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Coffee pulp compost

A viable organic source of nutrients for Soil and Crops

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Abstract

The principles behind composting are specific enzyme production systems of microbes, which can degrade the complex organic debris into simpler substances that crops can utilize as nutrient sources. Coffee pulp is the major residue during the recovery of parchment coffee beans which is left unutilized. This can be converted into utilizable organic manure without endangering the environment by employing potential microbial agents and earthworms. Farmers of the plain region popularly adopt these technologies to produce organic manures from crop residues for sustainable production. Generally, these technologies are less popularized in hill regions due to a lack of knowledge on the decomposition of coffee pulp waste, available microbial decomposition methods and negligence of the importance of the nutritional value of coffee pulp into nutrient rich manure. Hence, the knowledge of composting coffee pulp waste through various composting technologies is essential for the farmers to recycle the wastes into organic manure, which enriches soil nutrients and utilizing in organic farming.

Introduction

Shevaroy hills, the lungs of Eastern Ghat with an extended area of 382.7sq.km covering 67 tribal villages and 25 hamlets in Yercau, Salem District, Tamil Nadu. The hill is endowed with low temperature prevailing landscapes with intensive cultivation of high value horticultural crops viz., Coffee, Black pepper, Orange, Banana, Anthurium, Gerbera and Hill Vegetables. Crops like paddy, finger millet, maize, onion, banana, coconut, tamarind, mango, wheat, mustard etc., are grown by the tribal farmers, especially in lower elevations of the hills. The farmers of Shevroy hills growing coffee as a major commercial crop under multi-tier cropping system. From cofee about 15,000 tons of coffee pulp waste is produced annually, which is not used effectively, and the large quantity of coffee pulp wastes are dumped in open pits. Coffee pulp wastes require a very long period for natural degradation due to their high tannins, polyphenols, chlorogenic acid content.

The production of one ton of clean coffee beans leaves around three tons of fruit pulp and cherry husk as wastes (Karthikeyan and Stephen, 2005). The coffee processing industries are generating large amounts of solid wastes that have the potential for organic manure production. Our Indian farmers were basically organic farmers before introducing inorganic fertilizers and chemical pesticides. Applying synthetic fertilizers for crop nutrient had adverse effects on the environment and human health in the due course period. Now the organic method of cultivating crops with organic inputs like vermicompost, bio compost, enriched manure, etc. is essential to produce residue free crop produces and maintain soil fertility. Currently, consumers demand organic products. To progress in organic farming, eco-friendly technologies like vermicomposting, bio composting are essential to produce organic manure to make it available to the farmers. Effective Microorganisms (EM), a mixed culture of various bacteria, actinomycetes, yeast and fungi, have become essential and safe for composting any residues. Effective microorganisms containing a high diversity of beneficial microorganisms can be employed to compost waste in the diversification of the ecosystem. The EM involved compost has improved the soil's biological activity and supports crop growth (Kassa et al.,2011). The coffee husk and pulp contain more macro and micro nutrients and organic matter and caffeine, tannins, and polyphenols (Franca and Oliveira 2009). The waste has more organic compounds and essential nutrients, which can be utilized by proper composting.

Coffee pulp

Microorganisms for the composting of coffee pulp

Generally, the microorganism can decompose the crop residues fallen on the earth for a longer period. Some of the microorganisms have the potential to decompose the wastes in a short duration if the proper environment is adopted in the selection of methods like pit or heap, correct season by avoiding summer and rainy season, specific microorganism based on the composition of waste, which results faster production of organic manures. Studies indicated that the bacteria *Bacillus subtilis* fungi, *Aspergillus niger, Trichoderma reesei* were composting the pulp waste by breaking the sugar molecules in the waste than pulp waste alone (Fig-1) (Ivetić *et al.*, 2014).

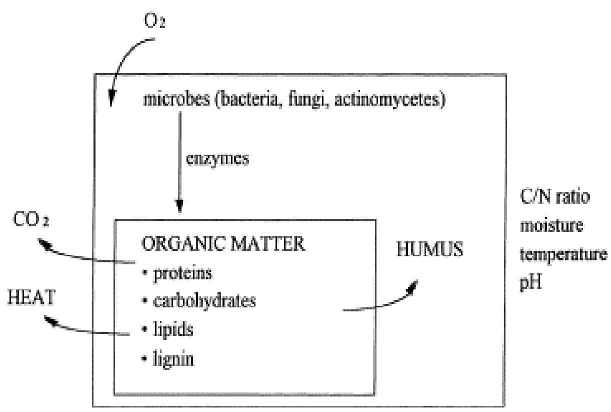

Fig -1: Biodegradation of Lignin in the waste products (Ivetić *et al.*, 2014)

Composting coffee pulp waste is time consuming process. The addition of microorganisms in the composting process of organic compounds reduces the composting time. Even the microbial consortium is more effective in biodegrading of coffee pulp waste. The organic manure of coffee pulp has been used as a soil amendment for the improvement soil physical, chemical and biological properties with improvement in soil fertility and quality (Table -1)

