Adenovirus
      8.4.2. Bacterial pathogens in amoeba, which inhabit cooling towers and spread through aerosols
   8.5. Nanoparticles used in paints, surface coatings, food additives, polishing compounds, industrial catalysts, and personal care products

3 Energy and Environment

Acid value - Acid value (or neutralization number or acid number or acidity) is the mass of potassium hydroxide (KOH) in milligrams that is required to neutralize one gram of chemical substance. https://en.wikipedia.org/wiki/Acid_value.

Band gap - The band gap of a semiconductor is the minimum energy required to excite an electron that is stuck in its bound state into a free state where it can participate in conduction. The smaller the band gap, the better the material is a conductor of electricity. https://energyeducation.ca/encyclopedia/Band_gap#cite_note-RE2-1.

Biogas – is the mixture of gases produced by the breakdown of organic matter in the absence of oxygen (anaerobically). Biogas consists of CH_4 (50-75%), CO_2 (25-50%), N_2 (0-10%), H_2 (0-1%), H_2S (0.1-0.5%), O_2 (0-0.5%). H_2O is also present in trace quantities. https://en.wikipedia.org/wiki/Biogas.

Breeder reactor - is a nuclear reactor that generates more fissile material than it consumes. https://en.wikipedia.org/wiki/Breeder_reactor.

Cetane number - a quantity indicating the ignition properties of diesel fuel relative to cetane as a standard. https://en.wikipedia.org/wiki/Cetane_number.

Coal grade, anthracite – often referred to as hard coal, is a hard, compact variety of coal. It has the highest carbon content, the fewest impurities, and the highest energy density of all types of coal and is the highest ranking of coals. https://en.wikipedia.org/wiki/Anthracite.

Coal grade, bituminous – has maximum sulphur content. Relatively soft coal containing a tarlike substance called bitumen or asphalt. It is of higher quality than lignite coal but of poorer quality than anthracite. https://en.wikipedia.org/wiki/Bituminous_coal.

Coal grade, lignite - often referred to as brown coal, is a soft, brown, combustible, sedimentary rock formed from naturally compressed peat. Poorest quality coal, second only to peat. Has maximum ash and water content https://en.wikipedia.org/wiki/Lignite.

Cracking – a process of breaking bigger hydrocarbons into smaller hydrocarbons.

Diesel oil – in general is any liquid fuel used in diesel engines, whose fuel ignition takes place, without any spark, as a result of compression of the inlet air mixture and then injection of fuel. https://en.wikipedia.org/wiki/Diesel_fuel.

Digestion, anaerobic - is a sequence of processes by which microorganisms break down biodegradable material in the absence of oxygen. https://en.wikipedia.org/wiki/Anaerobic_digestion.

Engine knocking – in layman terms, engine knock occurs when the air/fuel mixture inside a cylinder is incorrect, which makes the fuel burn unevenly. https://en.wikipedia.org/wiki/Engine_knocking.

Fermentation - the chemical breakdown of a substance by bacteria, yeasts, or other microorganisms, typically involving effervescence and the giving off of heat. https://en.wikipedia.org/wiki/Fermentation.

Flash steam cycle – water from deep inside the earth and convert it to steam to drive generator turbines. When the steam cools, it condenses to water and is injected back into the ground to be used again. Most geothermal power plants are flash steam plants. https://www.eia.gov/energyexplained/geothermal/geothermal-power-plants.php.

Fuel cell - A fuel cell is an electrochemical cell that converts the chemical energy of a fuel (often hydrogen) and an oxidizing agent (often oxygen) into electricity through a pair of redox reactions. Proton exchange membrane cell has the lowest operating temperature. A fuel cell is characterised by the type of electrolyte it uses. https://en.wikipedia.org/wiki/Fuel_cell.

Fuel cell, molten carbonate (MCFC) – are high-temperature fuel cells that operate at temperatures of 600 °C and above. MCFCs are high-temperature fuel cells that use an electrolyte composed of a molten carbonate salt mixture suspended in a porous, chemically inert ceramic matrix of beta-alumina solid electrolyte (BASE). advantages: very high efficiency (60%). https://en.wikipedia.org/wiki/Molten_carbonate_fuel_cell.

Fuel cell, phosphoric acid (PAFC) - are a type of fuel cell that uses liquid phosphoric acid as an electrolyte. Advantage: very high efficiency. Disadvantages: low power density and aggressive electrolyte. https://en.wikipedia.org/wiki/Phosphoric_acid_fuel_cell.

Fuel cell, proton exchange membrane (PEMFC) - A proton exchange membrane fuel cell transforms the chemical energy liberated during the electrochemical reaction of hydrogen and oxygen to electrical energy, as opposed to the direct combustion of hydrogen and oxygen gases to produce thermal energy. Advantages: low operating temperature. https://en.wikipedia.org/wiki/Proton-exchange_membrane_fuel_cell.

Fuel cell, solid oxide (SOFC) - is an electrochemical conversion device that produces electricity directly from oxidizing a fuel. Fuel cells are characterized by their electrolyte material; the SOFC has a solid oxide or ceramic electrolyte. Advantages: high heat and power efficiency, long term stability, fuel flexibility, low emissions. Disadvantages: high operating temperature. https://en.wikipedia.org/wiki/Solid_oxide_fuel_cell.

Gasification - is a process that converts organic- or fossil fuel-based carbonaceous materials into carbon monoxide, hydrogen and carbon dioxide. This is achieved by reacting the material at high temperatures (>700 °C), without combustion, with a controlled amount of oxygen and/or steam. https://en.wikipedia.org/wiki/Gasification.

Geothermal - Geothermal energy is the heat that comes from the sub-surface of the earth.

Halocline – a salinity gradient in a water body.

Heating value or energy value or calorific value – of a substance, usually a fuel or food (see food energy), is the amount of heat released during the combustion of a specified amount of it. https://en.wikipedia.org/wiki/Heat_of_combustion.

Hot Dry Rock (HDR) cycle – is an abundant source of geothermal energy available for use. A vast store of thermal energy is contained within hot – but essentially dry – impervious

crystalline basement rocks found almost everywhere deep beneath the Earth's surface. https://en.wikipedia.org/wiki/Hot_dry_rock_geothermal_energy.

Hydroelectricity is electricity made by generators that are pushed by the movement of water.

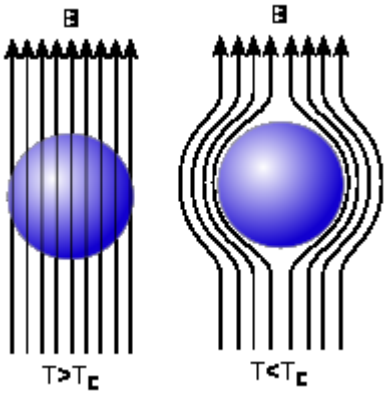
integrated gasification combined cycle (IGCC) – is a technology that uses a high pressure gasifier to turn coal and other carbon based fuels into pressurized gas—synthesis gas (syngas). It can then remove impurities from the syngas prior to the power generation cycle. It is effective at removing particulates and sulphur. https://en.wikipedia.org/wiki/Integrated_gasification_combined_cycle.

Iodine value - iodine value (or iodine adsorption value or iodine number or iodine index) in chemistry is the mass of iodine in grams that is consumed by 100 grams of a chemical substance. https://en.wikipedia.org/wiki/Iodine_value.

Keeling curve - is a graph of the accumulation of carbon dioxide in the Earth's atmosphere based on continuous measurements taken from 1958 to the present day. https://en.wikipedia.org/wiki/Keeling_Curve.

Magnetohydrodynamic (MHD) generator – converts thermal and kinetic energy directly into electricity.

Meissner effect - is the expulsion of a magnetic field from a superconductor during its transition to the superconducting state when it is cooled below the critical temperature.



https://en.wikipedia.org/wiki/Meissner_effect

Methanol – or woody fuel. Produced from the acidification and distillation of woody crops.

Ocean thermal energy conversion (OTEC) - is a process that can produce electricity by using the temperature difference between deep cold ocean water and warm tropical surface waters. The minimum temperature gradient in OTEC is 20 °C/km. https://en.wikipedia.org/wiki/Ocean_thermal_energy_conversion.

Octane number or octane rating – a measure for the ignition quality of gasoline. https://en.wikipedia.org/wiki/Octane_rating.

Phile, extremo - Organisms that prefer extreme environments (too hot or too cold) are known as extremophiles.

Phile, meso - is an organism that grows best in moderate temperature, neither too hot nor too cold, with an optimum growth range from 20 to 45 °C. A term mostly used for microorganisms. https://en.wikipedia.org/wiki/Mesophile.

Producer gas or suction gas – is a fuel gas that is manufactured from material such as coal, as opposed to natural gas. Our of all fuels, it has the minimum nitrogen content. https://en.wikipedia.org/wiki/Producer_gas.

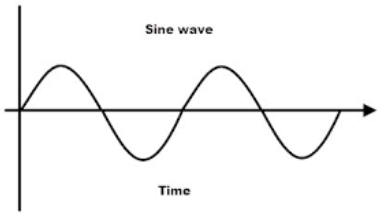
Production well cycle –

Pyrolysis - decomposition brought about by high temperatures. https://en.wikipedia.org/wiki/Pyrolysis.

Radiative forcing - is the difference between insolation (sunlight) absorbed by the Earth and energy radiated back to space. Positive radiative forcing means Earth receives more incoming energy from sunlight than it radiates to space. This net gain of energy will cause warming. Conversely, negative radiative forcing means that Earth loses more energy to space than it receives from the sun, which produces cooling. https://en.wikipedia.org/wiki/Radiative_forcing.

Rankine cycle – is a model used to predict the performance of steam turbine systems. The Rankine cycle is an idealized thermodynamic cycle of a heat engine that converts heat into mechanical work while undergoing phase change. https://en.wikipedia.org/wiki/Rankine_cycle.

Redox potential - Redox potential is a measure of the ease with which a molecule will accept electrons, which means that the more positive the redox potential, the more readily a molecule is reduced. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/redox-potential.



Sinusoidal flow regime –

Solar cell, Amorphous silicon (a-Si) – it is deposited in thin films onto a variety of flexible substrates, such as glass, metal and plastic. Advantages: one of the most environmentally friendly photovoltaic technologies, since they do not use any toxic heavy metals such as cadmium or lead. Disadvantages: low efficiency. https://en.wikipedia.org/wiki/Amorphous_silicon.