Table -1: Phsico – chemical properties of coffee raw pulp and composted pulp

Parameters	Raw pulp	Composted pulp
Moisture (%)	13.0	57.7
pH (1:10)	5.32	7.89
EC (dS m^{-1})	2.24	1.77
Organic C (%)	54.5	35.4
C/N ratio	29.8	11.5
Total N (%	1.83	2.58
C to N ratio	29.5	12.35

Vermicomposting of coffee pulp

Vermicomposting involves earthworm worms for the decomposition of organic waste materials into vermicast (vermicompost). For this process, 3 types of earthworms are involved epigeic, endogeic and mesogeic. Vermicomposting of coffee pulp requires predigestion with cow dung slurry. The vermicomposting of Coffee pulp using the earthworm *Eisenia foetida* reported by Orozco et al. (1996) and also found that nutrients like nitrates, phosphorus, soluble potassium, calcium, and magnesium present in the coffee pulp based vermicompost was readily utilized up by the plants. Vermicomposting coffee pulp using the exotic *E. eugeniae* and the native earthworm *Perionyx ceylanesis* increased nitrogen, phosphorus, potassium, calcium, and magnesium (Raphael et al., 2012).

Conclusions

Composting coffee pulp is vital to convert toxic compounds into harmless products. Microbial agents and earthworms can decompose by-products of coffee like pulp to get nutrient rich organic manure. The co-composting (Widjaja *et al.*, 2017), like the combination of Coffee pulp and other organic residues like leaf litter, fruit and vegetable wastes, can enhance the compost heap temperature, aeration, moisture content and chemical composition of the organic waste materials through the process of decomposition. The organic manure from coffee pulp can be utilized after three months of production to increase the yield of agriculture and horticulture crops. Many studies indicated that the 10: 90 coffee pulp and top soil ratios are suitable for producing seedlings in controlled conditions. However, organic manure from coffe pulp is the viable alternative for commercial growing media for producing vegetable and fruit seedlings in the nursery.

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Mapping Micronutrients status in KRP Dam Catchment of Tamil Nadu

A Diagnostic Kit to Paddy Farmers

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Soil plays a significant role in determining the sustainable productivity of an agro ecosystem. It is one of the essential sources of micronutrients for plants. Out of the 16 essential nutrients, Zinc (Zn), Copper (Cu), Iodine (I), Manganese (Mn), Molybdenum (Mo), Boron (B) and Iron (Fe) are referred micronutrients. These micronutrients are required in small quantities but have agronomic importance as they play are vital in the growth and development of plants (Ye *et al.,* 2015). Crop yield will be affected if any of these elements are lacking or excessive in the soil with other nutrients. Micronutrient deficiencies are alarmingly increased across the globe and further aggravated by many new cultivars as they are highly sensitive to micronutrient deficiency. Soils widely vary in micronutrient content and supply ability for optimal crop growth. soil's total micronutrient content is determined by the original geologic substrate and subsequent geochemical and pedogenic regimes. However, the total content is rarely indicative of available micronutrients as they depend on soil pH, organic matter content, surface area, and other physical, chemical, and biological conditions in the rhizosphere (Srinivasan *et al.,* 2021).

Plant uptake or techniques that correlate quantities of micronutrients extracted from soils are used to measure the availability of plants. Rational micronutrient management requires understanding how total and plant-available soil micronutrients vary across the soils. Various approaches have been used to map the status and distribution of soil micronutrients and availability at scales ranging from global to individual farmer’s fields. Soil micronutrient mapping for larger areas will guide us to understand the nature and extent of micronutrient problems (Shukla *et al.*, 2015).

Detailed micronutrient maps (at 1: 10000 scale) in individual fields are being developed for site-specific micronutrient management in precision agriculture. Modern tools like the Global positioning system (GPS), and geographic information systems (GIS), integrated with remote sensing technology, help policymakers with proper and balanced micronutrient management for sustainable crop production.

The Krishnagiri reservoir (KRP) is contributed by the river south Pennar, located about 6 km southwest of the Krishnagiri town of Tamil Nadu. The total command area is around 12482 ha, with paddy as a major crop. These paddy-growing soils are deficient in multi-nutrients with poor drainage capacity and soil sodicity /alkalinity due to high-water tables (Srinivasan *et al.*, 2019). This necessitates the identification of micronutrient deficiency in dam catchment, especially in paddy soils, which helps correct the specific nutrient deficiency and sustainable crop production.

Status and distribution micronutrients KRP Dam Catchment

Soil samples were collected from KRP dam catchment area and analyzed for the micronutrient status. After analysis it was categorized as deficient and sufficient in the specific micronutrient. The results are presented below

Table. 1 Area wise distribution of different micronutrients in Dam catchment

Nutrients	Class	Area (ha)	% TGA
Iron (Fe)	Deficient (< 4.5 ppm)	2507	20.08
	Sufficient (> 4.5 ppm)	7556	60.53
Manganese (Mn)	Deficient (< 3.0 ppm)	5728	45.89
	Sufficient (> 3.0 ppm)	4335	34.73
Copper (Cu)	Deficient (< 0.2 ppm)	-	-
	Sufficient (> 0.2 ppm)	10064	80.62

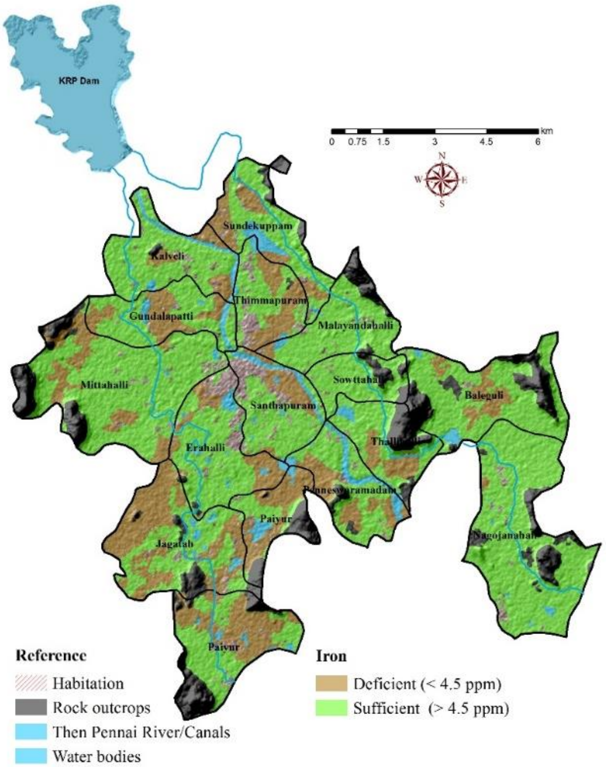
Zinc (Zn)	Deficient (< 0.8 ppm)	6190	49.58
	Sufficient (> 0.8 ppm)	3874	31.03
Boron (B)	Low (< 0.5 ppm)	7603	60.90
	Medium (0.5-1.0 ppm)	2460	19.70

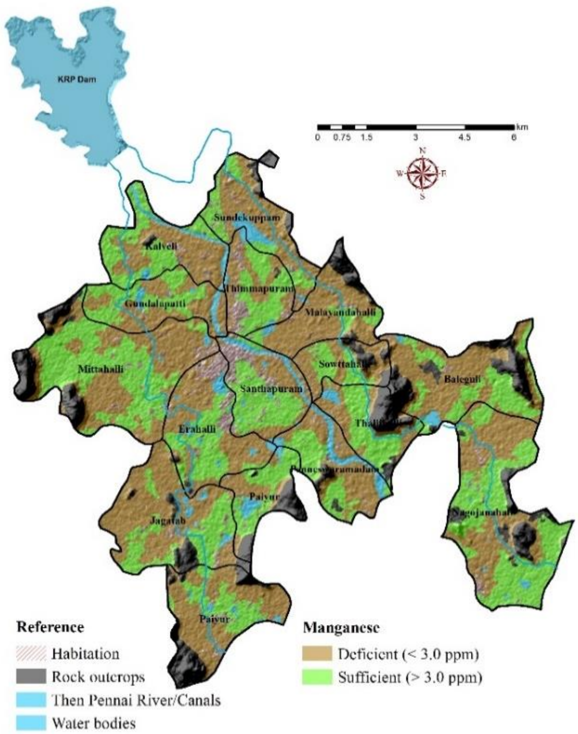
1. Iron (Fe)

Iron (Fe) is an essential micronutrient for crop growth and food production. It is the component of many enzymes associated with energy transfer, nitrogen reduction and fixation, and lignin formation. Fe is required for electron transport during photosynthesis. Plants uptake Fe in ferrous (Fe^{2+}) form. It is one of the most notable elements in paddy soils as it is abundant and undergoes redox transformation (Kyuma, 2004). Solubility of Fe increases after flooding and during organic matter decomposition (Dobermann and Fairhurst, 2000). Fe deficiency occurs when the soil concentration is below 4-5 ppm in rice soils while toxicity occurs above 300 ppm. In KRP Dam catchment, 2507 ha (20.08%) area is deficient in Fe. The deficiency zones were mapped with GIS that helps the farmers to know the status of Fe in their region.