Solar cell, Cadmium telluride (CdTe) – uses cadmium telluride in a thin semiconductor layer designed to absorb and convert sunlight into electricity. Advantages: smallest carbon footprint, lowest water use and shortest energy payback time of any current photo voltaic technology. Disadvantages: toxicity of cadmium is an environmental concern. https://en.wikipedia.org/wiki/Cadmium_telluride_photovoltaics.

Solar cell, gallium arsenide (GaAs) – is a multijunction cell made of Gallium Arsenide. They have a higher band gap. Advantage: has maximum efficiency. https://en.wikipedia.org/wiki/Multi-junction_solar_cell#Materials.

Solar cell, silicon polycrystalline (polySi or multiSi) - is a high purity, polycrystalline form of silicon, used as a raw material by the solar photovoltaic and electronics industry. https://en.wikipedia.org/wiki/Polycrystalline_silicon.

Solar cells – see Manahan (2017: 526-528) and https://en.wikipedia.org/wiki/List_of_types_of_solar_cells.

Solar flat plate collector – a technology for solar-powered domestic hot water systems. The Sun heats a dark flat surface, which collect as much energy as possible, and then the energy is transferred to water, air, or other fluid for further use. https://www.e-education.psu.edu/eme811/node/685.

Solar pond - is a pool of saltwater which collects and stores solar thermal energy. The saltwater naturally forms a vertical salinity gradient also known as a "halocline", in which low-salinity water floats on top of high-salinity water. The salt salinity varies from <5-20%. https://en.wikipedia.org/wiki/Solar_pond.

Solar pond, convective zones - The top zone is the surface zone, or UCZ (Upper Convective Zone), which is at atmospheric temperature and has little salt content. The bottom zone is very hot, 70– 85 °C, and is very salty. It is this zone that collects and stores solar energy in the form of heat, and is, therefore, known as the storage zone or LCZ (Lower Convective Zone). Separating these two zones is the important gradient zone or NCZ (Non-Convective Zone). Here the salt content increases as depth increases, thereby creating a salinity or density gradient. http://edugreen.teri.res.in/explore/renew/pond.htm.

Syngas or synthesis gas - a fuel gas mixture consisting primarily of hydrogen, carbon monoxide, and very often some carbon dioxide. The name comes from its use as intermediates in creating synthetic natural gas (SNG) and for producing ammonia or methanol. https://en.wikipedia.org/wiki/Syngas.

Thermoelectric – electricity generated from heat. The thermoelectric effect is the direct conversion of temperature differences to electric voltage and vice versa. https://en.wikipedia.org/wiki/Thermoelectric_effect.

Transesterification - In organic chemistry, transesterification is the process of exchanging the organic group R″ of an ester with the organic group R′ of an alcohol. It is one of the processes whereby biodiesels are manufactured. https://en.wikipedia.org/wiki/Transesterification.

4 Geosciences

Ablation - is removal or destruction of material from an object by vaporization, chipping, or other erosive processes.

Andesite - is an extrusive rock intermediate in composition between rhyolite and basalt. https://flexiblelearning.auckland.ac.nz/rocks_minerals/rocks/andesite.html.

Anhydrous – any substance that contains no water. https://en.wikipedia.org/wiki/Anhydrous.

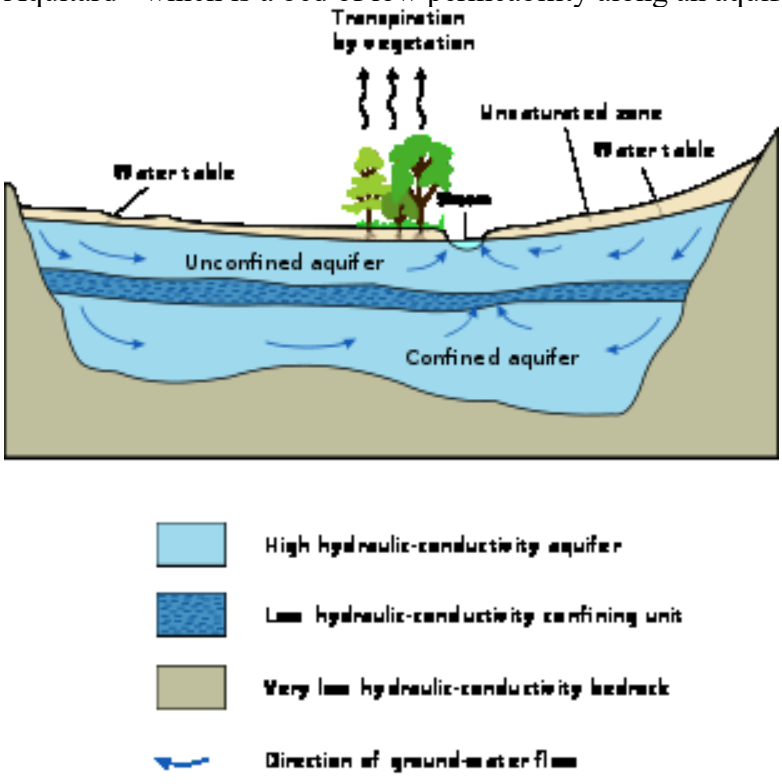
Anticline - is a type of fold that is an arch-like shape and has its oldest beds at its core. https://en.wikipedia.org/wiki/Anticline.

Aquiclude - is a solid, impermeable area underlying or overlying an aquifer.

Aquifer - is an underground layer of water-bearing permeable rock, rock fractures or unconsolidated materials (gravel, sand, or silt). Groundwater can be extracted using a water well.

Aquifer, unconfined – aquifers that extend continuously from land surface through material of high permeability. (Singh 2019: 637)

Aquitard - which is a bed of low permeability along an aquifer.



Atmophile elements – elements who atoms are able to form gases and liquids. H, C, N, He, Ne, Ar, Kr, Xe, and Rn.

Authigenic - Authigenesis is the process whereby a mineral or sedimentary rock deposit is generated where it is found or observed. Such deposits are described as authigenic.

Authigenic sedimentary minerals form during sedimentation by precipitation or recrystallization instead of being transported from elsewhere by water or wind. https://en.wikipedia.org/wiki/Authigenesis.

Bourne – an intermittent seasonal spring.

Bowen's reaction series – is a means of ranking common igneous silicate minerals by the temperature at which they crystallize. Minerals at the top have a relatively high crystallization temperature, which means that they will be the first minerals to crystallize from a magma that is cooling. http://jersey.uoregon.edu/~mstrick/AskGeoMan/geoQuerry32.html.

Caldera - is a volcanic feature formed by the collapse of a volcano into itself, making it a large, special form of volcanic crater. A caldera collapse is usually triggered by the emptying of the magma chamber beneath the volcano, as the result of a large volcanic eruption. https://en.wikipedia.org/wiki/Caldera.

Carbonate compensation depth (CCD) - is defined as the water depth at which the rate of supply of calcium carbonate from the surface is equal to the rate of dissolution. As long as the ocean floor lies above the CCD, carbonate particles will accumulate in bottom sediments, but below, there is no net accumulation. https://link.springer.com/referenceworkentry/10.1007%2F1-4020-4496-8_46.

Cation exchange capacity - Cation exchange capacity (CEC) is the total capacity of a soil to hold exchangeable cations. CEC is an inherent soil characteristic and is difficult to alter significantly. Soils with a higher clay fraction tend to have a higher CEC. Organic matter has a very high CEC. http://www.soilquality.org.au/factsheets/cation-exchange-capacity

Chalcophile elements – attracted to copper

Chalcopyrite – the principal ore of copper. a yellow crystalline mineral consisting of a sulphide of copper and iron. https://en.wikipedia.org/wiki/Chalcopyrite.

Cirque - is an amphitheatre-like valley formed by glacial erosion. https://en.wikipedia.org/wiki/Cirque.

Cleavage of a mineral - is the way it splits or breaks. Mica, for example, breaks into thin, flat sheets.

Cline, halo – a strong salinity gradient in a body of water. https://en.wikipedia.org/wiki/Halocline.

Cline, pycno – zone of rapid change in density in oceans.

Cline, thermo - A thermocline is the transition layer between warmer mixed water at the ocean's surface and cooler deep water below. https://oceanservice.noaa.gov/facts/thermocline.html.

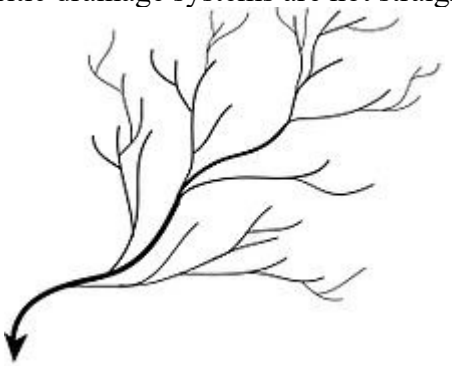
Columnar jointing - is a geological structure where sets of intersecting closely spaced fractures, referred to as joints, result in the formation of a regular array of polygonal prisms, or columns. 

Connate water – water trapped at the time of formation of sedimentary rocks.

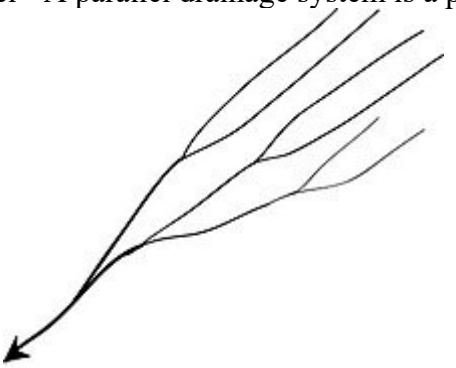
Cuesta - is a hill or ridge with a gentle slope on one side, and a steep slope on the other. https://en.wikipedia.org/wiki/Cuesta#:~:text=A%20cuesta%20(from%20Spanish%20cuesta,tilted%20somewhat%20from%20the%20horizontal..

Darcy's law for groundwater flow – states that groundwater flow (Q) = kIA where k is hydraulic conductivity of the rock, I is the hydraulic gradient and A is the cross sectional area.

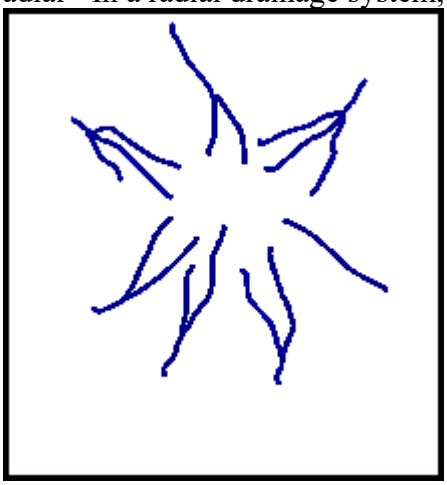
Debris flow - is a moving mass of loose mud, sand, soil, rock, water and air that travels down a slope under the influence of gravity. To be considered a debris flow, the moving material must be loose and capable of "flow," and at least 50% of the material must be sand-size particles or larger. https://geology.com/articles/debris-flow/.