2. Manganese (Mn)

Manganese (Mn) is a primary part of enzyme systems in plants and is involved in activating essential metabolic reactions and plays a direct role in photosynthesis. It also involved in oxidation-reduction reactions in the electron transport system and oxygen evolution in photosynthesis. Mn accelerates the germination of paddy seedlings while





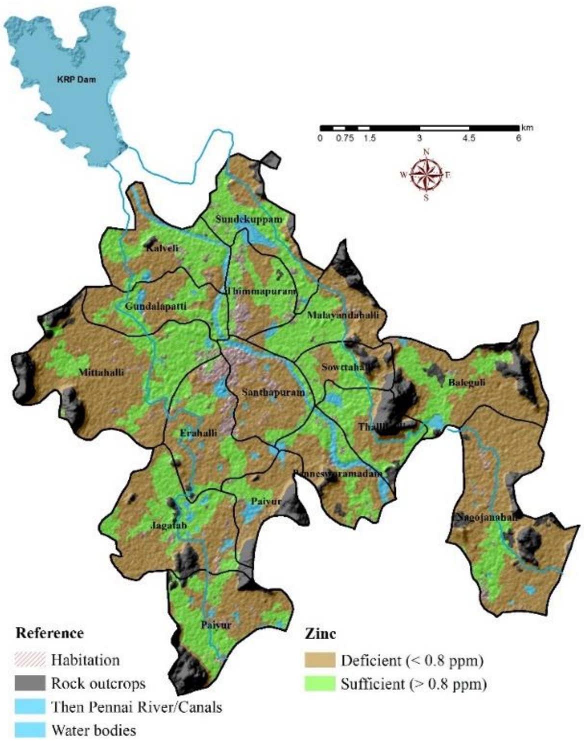
increasing the availability of phosphorus (P) and calcium (Ca). In KRP dam catchment, 5728 ha (45.89%) area is under Mn deficiency. Identification of critical Mn deficient soils helps to improve the paddy productivity in KRP dam Catchment.

3. Copper (Cu)

Cu is required for lignin synthesis and is a constituent of ascorbic acid and enzymes. It is a regulatory factor in enzyme reactions and a catalyst in oxidation reactions. In soils, Cu present as oxides, carbonates, silicates and sulphides and its chemistry in submerged soils is similar to that of Zn, forming sparingly soluble sulphides. Cu generally accumulated in the upper few centimetres of soils; however, it tends to be adsorbed by soil organic matter, carbonates, clay minerals and oxyhydroxides of Mn and Fe and accumulated in deeper layers of soil (Kabata Pendias, 2011). Cu concentration is sufficient in the study area as they are above critical levels of 0.2 ppm for rice production.

4. Zinc (Zn)

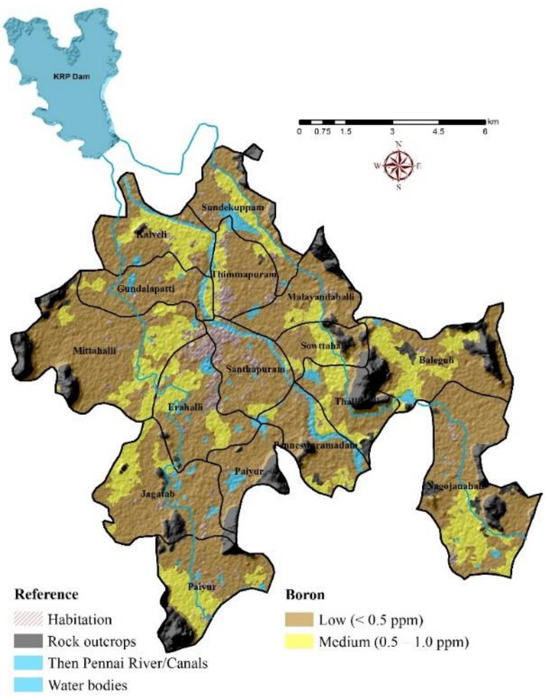
Plants take up zinc (Zn) as the divalent Zn^{+2} cation. Zn was the first micronutrients recognized as essential for plants and most commonly limiting yields. Though Zn requirement is meager, high yields are impossible if it is deficient. It is reportedly deficient in many paddy growing areas in the dam catchment. Available Zn status in the majority of the paddy growing soils (<0.8 ppm) was deficient. A sufficient (>0.8 ppm)



level of Zn was recorded in 31.03% of the KRP Dam catchment (Table 1). The extent and distribution of available Zn shown as thematic maps.

5. Boron (B)

Boron (B) is a unique non-metal micronutrient required for plants' normal growth and



development. It is mobile in soils and more often gets leached down the soil profile with excess moisture. B deficiency and toxicity range are very narrow. Boron concentration and its bioavailability in soils are affected by parent material, texture, clay minerals, pH, liming, organic matter content, sources of irrigation, interrelationship with other elements, and environmental conditions like rainfall and temperature. Boron (B) exists in soil as the BO_3^{-3} anion common plant uptake form. One of the most important micronutrients affecting membrane stability, B supports the structural and functional integrity of plant cell membranes. Boron-deficiency symptoms first appear at the growing points, and certain soil types are more prone to boron deficiencies.

Conclusion

Plants differ in their requirements for specific micronutrients. More than 40 % area was deficient in Mn, Zn, and B, whereas 20% area was deficient in Fe and Cu in the KRP dam catchment. These results showed that the paddy soils in KRP Dam Catchment are highly heterogeneous in micronutrient content. Identification of micronutrients deficient zones and mapping in GIS environment is a useful tool for better site-specific micronutrient management. Proper attention should be paid to the deficient nutrient through appropriate nutrient management practices for increasing the soil nutrient availability and sustain the yield and quality of paddy crop in the KRP Dam catchment.

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Termite mound impact on soil properties

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Termites are one of the dominant groups of soil macrofauna in the tropics. Termites belong to the order Isoptera, a group of cellulose-eating insects that build mounds to live. The structure of the termite mounds is complicated and has an extensive system of tunnels. There is a variety of shapes and sizes. The mound is constructed by the soil, termite saliva and dung. Though the mound appears to be in definite structure, it is porous in nature. Termite mounds can be observed in common fields may have a good source of nutrition. There are some evidences for the available plant nutrients in the soil, which are discussed hereunder:

Termites play a central role in the functioning of these ecosystems by regulating the distribution of natural resources such as water and nutrients. Termites are essentially detrivores, feeding on a wide range of dead plant material at various stages of decomposition. The utilization of such a wide range of food resources has been made possible by the close association with microbial symbionts in both gut and nest. As a consequence of a diet comprised entirely of autotrophically fixed carbon, they can exert a significant effect on carbon mineralization and nutrient recycling, especially where termite biomass is high, as in some tropical areas.

The nature of their parent materials largely determines the chemical properties of soils, but with additional influence from climate, vegetation cover and the activities of soil organisms, especially for older soils (Holt and Lepage, 2000). Termites use nutrient-rich salivary secretions and faecal material as cementing agents in construction. In some regions where termite activity is high, they can significantly modify soil chemical properties. Because of its higher clay content and usually higher exchangeable cation concentration, the translocation of soil from deeper to the surface during termite gallery and mound construction may also enrich the surface soil with nutrients useful to plants

Profile development

The mound building and gallery construction activities of termites in and on the soil significantly affect the structure and composition of soil profiles. The predominant termite-mediated processes causing profile modification are: 1) translocation of sub-surface soil to the surface, 2) microped structure and 3) creation of subsurface galleries.

Physical properties

The behaviour of termites in repacking soil, augmented with organic material derived from salivary and faecal products, during the construction of mounds and galleries has a marked effect on the physical properties of these constructions (Lee and Wood, 1971). Their subterranean galleries and chambers also influence soils' porosity and water-holding characteristics and under certain conditions, affect infiltration rates. In the case of soil feeding termites, although their galleries do not usually lead to the soil surface, they are numerous in the upper 200 mm of the soil profile. Where termite activity is high, the presence of galleries may significantly affect the hydraulic properties of the soils. Although there is less information on the effects of termites on the hydraulic properties of soils, the combined nest-building and foraging activity of termites in many tropical ecosystems is thought to have a considerable influence on their physical properties.

Chemical properties

In addition to altering the physical properties of soils, construction activity by termites often results in changes to the chemical properties of soils. Physical alterations primarily cause such changes via incorporating cation rich clay sub-soils into termite constructions and incorporating, or deposit of, organic rich faecal and salivary material into these constructions. Subsequent erosion of the mound material then provides the surface soil with additions relatively enriched in nutrients. Most research to date has shown that termite mound material contains significantly higher concentrations of the exchangeable cations Ca, Mg, Na, and K than adjacent soils. This enrichment has occurred because many species select particles from clay rich horizons within the soil profile to construct their mounds. Clay minerals present in termite mounds are mostly thought to have been derived from deeper parts of the soil profile although neo-formation by termite action has also been suggested as a possible origin for some minerals. The organic matter composition of termite mounds is influenced by the feeding habits of termites and concentrations are usually 2-5 times higher than that of the surrounding surface soil. The raised organic matter content of mound soil N and P is at a higher level.

Biological properties

Termite mound soil is similar to the soil from which it is constructed in that it usually contains large numbers of microorganisms. These microorganisms, predominantly fungi and bacteria, have various functions within the organic matter decomposition process (Adebajo, *et al.*,2021) The association between termites and fungi can be divided into two types, non-mutualistic and mutualistic. Non-mutualistic associations usually occur between dry wood termites and certain wood rotting fungi, with evidence suggesting that wood previously attacked by fungi is more palatable to these termites. Termite mound soil contains some useful bacteria capable of solubilizing phosphate and potassium and producing indole acetic acid, which are the plant growth-promoting potentials and suppress plant soil pathogen. It is evident from the three-fold increase in yield that plant growth is enhanced by termite mound soil (Rajagopal,1983).

Conclusion

Termite mound soil has a good source of plant nutrients and contributes to yield increase. The presence of organic matter, soil enzymes and rich microbial diversity in the termite mound soil helps to hasten the composting process of residues present in the soil. The farmers cultivating in sandy soils can enhance soil nutrient content through the mixed application termite mound soil with any organic manures and crop rotation with the legume crops. Further studies to explore the possibility of using termite mound soil as a nutrient source for crop production will helps the farmers to utilize the termite mound soil in productive ways.