Drainage pattern, dendritic - Dendritic drainage systems are not straight and are the most common form of drainage system. 

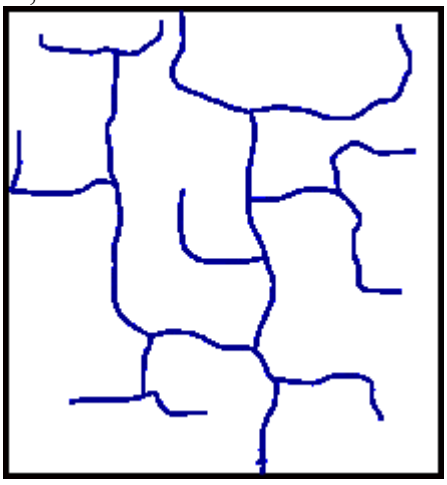
Drainage pattern, parallel - A parallel drainage system is a pattern of rivers caused by steep slopes with some relief.



Drainage pattern, radial - In a radial drainage system, the streams radiate outwards from a central high point.



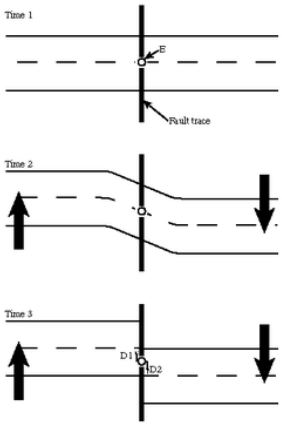
Drainage pattern, rectangular - Rectangular drainage develops on rocks that are of approximately uniform resistance to erosion, but which have two directions of jointing at approximately right angles or 90 degrees.



Drainage pattern, trellis - smaller tributaries feed into from the steep slopes on the sides of mountains. These tributaries enter the main river at approximately 90 degree angle.

Drowned river valley estuaries – aka coastal plain estuaries. In places where the sea level is rising relative to the land, sea water progressively penetrates into river valleys and the topography of the estuary remains similar to that of a river valley. https://en.wikipedia.org/wiki/Estuary#Drowned_river_valleys.

Elastic Rebound Theory - is an explanation for how energy is released during an earthquake. As the Earth's crust deforms, the rocks which span the opposing sides of a fault are subjected to shear stress. Slowly they deform, until their internal rigidity is exceeded. Then they separate with a rupture along the fault; the sudden movement releases accumulated energy, and the rocks snap back almost to their original shape. The previously solid mass is divided between the two slowly moving plates, the energy released through the surroundings in a



seismic wave.

Esker - is a long, winding ridge of stratified sand and gravel, examples of which occur in glaciated and formerly glaciated regions of Europe and North America. Eskers are frequently several kilometres long and, because of their uniform shape, look like railway embankments. https://en.wikipedia.org/wiki/Esker.

Extrusive igneous rock – is the rock that forms when magma exits the volcano and cools. https://www.usgs.gov/faqs/what-are-igneous-rocks.

Feldspar – rock forming tectosilicate minerals that make up 41% of the earth's surface. https://en.wikipedia.org/wiki/Feldspar.

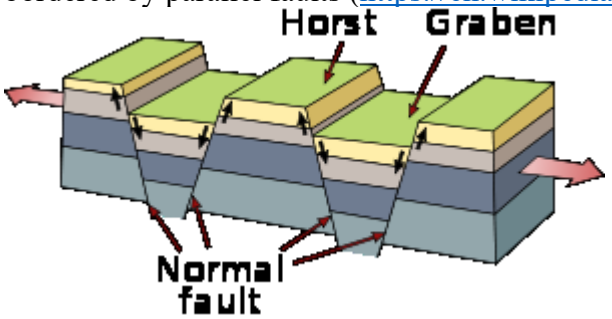
Fulvic acid - are a family of organic acids, natural compounds, and components of the humus (which is a fraction of soil organic matter). https://en.wikipedia.org/wiki/Fulvic_acid.

Geodesy – the science of accurately measuring and understanding Earth's geometric shape.

Geothermal gradient - is the rate of increasing temperature with respect to increasing depth in Earth's interior. https://en.wikipedia.org/wiki/Geothermal_gradient.

Glossopteris – a genus from the extinct Permian order of seed ferns called Glossopteridales. https://en.wikipedia.org/wiki/Glossopteris.

Graben - In geology, a graben (/ˈɡrɑːbən/) is a depressed block of the crust of a planet bordered by parallel faults (https://en.wikipedia.org/wiki/Graben).



Gravitational water is free water moving through soil by the force of gravity. It is largely found in the macropores of soil and very little gravitational water is available to plants as it drains rapidly down the water table in all except the most compact of soils.

Guyot – aka tablemount, an isolated underwater volcanic mountain with a flat top >200 m under the sea surface.

Habit - Minerals with more than one common crystal shape are said to have multiple habits.

Hamada - is a type of desert landscape consisting of high, largely barren, hard rocky plateaus, where most of the sand has been removed by deflation. Hamadas are produced by the wind removing the fine products of weathering: an aeolian process known as deflation. The finer-grained products are taken away in suspension, while the sand is removed through saltation and surface creep, leaving behind a landscape of gravel, boulders and bare rock. https://en.wikipedia.org/wiki/Hamada.

Harpoon effect - the “harpoon effect” which is believed to occur when there is reversal in the general sense of movement in a tear fault system. https://www.sciencedirect.com/science/article/abs/pii/0899536285900193.

Hogback - is a long, narrow ridge or a series of hills with a narrow crest and steep slopes of nearly equal inclination on both flanks. https://en.wikipedia.org/wiki/Hogback_(geology).

Hurricanes - A hurricane is a tropical cyclone that occurs in the Atlantic Ocean and northeastern Pacific Ocean. They have a special scale of 100 – 1000 kms.

Hygroscopic water - Water absorbed from the atmosphere and held very tightly by the soil particles, so that it is unavailable to plants in amounts sufficient for them to survive.

Intrusive rock - is formed when magma penetrates existing rock, crystallizes, and solidifies underground to form intrusions, for example plutons, batholiths, dikes, sills, laccoliths, and volcanic necks. https://en.wikipedia.org/wiki/Intrusive_rock.

Iridescent – an iridescent mineral is one that changes colour depending on the direction from which light is projected.

Isogons – points where two beds with an equal dip amount are joined. Dip amount is the angle at which a planar feature is inclined to the horizontal plane. https://www.britannica.com/science/dip.

Isomorph – two compounds having the same crystal form or containing ions of more or less the same size. (Oxford Dictionary of Earth Sciences (2013): 312).

Juvenile water - Magmatic water or juvenile water is water that exists within, and in equilibrium with, a magma or water-rich volatile fluids that are derived from a magma. This magmatic water is released to the atmosphere during a volcanic eruption. https://en.wikipedia.org/wiki/Magmatic_water.

Kame - is a glacial landform, an irregularly shaped hill or mound composed of sand, gravel and till that accumulates in a depression on a retreating glacier, and is then deposited on the land surface with further melting of the glacier. Kames are often associated with kettles, and this is referred to as kame and kettle topography. https://en.wikipedia.org/wiki/Kame.

Karst topography – any landform underlain by limestone, and has resulted largely from the action of carbonation. Oxford Dictionary of Earth Sciences (2013): 321.

Katabatic wind – (meaning "descending") is the technical name for a drainage wind, a wind that carries high-density air from a higher elevation down a slope under the force of gravity. Such winds are sometimes also called fall winds. https://en.wikipedia.org/wiki/Katabatic_wind.

Khondalite – a metamorphic rock.

Lagoon type or bar built - Bar-built estuaries are found in a place where the deposition of sediment has kept pace with rising sea levels so that the estuaries are shallow and separated from the sea by sand spits or barrier islands. They are relatively common in tropical and subtropical locations. https://en.wikipedia.org/wiki/Estuary.

Lahars - is a violent type of mudflow or debris flow composed of a slurry of pyroclastic material, rocky debris and water. The material flows down from a volcano, typically along a river valley. https://en.wikipedia.org/wiki/Lahar.

Lava – molten magma rock. Magma is generated by the internal heat of the planet or moon and it is erupted as lava at volcanoes or through fractures in the crust, usually at temperatures from 700 to 1,200 °C (1,292 to 2,192 °F). https://en.wikipedia.org/wiki/Lava.

Limestone - is a carbonate sedimentary rock that is often composed of the skeletal fragments of marine organisms such as coral, foraminifera, and molluscs. Its chemical constitution is $CaCO_3$. https://en.wikipedia.org/wiki/Limestone.

Liquefaction - is a phenomenon in which the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading.

Lithophile elements - is a term used to refer to elements that are preferentially partitioned into silicate minerals as opposed to sulphides or metals.

Loess – unconsolidated, wind deposited sediment composed largely of silt-sized quartz particles (0.015-0.05 nm) and showing little or no stratification. Oxford Dictionary for Earth Sciences – 346.

Long distance surface current – as the name suggests, it is the current that flows near the ocean's surface for thousands of kilometers.

Lustre - The lustre of a mineral describes how the mineral appears as it reflects light. Some minerals are transparent, or see-through. Others are iridescent, which means that their color changes as light hits them from different directions.

Magma - is the molten or semi-molten natural material from which all igneous rocks are formed. https://en.wikipedia.org/wiki/Magma.

Mass balance of a glacier - The mass balance of a glacier is the net change in its mass over a balance year or fixed year. If accumulation exceeds ablation for a given year, the mass balance is positive; if the reverse is true, the mass balance is negative. (Q208, p635) https://en.wikipedia.org/wiki/Glacier_mass_balance#Mass_balance.

Mesa - is an isolated, flat-topped elevation, ridge or hill, which is bounded from all sides by steep escarpments and stands distinctly above a surrounding plain.