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Intracellular Compartments and Protein Sorting

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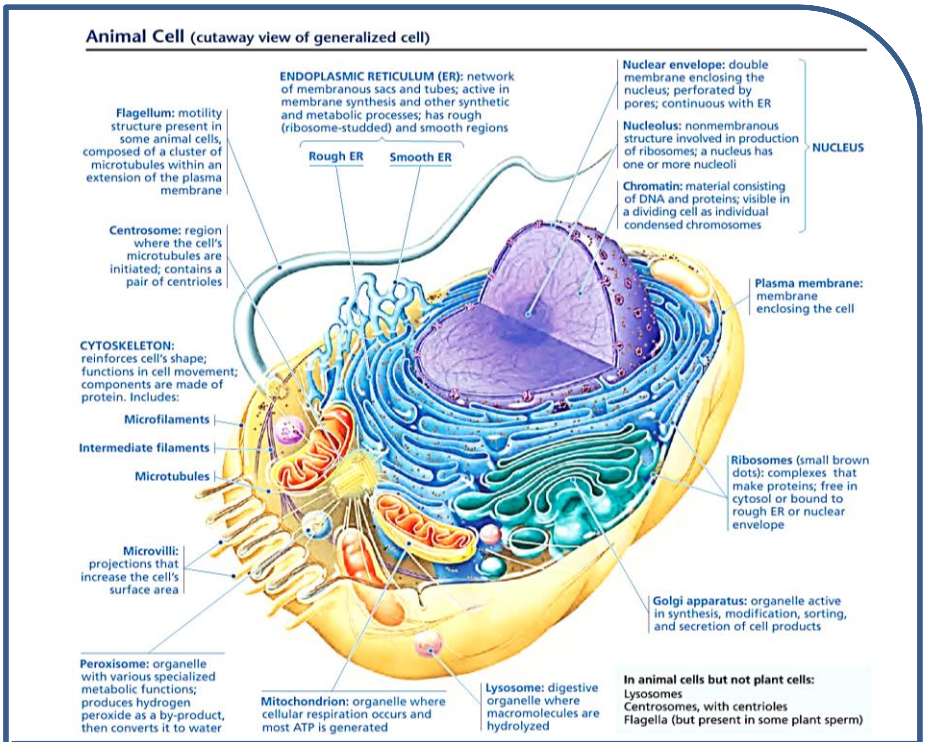
Cell is the basic unit of life. Cell exists in either prokaryotic or eukaryotic forms. Both the cells are different from each other in structure and function. A bacterium that generally consists of only intracellular compartment covered by a plasma membrane, is an example of prokaryotic cell whereas on the other side eucaryotic cell have membraned compartments that are functionally distinct and have enzymes of its own. It is necessary to study the structure and dynamics of these compartments of cell and role of protein trafficking in order to understand the cytology. These specific proteins confer upon each compartments their defined structural and functional properties. These protein beside acting as organelle specific surface markers, also catalases the various reactions inside the cell and transports biomolecule selectively into and out of the cell.



Reece Campbell biology chapter Unit1, chapter 5-page 100

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Components of Prokaryotic and Eukaryotic Cells and Their Functions				
Cell Component	**Function**	**Present in Prokaryotes?**	**Present in Animal Cells?**	**Present in Plant Cells?**
Plasma membrane	Separates cell from external environment; controls passage of organic molecules, ions, water, oxygen, and wastes into and out of the cell	Yes	Yes	Yes
Cytoplasm	Provides structure to cell; site of many metabolic reactions; medium in which organelles are found	Yes	Yes	Yes
Nucleoid	Location of DNA	Yes	No	No
Nucleus	Cell organelle that houses DNA and directs synthesis of ribosomes and proteins	No	Yes	Yes
Ribosomes	Protein synthesis	Yes	Yes	Yes
Mitochondria	ATP production/cellular respiration	No	Yes	Yes
Peroxisomes	Oxidizes and breaks down fatty acids and amino acids, and detoxifies poisons	No	Yes	Yes
Vesicles and vacuoles	Storage and transport; digestive function in plant cells	No	Yes	Yes
Centrosome	Unspecified role in cell division in animal cells; source of microtubules in animal cells	No	Yes	No
Lysosomes	Digestion of macromolecules; recycling of worn-out organelles	No	Yes	No
Cell wall	Protection, structural support and maintenance of cell shape	Yes, primarily peptidoglycan in bacteria but not Archaea	No	Yes, primarily cellulose
Chloroplasts	Photosynthesis	No	No	Yes
Endoplasmic reticulum	Modifies proteins and synthesizes lipids	No	Yes	Yes
Golgi apparatus	Modifies, sorts, tags, packages, and distributes lipids and proteins	No	Yes	Yes
Cytoskeleton	Maintains cell's shape, secures organelles in specific positions, allows cytoplasm and vesicles to move within the cell, and enables unicellular organisms to move independently	Yes	Yes	Yes
Flagella	Cellular locomotion	Some	Some	No, except for some plant sperm.
Cilia	Cellular locomotion, movement of particles along extracellular surface of plasma membrane, and filtration	No	Some	No

INTRACELLULAR COMPARTMENT	PERCENTAGE OF TOTAL CELL VOLUME
Cytosol	54
Mitochondria	22
Rough ER cisternae	9
Smooth ER cisternae plus Golgi cisternae	6
Nucleus	6
Peroxisomes	1
Lysosomes	1
Endosomes	1