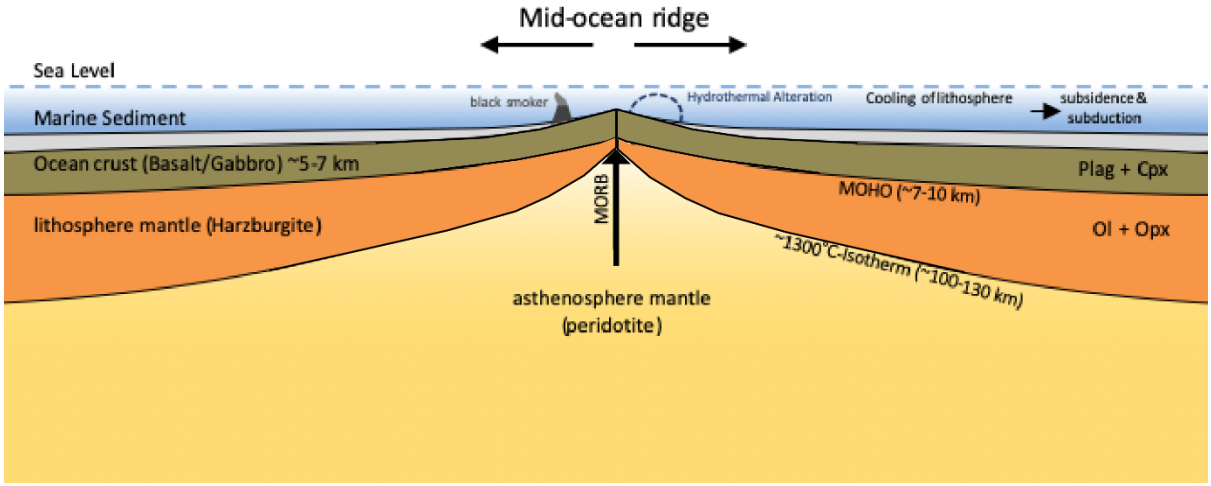
https://en.wikipedia.org/wiki/Mesa.

Meteoric water - Meteoric water is the water derived from precipitation. This includes water from lakes, rivers, and icemelts, which all originate from precipitation indirectly. https://en.wikipedia.org/wiki/Meteoric_water.

Mica – a group of silicate minerals. https://en.wikipedia.org/wiki/Mica.

Mid oceanic ridges - is an underwater mountain range, formed by plate tectonics. This uplifting of the ocean floor occurs when convection currents rise in the mantle beneath the

oceanic crust and create magma where two tectonic plates meet at a divergent boundary.



Mohs scale – used to describe the hardness of a mineral. The scale lists 10 typical minerals, from the softest (talc) to the hardest (diamond). A mineral can be identified by comparing its hardness to the hardness of these 10 minerals. They are: (1) talc; (2) gypsum; (3) calcite; (4) fluorite; (5) apatite; (6) orthoclase; (7) quartz; (8) topaz; (9) corundum; and (10) diamond.

Monadnock or inselberg - is an isolated rock hill, knob, ridge, or small mountain that rises abruptly from a gently sloping or virtually level surrounding plain.

Moraine - is any glacially formed accumulation of unconsolidated glacial debris (regolith and rock) that occurs in both currently and formerly glaciated regions on Earth (i.e. a past glacial maximum), through geomorphological processes. Different types of moraines are ground, end, recessional, lateral, medial, washboard etc. https://en.wikipedia.org/wiki/Moraine.

Mudslides - develop when water rapidly accumulates in the ground and results in a surge of water-saturated rock, earth, and debris. https://www.cdc.gov/disasters/landslides.html.

Olivine - is the name of a group of rock-forming minerals that are typically found in mafic and ultramafic igneous rocks such as basalt, gabbro, dunite, diabase, and peridotite. They are usually green in color and have compositions that typically range between Mg2SiO4 and Fe2SiO4.

Olivine - the name of a group of rock-forming minerals that are typically found in mafic and ultramafic igneous rocks such as basalt, gabbro, dunite, diabase, and peridotite. https://geology.com/minerals/olivine.shtml.

Ooze – a pelagic mud consisting of the calcareous and siliceous remains of pelagic organisms. Calcareous oozes will accumulate in oceans at depths lower than the carbon compensation depth (CCD). Oxford Dictionary of Earth Sciences (2013): 410.

Ooze, diatom - Soft, siliceous, deep-sea deposit composed of more than 30% diatom cell walls. Oxford Dictionary of Earth Sciences (2013): 167.

Ooze, globigerina – deep sea ooze in which 30% of the sediments consists of planktonic foraminifera, including chiefly globigerina. It is the most widespread pelagic deposit, covering almost 50% of the deep-sea floor. Species occurring in this deposit have been used to establish climatological and temperature criteria. Oxford Dictionary of Earth Sciences (2013): 252.

Ooze, pteropod - Deep-sea ooze in which at least 30% of the sediment consists of the shells of planktonic small gastropods (known as pteropods or 'wing-footed' snails). pteropod ooze is restricted to water depths less than 2500 m. Oxford Dictionary of Earth Sciences (2013) (2013): 472.

Ooze, radiolarian - Deep-sea ooze in which at least 30% of the sediment consists of the siliceous radiolarian tests. They are usually deposited at a depth greater than 4500 m (i.e. the carbon compensation depth in most oceans). Oxford Dictionary of Earth Sciences (2013): 481.

Orogenic - An orogeny is an event that leads to both structural deformation and compositional differentiation of the Earth's lithosphere at convergent plate margins. https://en.wikipedia.org/wiki/Orogeny.

Osmolytes - are low-molecular weight organic compounds that influence the properties of biological fluids.[1] Their primary role is to maintain the integrity of cells by affecting the viscosity, melting point, and ionic strength of the aqueous solution. When a cell swells due to external osmotic pressure, membrane channels open and allow efflux of osmolytes which carry water with them, restoring normal cell volume. https://en.wikipedia.org/wiki/Osmolyte.

Oxisol – a kind of soil found in tropical, hot and humid climates. It has a prominent oxic horizon, which is marked by the presence of clay, insoluble minerals like quartz, and hydrated oxides of iron and aluminium.

Parasitic fold – when a folded mountain develops a small fold.

Pelagic sediment or pelagite – is a fine-grained sediment that accumulates as the result of the settling of particles to the floor of the open ocean, far from land. Based upon the composition of the ooze, there are three main types of pelagic sediments: siliceous oozes, calcareous oozes, and red clays. Ooze* refers to a sediment's composition. https://en.wikipedia.org/wiki/Pelagic_sediment.

Peneplain - is a low-relief plain formed by protracted erosion. https://en.wikipedia.org/wiki/Peneplain.

Peridotite - is a dense, coarse-grained igneous rock consisting mostly of the minerals olivine and pyroxene. https://en.wikipedia.org/wiki/Peridotite.

Peridotite - is a dense, coarse-grained igneous rock consisting mostly of the minerals olivine and pyroxene. Is present in high quantity in upper mantle. https://en.wikipedia.org/wiki/Peridotite.

Permafrost – ground that remains permanently frozen. Covers 20-25% of the earth's surface (Britannica Landforms p223).

Pitchblende – an ore of uranium.

Plygioclase - is a member of the feldspar group (like orthoclase) and is a framework silicate. (Q269, p639)

Potamon zone - in any river, zones are divided from the source to its mouth at the sea. Rhithron is the head water zone, which is characterised by a steep and torrential river course.

Pyroclastic cone - is a steep conical hill of loose pyroclastic fragments, such as either volcanic clinkers, volcanic ash, or cinder that has been built around a volcanic vent. Pyroclastic rocks are sedimentary clastic rocks composed solely or primarily of volcanic materials. https://en.wikipedia.org/wiki/Cinder_cone.

Pyroxene - are a group of dark-colored rock-forming minerals found in igneous and metamorphic rocks throughout the world. They form under conditions of high temperature and/or high pressure. https://en.wikipedia.org/wiki/Pyroxene.

Pyroxene - The pyroxenes (commonly abbreviated to Px) are a group of important rock-forming inosilicate minerals found in many igneous and metamorphic rocks. https://en.wikipedia.org/wiki/Pyroxene.

Quartz – SiO_2, second most abundant mineral in Earth's crust. https://en.wikipedia.org/wiki/Quartz.

Quartzite - is a hard, non-foliated metamorphic rock which was originally pure quartz sandstone. Sandstone is converted into quartzite through heating and pressure usually related to tectonic compression within orogenic belts. https://en.wikipedia.org/wiki/Quartzite.

Reef, Atoll - a ring-shaped reef, island, or chain of islands formed of coral. https://en.wikipedia.org/wiki/Atoll.

Reef, Barrier - Barrier reefs are separated from a mainland or island shore by a deep channel or lagoon. https://en.wikipedia.org/wiki/Coral_reef#Barrier_reef.

Reef, Fringing – a coral reef that lies close to the shore. https://en.wikipedia.org/wiki/Fringing_reef.

Residence Time - of a fluid parcel is the total time that the parcel has spent inside a control volume (e.g.: a chemical reactor, a lake, a human body). https://en.wikipedia.org/wiki/Residence_time and Brantley 2008.

Rhithron – in any river, zones are divided from the source to its mouth at the sea. Rhithron is the head water zone, which is characterised by a steep and torrential river course. http://www.biologydiscussion.com/biotic-community/stream-zonation-and-communities-with-diagram/4726.

Rhyolite - is an extrusive igneous rock with a very high silica content.

Rip current - is a specific kind of water current that can occur near beaches with breaking waves. A rip is a strong, localized, and narrow current of water which moves directly away from the shore, cutting through the lines of breaking waves like a river running out to sea. A rip current is strongest and fastest nearest the surface of the water. https://en.wikipedia.org/wiki/Rip_current

Saffir-simpson scale – a scale for assessing hurricanes on the basis of windspeeds.

Sea water, major constituents – Most dissolved material in sea water consists of Cl, Na, SO_4, Mg and K. No removal mechanism exists for these elements, while Ca^{2+} and HCO_3 form $CaCO_3$, and Si is used by organisms. Relative proportions of elements are constant in all oceans regardless of salinity (Oxford Dictionary of Earth Sciences 2013: 519).

Sea water, pH – 8.0-8.4 (sea water is alkaline).

Sediment – particles transported by water or wind or people. They are different from soils in that soils are vertically weathering profiles that develop in place. Soils require time and a stable ground surface to develop. Different layers in soils are called horizons, while different layers in sediments are called deposits. https://www.monticello.org/site/blog-and-community/posts/soil-or-sediment-horizons-or-deposits-geoarchaeology-rescue.

Sedimentary rocks, sequence of chemical constituents – SiO2 > Al2O3 > Fe2O3 > TiO2

Seismic waves… See Spooner (2020: 158)
https://www.bgs.ac.uk/discoveringGeology/hazards/earthquakes/seismicWaves.html

Shale - is a fine-grained, clastic sedimentary rock, composed of mud that is a mix of flakes of clay minerals and tiny fragments (silt-sized particles) of other minerals, especially quartz and calcite.