Table 2. Relative Volumes Occupied by the Major Intracellular Compartments

Protein Sorting

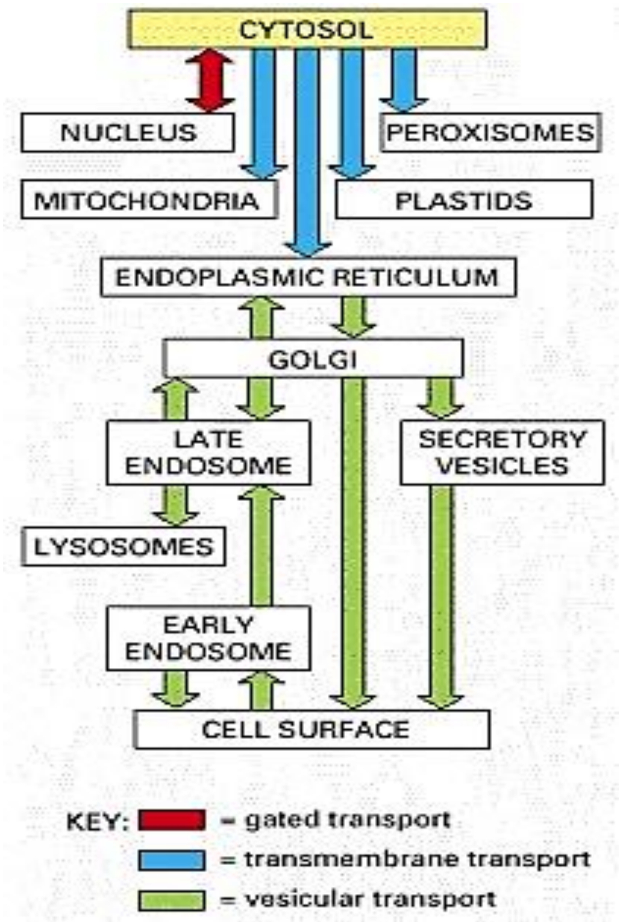
Most of the protein are synthesized in the cytosol by ribosomes except those that are synthesized by ribosome of mitochondria and in case of plant cell, those that are synthesized by ribosome of plastids. The fate of most of the protein are found in the form of sorting signal that guide them to the comparment or location outside the cytosol to nucleus, ER, or any other destination. Those protein that lacks such sorting signals stays behind in the cytosol as permanent residents.

The principle of protein sorting relies on the understanding of the fundamentals of movement of proteins from one portion/ compartment to another. These pathways include gated transport presented by red arrows, transmembrane transport and vesicular transport shown in blue and green color respectively. A signal is always required for either retention or for exit from a compartment.

The various mechanism can be divided into three as describe below:

1. Gated transport
2. Transmemebrane transport
3. Vesicular transport

Gated transport: It is most notable at the junction between the nucleus and the cytoplasm, where selected macromolecules are actively

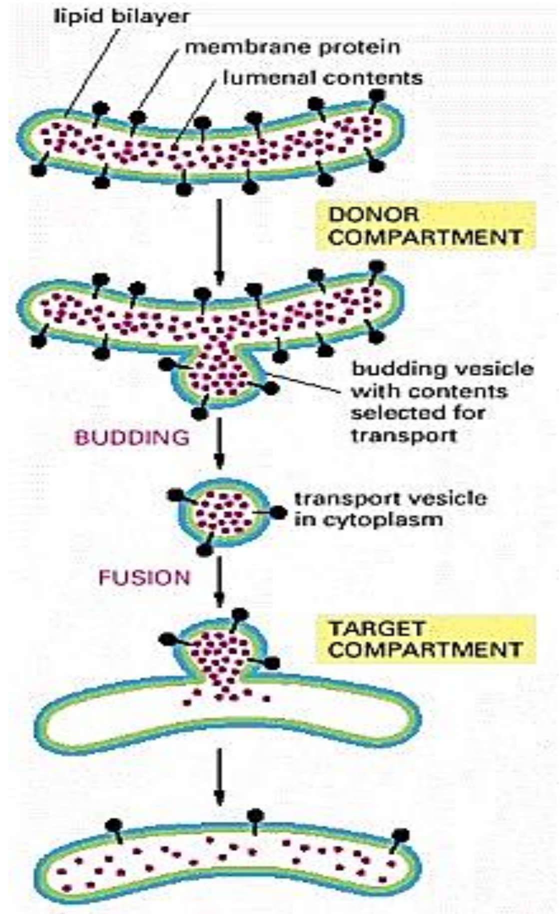


transported while smaller molecules are allowed free passage.

Transmembrane transport involves the participation of membrane-bound protein translocators which actively allow migration of proteins from the cytoplasm to other cellular cavities. It is believed that in many cases some degree of protein unfolding is required.