Siderophile – iron loving. https://en.wikipedia.org/wiki/Siderophile.

Slope - is a form of mass wasting that occurs when a coherent mass of loosely consolidated materials or a rock layer moves a short distance down a slope. https://en.wikipedia.org/wiki/Slump_(geology).

Soil creep – slow downslope movement of regolith due to gravity. (Oxford Dictionary for Earth Sciences 2013: 140).

Solifluction – downhill movement of regolith (an unconsolidated mass of rocks, minerals etc) that has been saturated with water. (Oxford Dictionary for Earth Sciences 2013: 543; https://en.wikipedia.org/wiki/Solifluction.

Specific retention – is the ratio of undrained water left in the rock to the amount of total water contained in it. *See specific yield before specific retention*. (Oxford Dictionary of Earth Sciences (2013) 2013: 547).

Specific yield – the ratio of the amount of water drained from a rock due to gravity to the total volume of pore space in the rock. (Oxford Dictionary of Earth Sciences (2013) 2013: 547).

Spectral reflectance - Spectral reflectance is a measure of the wavelength of the electromagnetic energy collected, and spatial resolution refers to the size of the raster grid cells that represent spectral data. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/spectral-reflectance.

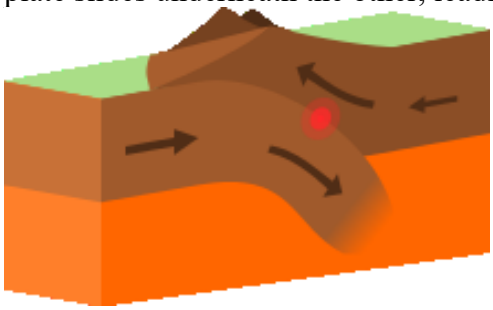
Spring tides – nothing to do with the season of spring. A tide just after a new or full moon, when there is the greatest difference between high and low water. It's a tide that occurs when sun, moon, earth are aligned linearly.

Steptoe – an isolated hill surrounded by lava flow.

Streak - Streak is the colour of a mineral's powder. Streak is produced by rubbing a piece of mineral against the surface of rough porcelain, a type of pottery.

Strike slip - Strike-slip faults are vertical (or nearly vertical) fractures where the blocks have mostly moved horizontally. https://earthquake.usgs.gov/learn/glossary/?term=strike-slip.

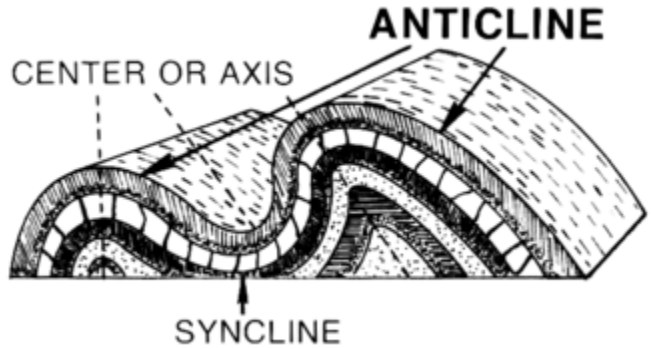
Subduction zone - is a region of the Earth's crust where tectonic plates meet and results in one plate slides underneath the other, leading to the second one to rise.



Subsidence – the gradual caving in or sinking of an area of land. https://en.wikipedia.org/wiki/Subsidence.

Supergene process - are those that occur relatively near the surface as opposed to deep hypogene processes. https://en.wikipedia.org/wiki/Supergene_(geology).

Syncline - is a fold with younger layers closer to the center of the structure. https://en.wikipedia.org/wiki/Syncline.



Taiga climate - generally referred to in North America as boreal forest or snow forest, is a biome characterized by coniferous forests consisting mostly of pines, spruces, and larches. It is the largest land biome.

Talus – in peri/glacial areas, repeating heating and cooling of water deposited in cracks causes rock to thaw. These rock fragments are transported downslope by flowing water. These depositions are known as talus. Over time, these rocks may create a fixed channel creating a talus cone >>  Britannica landforms p222.

Test – protective shell covering the cells of many protists and soft parts of invertebrate animals.

Thermal inertia - the degree of slowness with which the temperature of a body approaches that of its surroundings and which is dependent upon its absorptivity, its specific heat, its thermal conductivity, its dimensions, and other factors. https://www.merriam-webster.com/dictionary/thermal%20inertia.

Types of tectonic zones - https://www.gns.cri.nz/Home/Learning/Science-Topics/Earthquakes/Earthquakes-at-a-Plate-Boundary/Tectonic-Plates-and-Plate-Boundaries

Ultisols - commonly known as red clay soils. The word "Ultisol" is derived from "ultimate", because Ultisols were seen as the ultimate product of continuous weathering of minerals in a humid, temperate climate without new soil formation via glaciation. https://en.wikipedia.org/wiki/Ultisol.

Urban heat island effect - An urban heat island (UHI) is an urban area or metropolitan area that is significantly warmer than its surrounding rural areas due to human activities. https://en.wikipedia.org/wiki/Urban_heat_island.

Usar soils - are unproductive, impermeable and hard due to the presence of undesirable salts on the surface.

Vesicular – in geology, vesicular is a rock texture wherein the rock is pitted with many cavities.

Volcano, shield - A shield volcano is a type of volcano usually composed almost entirely of fluid lava flows. It is named for its low profile, resembling a warrior's shield lying on the ground. https://en.wikipedia.org/wiki/Shield_volcano.

Volcano, strato - also known as a composite volcano, is a conical volcano built up by many layers (strata) of hardened lava, tephra, pumice and ash. Unlike shield volcanoes, stratovolcanoes are characterized by a steep profile with a summit crater and periodic intervals of explosive eruptions and effusive eruptions, although some have collapsed summit craters called calderas. https://en.wikipedia.org/wiki/Stratovolcano.

Westerlies current – planetary winds that blow from subtropical high pressure belt (~30 ^{o}N/S) to subpolar low pressure belt (~60 ^{o}N/S).

4.1 Geosciences factfile

Table 7 Discontinuities in the Earth's interior

Conorod discontinuity	Between upper and lower crusts
Mohorovicc	Between crust and mantle
Repiti	Between upper and lower mantle
Wiechert-Gutenberg	Between mantle and outer core
Lehmann	Between outer and inner core

Table 8 Geochemical distribution in the Earth's interior

Layer	Elemental composition	Volume, mass, density	Thickness
Crust	O, Si, Al, Fe, Ca, K, Na, Mg, Ti, C, S, Mn, P, F, Cl (Yaroshevsky 2006: 54)	Less than 1% of the earth's volume, 2800 kg/m³	60 km beneath mountains, 5 km beneath oceans
Mantle	O, Mg, Si, Fe, Ca, Al, Na, K (https://en.wikipedia.org/wiki/Abundance_of_the_chemical_elements#Mantle)	84% of Earth's volume and 68% mass	2300 km
Core	Largely metallic iron, some nickel and cobalt, and lighter elements like carbon and sulphur (https://www.britannica.com/science/chemical-element/The-Earths-mantle)	16% of the Earth's volume and 32% of its mass	1220 km

Table 9 USDA classification for soil texture

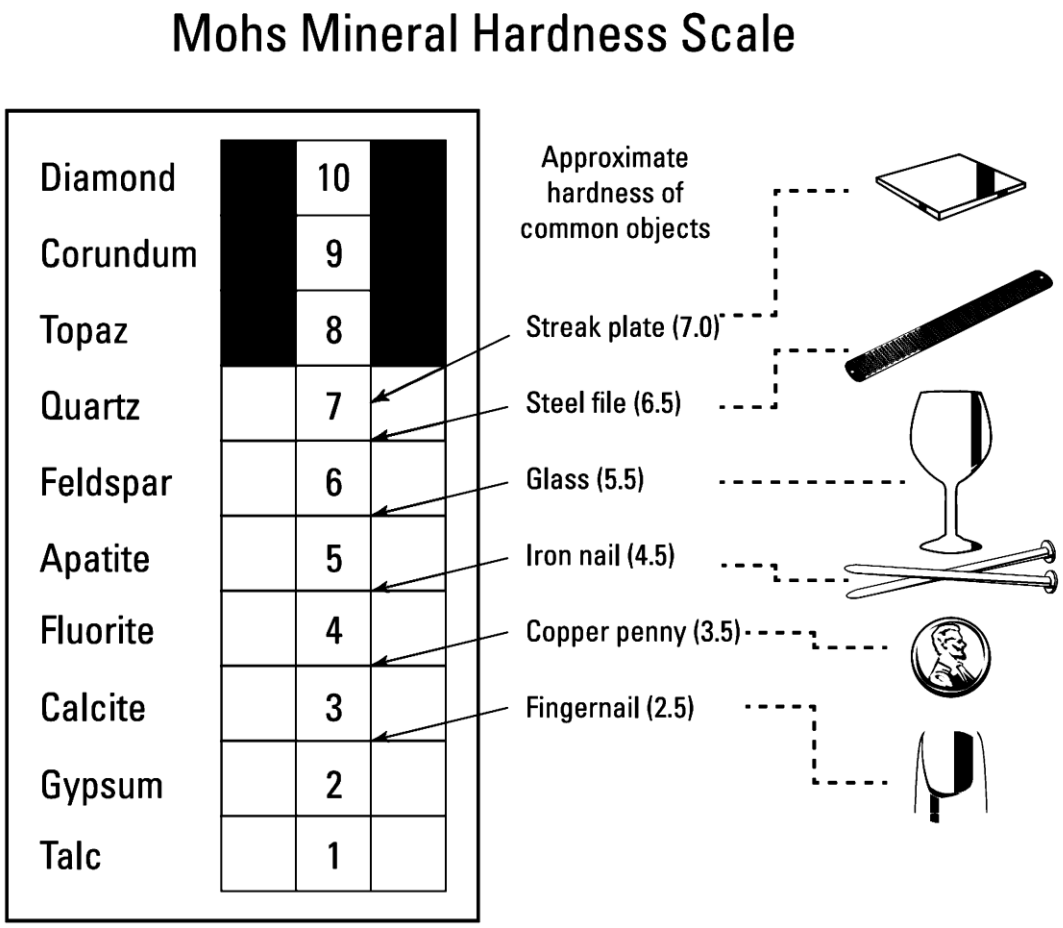
Sand	0.05 – 2 mm (diameter)
Silt	0.002 – 0.05 mm
Clay	<0.002 mm

Indian monsoon – read up from Singh 2019

~~Residence time of different elements in and compounds in soil and the atmosphere~~

Igneous rocks (Q149), Sedimentary rocks (Q344), Metamorphic rocks (Q390), Landforms (Q405), Soil, Minerals (Q200, 288, 296, 443)

Table 10 Mohs scale of hardness of minerals



RE 6-1:
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scale.

Table 11 Silicate Mineral groups

TABLE 6-1 Silicate Mineral Groups

Group Name	Chemical Formula	Example Mineral	Tetrahedra Structure
Olivine group	$(Mg, Fe)_2SiO_4$	Olivine	Single tetrahedra
Pyroxene group	$(Mg, Fe)_2SiO_3$	Augite	Single chains
Amphibole group	$Ca_2(Fe, Mg)_5Si_8O_{22}(OH)_2$	Hornblende	Double chains
Mica group	$K(Mg, Fe)_3AlSi_3O_{10}(OH)_2$ / $KAl_2(AlSi_3O_{10})(OH)_2$	Biotite/Muscovite	Sheets
Feldspar group	$KAlSi_3O_4$ / $(Ca, Na)AlSi_3O_8$	Orthoclase/ Plagioclase	Framework
Silica group	SiO_2	Quartz	Framework
Kaolinite group (clays)	$Al_2Si_2O_5(OH)_4$	Kaolinite	Ring

Silicate minerals contd…

Clay minerals and organic matter have negatively charged sites on their surfaces which adsorb and hold positively charged ions (cations) by electrostatic force. The number of negatively charged sites determines how many cations the soil is capable of attracting, and is referred to as the soil 'cation exchange capacity' or CEC.

Clay mineral: kaolinite	$2SiO_2 \cdot Al_2O_3 \cdot 2H_2O$	Lowest cation exchange capacity (5-25). Van der Waal forces and hydrogen bonds are found between successive layers. It is widely used in the ceramic industry as it does not absorb water or expand.
Clay mineral: halloysite		A single layer of water is present in unit layers. If temp > 50 C or relative humidity < 50%, the hydrated halloysite will lose its interlayer water.
Clay mineral: illite		Most common clay mineral Formed from weathering of K and Al rich rocks under high pH conditions. Medium cation exchange capacity (20-40) The K, Ca or Mg interlayer cations prevent the entrance of H_2O into the structure. Thus, illite clays are not expanding
Clay mineral: smectite		High specific surface, High cation exchange capacity (100-120) and affinity to water.
Clay mineral: vermiculite		Highest cation exchange capacity (150-160)
Clay mineral: chlorite		Central cation in octahedral sheets is either Fe or Mg. It shows minimum swelling and is non expandable.
Clay mineral: pyrophyllite	$4SiO_2 \cdot Al_2O_3 \cdot H_2O$	
Clay mineral: talc	$4SiO_2 \cdot 3MgO \cdot H_2O$	
Clay mineral: chamosite	$3SiO_2 \cdot Al_2O_3 \cdot 5FeO \cdot 4H_2O$	

Table 12 Common carbonate minerals

Common Carbonate Minerals

Mineral Name	Chemical Formula	Common Use
Calcite	$CaCO_3$	Cement
Dolomite	$CaMg(CO_3)_2$	Cement

Table 13 Sulphide and Sulphate minerals

Sulfide and Sulfate Minerals

Mineral Name	Chemical Formula	Common Use
Sulfates		
Gypsum	$CaSO_4 + 2H_20$	Plaster
Anhydrite	$CaSO_4$	Plaster
Sulfides		
Galena	PbS	Lead ore
Pyrite	FeS_2	Sulfur ore
Cinnabar	HgS	Mercury ore
Chalcopyrite	$CuFeS_2$	Copper ore

Table 14 Common oxide minerals

Common Oxide Minerals

Mineral Name	Chemical Composition	Common Use
Hematite, Magnetite	Fe_2O_3, Fe_3O_4	Iron ore
Corundum	Al_2O_3	Gemstone
Cassiterite	SnO_2	Tin ore
Rutile	TiO_2	Titanium ore
Uraninite	UO_2	Uranium ore

Table 15 Common Native Element Minerals

Common Native Element Minerals

Mineral Name	Chemical Composition	Common Use
Gold	Au	Jewelry, coins, electronics
Silver	Ag	Jewelry, coins, photography
Platinum	Pt	Jewelry, gasoline production
Diamond	C	Jewelry, drill bits
Copper	Cu	Electrical wiring

Table 16 The Richter Scale

Richter scale	**Earthquake effects**
0	Instrumental
3.5	Feeble
4.2	Slight
4.8	Moderate
4.9 – 5.4	Rather strong
5.5 – 6.1	Strong
6.5	Very strong
6.9	Destructive
7.0 – 7.3	Ruinous
7.4-8.1	Disastrous
8.2-8.9	Catastrophic

5 Atmospheric Science

Zones of Atmosphere

The atmosphere consists of different layers with varying density and temperature. Density is highest near the surface of the earth and decreases with increasing altitude. The column of atmosphere is divided into five different layers depending upon the temperature condition. They are troposphere, stratosphere, mesosphere, thermosphere and exosphere.

1. Troposphere
   1.1. Lowermost layer
   1.2. Extends up to 13 km over the equator, 8 km above poles. Thus, thickness is greatest at the equator as heat is carried by strong convectional currents.
   1.3. Temperature decreases with increase in altitude
   1.4. This layer contains dust – all changes in weather and climate – most important layer for biological activity

2. Tropopause
   2.1. The layer forming the base of the stratosphere
   2.2. The air temperature in the troposphere is -80 C over the equator and -45 C over poles
   2.3. Temperature constant, hence tropo'pause'

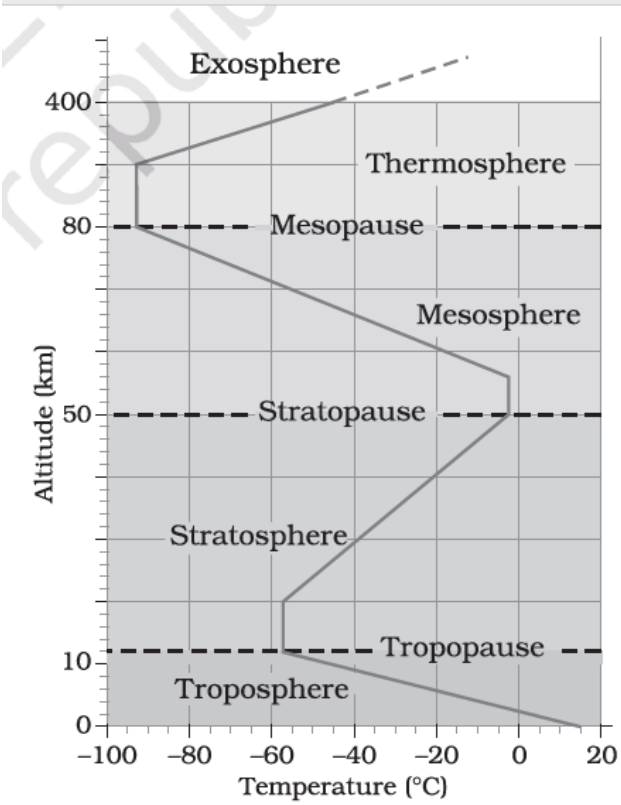
3. Stratosphere
   3.1. Above the tropopause, extends from a height of 10 km to a height of 50 km at the stratopause.
   3.2. Temperature increase with altitude and reaches ~0 C at stratopause
   3.3. Contains ozone layer, which absorbs UV radiation.
   3.4. Apparently, both tropopause and stratopause are a part of the stratosphere – the tropopause marks the base while the stratopause marks the ceiling (Oxford Dictionary of Earth Sciences 2013: 561).

4. Mesosphere
   4.1. Lies above stratosphere, extends from a height of 50 km (i.e. above the stratopause) to a height of 80 km
   4.2. Temperature starts decreasing with increase in altitude and reaches -100 C at the height of 80 km.
   4.3. Includes Mesopause, its topmost layer
      4.3.1. The layer that separates mesosphere from the thermosphere above.
      4.3.2. Temperature constant for the first 10 km in this layer.

5. Thermosphere
   5.1. Above 80km up to 400 km
   5.2. At its base, this layer contains the lowest temperature in the atmosphere. Temperature increases with height after this. But because of low atmospheric density there, heat capacity is minute.
   5.3. Solar radiations of the shortest wavelengths are absorbed
   5.4. Includes ionosphere
      5.4.1. Ionosphere is located 8 – 400 km above the mesopause.
      5.4.2. Absorbs solar and cosmic radiations. Contains electrically charged particles (ions), hence called ionosphere.

5.4.3. Radio waves transmitted from earth are reflected back to the earth by this layer.

6. Exosphere
   6.1. Highest layer. Very little known. Whatever contents are there in this layer are extremely rarefied and gradually merges with outer space.



(NCERT Class 11: 73)

remote sensing

Different wavelengths or bands in remote sensing

6 Environmental Chemistry

Redox potential - is a measure of the ease with which a molecule will accept electrons, which means that the more positive the redox potential, the more readily a molecule is reduced. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/redox-potential.

Inorganic – anything that lacks carbon-hydrogen bonds. Not derived from plants or animals or living organisms.

Enthalpy concept

$$U_1 + Q = U_2 + W$$

U_1 = internal energy of the chemical system at the beginning

Q = heat absorbed during the reaction

U_2 = internal energy at the end

W = work done by the system during the reaction

Q is calculated by subtracting the standard enthalpy of the products side of the reaction from the reactants side of the reaction.

When Q is positive, heat is absorbed and the reaction is **endothermic**.

When Q is negative, heat is liberated and the reaction is **exothermic**.

Two heat of combustion values –

Higher heating value (HHV) aka gross heat of combustion is when water condenses into liquid form i.e. the true heat liberation potential of the system is realised.

Lower heating value (LHV) aka net heat of combustion when is when water is released into vapour i.e. some of the heat gained from the reaction is wasted into vaporising water.

Logarithms and antilogarithms

If *a* and *N* are numbers that are so related that $a^x = N$, then *x* is called the logarithm of *N* to the base *a*, or briefly,

$\log_a N = x$

So, if $2^3 = 8$, then $\log_2 8 = 3$

Antilogarithm is the number whose logarithm is a given number. Put simply, there are two ways of saying the same thing

- 8's logarithm is 3
- 8 is the number whose logarithm is 3

Just like we can say ‘my dog is Tommy’ or ‘I am the guy whose dog is Tommy’.

So, *antilog(log8)* would mean the number whose log is *log8*.

Antilog3 would mean the number whose log is 3.

6.1 Various measurement techniques

Table 17 Various measurement techniques

Technique name	Used for	Principle
Flame photometry or Flame atomic emission spectrometry (FAES)	assessing different gases like nitrous oxide or methane alkali metals like Na, K in solutions	With Na and K excited, they emit light 569-768 nm respectively. Amount of light directly proportional to the concentration of ions
Atomic Absorption Spectrophometry (AAS)	Na^+, K^+, Ca^{2+}, Mg^{2+} and heavy metals	Flame disassociates the elements from chemical bonds and places it in its ground state. The element then absorbs lights of a specific wavelength
X-Ray Diffraction (XRD)	Study of structures and atomic spacing of unknown crystalline materials (e.g. minerals and inorganic compounds)	A beam diffracts X-rays in many directions. Based on Bragg's Law.
IR spectroscopy	Identify structure of functional groups	Molecules tend to absorb specific frequencies of light based on their structure
UV spectroscopy	Quantitative determination of concentrations of absorber in the solutions of transition metal ions and highly conjugated organic compounds.	Absorption of UV radiation (200-400 nm) excites electrons from ground state to higher energy state. Beer Lambert Law: rate at which radiation intensity decreases with the thickness of the absorbing solution is proportional to the incident radiation and concentration of the solution.
Raman spectroscopy	Determine vibrational, rotational and low frequency modes of molecules	Used to determine a structural fingerprint by which molecules can be identified. Uses Stokes lines (where wavelengths are longer than that of incident light) and anti-Stokes lines (where wavelengths are shorter than incident light)
Inductively coupled plasma atomic emission spectroscopy (ICPAES)	Determining the concentration of the element in the sample	Inductively coupled plasma produces excites atoms and ions, and produces electromagnetic radiation at wavelengths characteristic of a particular element.

Technique name	Used for	Principle
Inductively coupled plasma mass spectrometry (ICPMS)	Determining concentration of metals and non-metals at low concentrations in solutions Can also detect various isotopes in samples (aka isotope labelling)	Inductively coupled plasma ionises the sample, creates poly/atomic ions that are then detected
Electrophoresis	Used to separate biomolecules like DNA, proteins according to their size	Uses the length and speed of nucleic acid fragments to assess its size.
X-Ray fluorescence (XRF)	Investigation of metals, glass, ceramics, building materials, geochemistry, forensic science, archaeology, art objects	Emission of characteristic 'secondary', 'fluorescent' X-rays from a material that has been excited by being bombarded with high energy X-rays/gamma rays.
Nuclear magnetic resonance spectroscopy (NMR)	Gives us details about the detailed electronic structure of the molecule; Local magnetic fields around atomic nuclei; identifying monomolecular organic compounds; identifying proteins and biomolecules	Sample is placed in a magnetic field; nuclei get excited with radio waves; send NMR signal. They are detected with radio receivers.
Fourier transform infrared spectroscopy (FTIR)	Obtain an infrared spectrum of absorption or emission of a solid, liquid, gas.	Collects high spectral resolution data over a wide spectral range. It is therefore better than a dispersive spectrometer, which measures narrow range of wavelength at a time.
Paper chromatography	Separating mixtures and identifying components	**Mobile phase** (non-polar organic solvent) travels up the **stationary phase** (paper) due to capillary action. Some components are more attracted to mobile phase and move along, while some are more attracted to stationary phase and stick to it. This process is called elution.
Thin layer chromatography	Separating non-volatile mixtures	Performed on a sheet of glass coated with a thin layer of adsorbent material (polar stationary phase): silica gel, aluminium oxide or cellulose. After sample has been applied on plate, a solvent (non-polar mobile

Technique name	Used for	Principle
		phase like heptane) is added. Sample moves through capillary action like paper chromatography. Can be visualised by projecting UV light or by treating sheet with phosphor.
Gas chromatography	Used for separating volatile compounds i.e. compounds that vaporise easily. Tests the purity of a substance or even identifies a compound.	Mobile phase (gas like He or N). Stationary phase (microscopic layer of liquid or polymer on an inert solid support, inside a column of glass). Each compound elutes at a different time i.e. retention time.
Gas chromatography mass spectrometry (GCMS)	Identifies different substances within a test sampling and can be used for isotope labelling. Drug detection, fire investigation, environmental analysis, explosives, investigation.	Combines mass spectrometry and gas chromatography and uses each component's charge-to-mass ratio.
High performance liquid chromatography (HPLC)	Separate, identify and quantify each component in a mixture.	A pump passes pressurised liquid solvent containing sample mixture across a column filled with a solid adsorbent material. Each compound interacts differently, and different flow rates leads to separation of components, and hence their identification. It operates at a higher pressure than ordinary liquid chromatography, which uses gravity instead of a pump.
Scanning electron microscope (SEM)	Can achieve resolutions better than 1 nm.	Scans surface of a sample with a focused beam of electrons twice. The electrons interact with the atoms and produce various signals that contain info about the composition of the sample. These secondary electrons are detected by an Everhart-Thornley detector.
Transmission electron microscopy		Beam of electrons transmitted through a

Technique name	Used for	Principle
		specimen to form an image. Specimen is usually an ultra thin section less than 100 nm thick. Image viewed on a fluorescent screen, layer of photofilm, sensors like scintillators attached to a charge coupled device.
Gravimetric analysis	Quantitative determination of an ion based on mass.	Once an ion's mass has been determined in a compound, the measurement can be used to determine the same analyte's mass in a mixture, esp if the other constituents are known. Main types: precipitation, volatilization, electro-analytical, miscellaneous.
Bomb calorimeter	Heat of combustion in a particular reaction	Electrical energy is used to ignite the fuel; fuel burns, heats surrounding air; air expands and escapes through a copper tube that leads air out of the calorimeter; heats water outside tube as well. this change in temperature of water allows for calculating the calorie content of the fuel.

Atmospheric chemistry – 8, 10, 86, 90, 67, 99, 100, 220

Insecticides – 72, 96, 229

Diseases and Toxicity – 89, 97, 205, 184, 224, 258, 267 (Madhuraj 2020: 46)

Measurement techniques – 1, 6, 15, 106, … *make a table*

Chemical analysis – 108

Gases dissolution in water – 131

Water pollution

Photodissociation, NO_2 - 195

Soil – 240

7 Environmental Legislation

Table 18 Indian legislation and agreements.

Name of legislation	Year	Agenda
National Land Reform Policy		Tenancy reforms
Disaster Management Act	2005	
Municipal Solid Waste Management and Handling Rules		

India's renewable energy targets by 2022: The Government of India has set a target of installing of installing 175 GW of renewable energy capacity by the year 2022, which includes 100 GW from solar, 60 GW from wind, 10 GW from bio-power and 5 GW from small hydro-power. https://sustainabledevelopment.un.org/partnership/?p=34566.

Q4, p506

Q109, 475 -- environmental chemistry

Table 19 Major environmental awareness days

	Occasion	Day	First observed
1	**World Wetlands Day**	02 Feb	1971
2	**World Wildlife Day**	03 Mar	2013
3	**International Day of Forests**	21 Mar	2012
4	**World Water Day**	22 Mar	1993
5	World Meteorological Day	23 Mar	1950
6	Fossil Fools Day	01 Apr	2004
7	**Earth Day**	22 Apr	1970
8	**International Day for Biological Diversity**	22 May	2000
9	**UN World Environment Day**	05 Jun	1974
10	World Oceans Day	08 Jun	1992
11	Global Wind Day	15 Jun	2009
12	World Day to Combat Desertification and Drought	17 Jun	1995
13	**International Climate Change Day**	21 Jun	
14	**World Nature Conservation Day**	28 Jul	
15	International Tiger Day	29 Jul	2010
16	**International Day for the Preservation of the Ozone Layer**	16 Sep	1994
17	World Water Monitoring Day	18 Oct	2007
18	**International Day of Climate Action**	24 Oct	
19	International Day for Preventing the Exploitation of the Environment in War and Armed Conflict	06 Nov	2001
20	Mountain Day	11 Dec	2003

Table 20 International Environmental Conventions and Agreements

	Name	Place	Year
1.	**The Convention on International Trade in Endangered Species (CITES)** Drafted at a meeting of International Union for the Conservation of Nature (IUCN) Governs trade in endangered species; ensures animals and plants near extinction are not harmed by international trade that further diminishes their populations	Geneva, Switzerland	1963
2.	**Ramsar Convention on Wetlands** – to protect all water habitats and biomes except oceans	Ramsar, Iran	1971
3.	**UN Conference on Human Environment** Resulted in **Stockholm Declaration**, which eventually led to **United Nations Environment Programme (UNEP)** The Stockholm Declaration aims at ensuring fundamental rights for all humans; and sharing responsibility to conserve Earth's resources for future.	Stockholm, Sweden	1972
4.	**United Nations Environment Programme (UNEP)** Responsible for coordinating the UN's environmental activities and assisting developing countries in implementing environmentally sound policies and practices.	Nairobi, Kenya	1972
5.	Convention Concerning the Protection of the World Cultural and Natural Heritage (aka **World Heritage Convention**)	Paris, France	1972
6.	**Convention on the Conservation of Migratory Species of Wild Animals (CMS)** aka **Bonn Convention** To protect migratory species across their range	Bonn, Germany	1979
7.	**UN Convention on the Law of the Sea (UNCLOS)** defines the rights and responsibilities of nations with respect to their use of the world's oceans and the management of marine natural resources	Montego Bay, Jamaica	1982
8.	**Intergovernmental Panel on Climate Change (IPCC)** Established by World Meteorological Organisation (WMO) and United Nations Environment Programme (UNEP). Publishes reports on topics relevant to UNFCCC. Does not do any original research.	Geneva, Switzerland	1988
9.	**Basel Convention** on the Control of Transboundary Movement of Hazardous Wastes and their Disposal	Basel, Switzerland	1989
10.	**Montreal Protocol** Aimed at phasing out chloroflurorocarbons to prevent further damage to the ozone layer	Montreal, Canada	1987
11.	**Global Environmental Facility (GEF)** Is a fund to support environmental research. Established on the eve of UNCED 1992.	Washington DC, USA	1992

	Name	Place	Year
12.	**United Nations Conference on Environment and Development (UNCED)** aka First **Earth Summit** **Three documents were issued: Rio Declaration on Environment and Development, Agenda 21, Forest Principles** **Three conventions were opened for signature at UNCED:** - Convention on Biological Diversity (CBD) - **Framework Convention on Climate Change (UNFCCC)**, which laid the groundwork for later agreements like Kyoto Protocol. - United Nations Convention to Combat Desertification (UNCCD)	Rio, Brazil	1992
13.	**Agenda 21** Product of the UNCED, Rio 1992. It is an action agenda for the UN, other multilateral organizations, and individual governments around the world that can be executed at local, national, and global levels. 21 refers to 21st century.	USA	1992
14.	**Convention on Biological Diversity (CBD)** Resulted in the **Cartagena Protocol** on Biosafety. Aims at preserving genetic biodiversity by mandating safe transport of genetically modified organisms to avoid ecosystem disruption Resulted in **Nagoya Protocol**, which aims at ensuring fair and equitable sharing of benefits arising out of the utilization of genetic resources	Rio de Janeiro, Brazil New York, USA	1993
15.	United Nations Convention to Combat Desertification (CCD)	Paris, France	1994
16.	**Kyoto Protocol** A product of UNFCCC; via **Clean Development Mechanism (CDM)**, aims to set reduction goals for carbon dioxide and other greenhouse gases emissions for various countries. India became a signatory in 2017.	Kyoto, Japan	1997
17.	**World Summit on Sustainable Development (WSSD)** aka Earth Summit 2002 and Rio+10 ('+10' since it took place 10 years since the first Earth Summit in Rio) Johannesburg Agreement on restoring world's depleted fisheries.	Johannesburg, S Africa	2002
18.	**United Nations Conference on Sustainable Development (UNCSD)** aka **Rio+20** ('+20' refers to 20 years since the first Earth Summit in Rio.) Renewed political commitment for sustainable development, to assess the progress and implementation	Rio, Brazil	2012

	Name	Place	Year
	gaps in meeting previous commitments, and to address new and emerging challenges		
19.	**Conference of Parties (COP)** of the **UNFCCC** aka **United** Nations Climate Change conference (UNCCC) Takes place each year. Most notable contribution was Kyoto Protocol. (COP refers parties that are signatory to any international agreement, there can be COPs for anything)	Various locations worldwide	1995
20.	United Nations Summit on Climate Change	Copenhagen, Denmark	2009
21.	**Millennium Summit** of United Nations Noted for the adoption of Millennium Development Goals (MDGs) until 2015	New York City, USA	2000
22.	International Geosphere-Biosphere Programme (IGBP) A research programme that ran from 1987 to 2015 dedicated to studying the phenomenon of global change.		1987-2015

References

https://en.wikipedia.org/wiki/United_Nations_Conference_on_Sustainable_Development

https://en.wikipedia.org/wiki/United_Nations_Climate_Change_conference

https://en.wikipedia.org/wiki/Earth_Summits

https://en.wikipedia.org/wiki/Earth_Summit

https://en.wikipedia.org/wiki/Earth_Summit_2002

Table 21 Ramsar sites in India

Ashtamudi Wetland	Kerala
* Beas Conservation Reserve	Punjab
* Bhitarkanika Mangroves	Odisha
* Bhoj Wetland	Madhya Pradesh
* Chandertal Wetland	Himachal Pradesh
* Chilika Lake	Odisha
* Deepor Beel	Assam
* East Calcutta Wetlands	West Bengal
* Harike Lake	Punjab
* Hokera Wetland	Jammu & Kashmir
* Kanjli	Punjab
* Keoladeo National ParkMR	Rajasthan
* Keshopur-Miani Community Reserve	Punjab
* Kolleru Lake	Andhra Pradesh
* Loktak LakeMR	Manipur
* Nalsarovar	Gujarat
* Nandur Madhameshwar	Maharashtra

* Nangal Wildlife Sanctuary	Punjab
* Nawabganj Bird Sanctuary	Uttar Pradesh
* Parvati Arga Bird Sanctuary	Uttar Pradesh
* Point Calimere Wildlife and Bird Sanctuary	Tamil Nadu
* Pong Dam Lake	Himachal Pradesh
* Renuka Wetland	Himachal Pradesh
* Ropar	Punjab
* Rudrasagar Lake	Tripura
* Saman Bird Sanctuary	Uttar Pradesh
* Samaspur Bird Sanctuary	Uttar Pradesh
* Sambhar Lake	Rajasthan
* Sandi Bird Sanctuary	Uttar Pradesh
* Sarsai Nawar Jheel	Uttar Pradesh
* Sasthamkotta Lake	Kerala
* Sundarban Wetland	West Bengal
* Surinsar-Mansar Lakes	Jammu & Kashmir
* Tsomoriri	Jammu & Kashmir
* Upper Ganga River	Uttar Pradesh
* Vembanad-Kol Wetland	Kerala
* Wular Lake	Jammu & Kashmir

From Ramsar 2020: 24 (https://www.ramsar.org/sites/default/files/documents/library/sitelist.pdf)

Table 22 Major Dams in India

List of Major Dams in India	State	River
Bisalpur Dam	Rajasthan	Banas
Maithon Dam	Jharkhand	Barakar
Tehri Dam	**Uttarakhand**	**Bhagirathi**
Bhavani Sagar dam	Tamil Nadu	Bhavani
Cheruthoni Dam	Kerala	Cheruthoni
Mettur Dam	Tamil Nadu	Kaveri
Krishnarajasagar Dam	Karnataka	Kaveri
Koyna Dam	**Maharashtra**	**Koyna**
Nagarjuna Sagar Dam	**Telangana**	**Krishna**
Lal Bahadur Sastri Dam aka Almatti Dam	**Karnataka**	**Krishna**
Hirakud dam	**Odisha**	**Mahanadi**
Indira Sagar Dam	Madhya Pradesh	Narmada
Sardar Sarovar Dam	**Gujarat**	**Narmada**
Rihand Dam	**Uttar Pradesh**	**Rihand**
Bhakra Nangal Dam	**Punjab-Himachal Pradesh Border**	**Sutlej**
Tungabhadra Dam	**Karnataka**	**Tungabhadra**

From https://byjus.com/bank-exam/dams-of-india/.

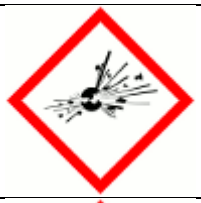
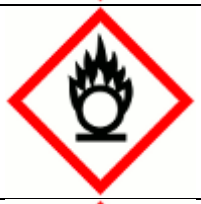
Figure 1 Major reserves in India (Source: NCERT Class 9: 49)

8 Solid waste management

Table 23 Biomedical waste management protocols

Colour code	Waste	Recommended methods
Yellow	Human tissues, blood, microbiology related waste	Incineration or plasma pyrolysis or deep burial. Expired drugs returned to manufacturer.
Red	Waste generated from disposable bottles like tubing, bottles, intravenous tubes, catheters, urine bags, syringes	Autoclaving or microwaving or hydroclaving or shredding
White (translucent)	Needles, sharps, metals, blades etc.	Autoclaving or dry heat sterilisation followed by shredding or mutilation or encapsulation in a metal container. Disposed in a special sanitary landfill
Blue	Glassware – broken or discarded and contaminated glass including medicine vials and ampoules	Disinfection with sodium hypochlorite solution or through autoclaving or microwaving or hydroclaving etc.

Table 24 Control of Substances Hazardous to Health (COSHH) Regulations symbols

Explosive (Symbol: exploding bomb)	
Flammable (Symbol: flame)	
Oxidising (Symbol: flame over circle)	
Corrosive (Symbol: Corrosion)	

Acute toxicity (Symbol: Skull and crossbones)	
Hazardous to the environment (Symbol: Dead tree and fish)	
Health hazard/Hazardous to the ozone layer (Symbol: Exclamation mark)	
Serious health hazard (Symbol: health hazard)	
Gas under pressure (Symbol: Gas cylinder	

Table 25 Types of toxins

Nomenclature	Definition	Examples
Allergens	anything that triggers an organism's immune system to respond. In many cases, the allergens themselves aren't toxic, but they may trigger extreme responses by the immune system that lead to death.	Pollen, that can swell up a person's airway, which leads to asphyxiation and death. Formaldehyde, which leads to sick building syndrome
Carcinogens	A toxin that makes a cell go rogue Some carcinogens are also mutagens, but not all mutagens are carcinogens	Asbestos, a common building material
Endocrine disruptors	Toxins that interfere with the hormone function of the body (i.e. the endocrine system)	Environmental oestrogen, mimics natural hormones of the body and interferes with the body's normal hormonal response
Mutagens	is a toxin that damages the genetic material inside a cell, causing it to mutate or change. If these mutations occur in reproductive cells, they can cause birth defects.	Arsenic
Neurotoxin	Impacts an organism's nervous system. Can cause paralysis and brain damage.	Mercury and Lead
Teratogens	Damage a foetus when it is developing the mother's womb. Damage ranges from low birth weight to stillbirth.	alcohol

*all toxins are hazardous, but not all hazardous materials are toxins. (Spooner 2012: 250)

Table 26 Persistent Organic Pollutants (POPs)

Name	Found in	What does it do?
Bisphenol A (BPA)	Water bottles	Endocrine disruptor, affects reproductive systems, miscarriages, mental retardation in animals
Polychlorinated biphenyls (PCBs) (manmade organic Compounds, organic here simply means they contain carbon)	electrical wiring insulation, paint, flame retardants, and sealants	Immune system suppressants
Polybrominated diphenyl ethers (PBDE)	a flame retardant commonly used in fabrics, furniture foam, plastics, appliances	Thyroid dysfunction, neurological damage
Perfluorooctane sulfonate (PFOS)	Heat resistant and are used in non-stick cooking appliances	Carcinogens, can cause brain damage and reproductive damage in rats
Phthalates	as makeup, plastic food packaging, body care products, and children's toys.	Endocrine disruptors, can damage reproductive system.
Perchlorate	Rocket fuel, can percolate into water and enters food chain	Endocrine disruptor, scientists have found in breast milk samples
Atrazine	A common herbicide used on crops etc.	Endocrine disruptor

* These compounds are all manmade. Organic here simply means they contain carbon. (Spooner 2012: 251-2).

Table 27 Heavy metals and their diseases

Heavy Metal	Sources	Toxic effects
Cadmium	Coal and nuclear power plants, batteries and ceramics	Itai Itai
Chromium	Leather, tanner, coal power plant and textiles	Allergies and bronchial asthma
Lead	Mining, automobiles, petrochemicals, paint	Mental Retardation, learning disability
Mercury	Mining, coal power plant, electrical equipment	Minamata
Arsenic	Textiles, wood, electronics	Skin diseases, visceral cancer

Read from: Madhuraj 2020: 46; Singh 2019; Masters and Ela 2014