Vesicular transport does not require the protein molecules to pass through membranes. Instead, it is the membrane that migrates and fuses with other compartments taking the protein along with it, via a process known as pinocytosis. A transport intermediate enclosed with membrane of variable size and shape loads the cargo of molecule from lumen of a compartment by pinching off from its membrane, unloads their cargo into some other compartment by simply fusing with membrane. Movement between the endoplasmic reticulum and the Golgi apparatus occurs in this manner.

As visible from the diagram, from the donor compartment a transport vesicle buds off and fuses with recipient compartment or target compartment discharging the soluble protein. It can be observed that membrane also gets



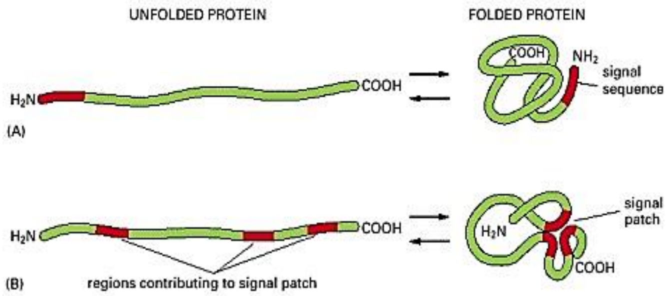
transferred and the original orientation of both proteins and lipids in the donor-compartment membrane is preserved in the target-compartment membrane. Thus, membrane proteins retain their asymmetric orientation, with the same domains always facing the cytosol.

In all three cases of protein trnasport, the sorting signals in the transported protein guides the protein transfer. This signal sequance is recognised by protein receptors that are complementary with the signal sequence. Thus, every proteins fate is dependent on the sequence they carry. Eg. A protein to be transported to nucleus must be carrying sorting signal that is recognised by receptor proteins that will allow to pass through the nuclear core complex and if a protein is to be transported directly through the membrane, must be carrying a signal that will allow allowed by translocators present in the membrane to be crossed. Likewise, there are sorting signals also for those protein that will be loaded in a vesicle or will be retained in the compartment.

Signal Sequences and Signal Patches Direct Proteins to the Correct Cellular Address

As discussed in above, protein fate relies on the sorting signal. There are atleast two sorting signals observable in proteins.

1. First is a continuous amino acid stretch of 15-60 residues, some of which are eliminated at the final stage of sorting process by signal peptidase.
2. The second signal patch consists of 3D arranged atoms on the surface of protein during the folding. The amino acid residues that comprise this signal patch can be distant from one another in the linear amino acid sequence, and they generally persist in the finished protein



A) The signal resides in a single discrete stretch of amino acid sequence, called a signal sequence, that is exposed in the folded protein. Signal sequences often occur at the end of the polypeptide chain (as shown), but they can also be located internally. (B) A signal patch can be formed by the juxtaposition of amino acids from regions that are physically separated before the protein folds (as shown). Alternatively, separate patches on the surface of the folded protein that are spaced a fixed distance apart can form the signal.

Each sequence acting as a sorting signal leads to different destination eg.Protein to be sent to ER will have a N- Terminus sequence composed of 5-10 hydrophobic Amino Acids(AA). Out of the proteins that have specific sequence of 4 AA at C termnius will be recgonised as ER resident and returned

FUNCTION OF SIGNAL SEQUENCE	EXAMPLE OF SIGNAL SEQUENCE
Import into nucleus	-Pro-Pro-Lys-Lys-Lys-Arg-Lys-Val-
Export from nucleus	-Leu-Ala-Leu-Lys-Leu-Ala-Gly-Leu-Asp-Ile-
Import into mitochondria	$^{+}H_3N$-Met-Leu-Ser-Leu-Arg-Gln-Ser-Ile-Arg-Phe-Phe-Lys-Pro-Ala-Thr-Arg-Thr-Leu-Cys-Ser-Ser-Arg-Tyr-Leu-Leu-
Import into plastid	$^{+}H_3N$-Met-Val-Ala-Met-Ala-Met-Ala-Ser-Leu-Gln-Ser-Ser-Met-Ser-Ser-Leu-Ser-Leu-Ser-Ser-Asn-Ser-Phe-Leu-Gly-Gln-Pro-Leu-Ser-Pro-Ile-Thr-Leu-Ser-Pro-Phe-Leu-Gln-Gly-
Import into peroxisomes	-Ser-Lys-Leu-COO^{-}
Import into ER	$^{+}H_3N$-Met-Met-Ser-Phe-Val-Ser-Leu-Leu-Leu-Val-Gly-Ile-Leu-Phe-Trp-Ala-Thr-Glu-Ala-Glu-Gln-Leu-Thr-Lys-Cys-Glu-Val-Phe-Gln-
Return to ER	-Lys-Asp-Glu-Leu-COO^{-}

Some characteristic features of the different classes of signal sequences are highlighted in color. Where they are known to be important for the function of the signal sequence, positively charged amino acids are shown in *red* and negatively charged amino acids are shown in *green*. Similarly, important hydrophobic amino acids are shown in *yellow* and hydroxylated amino acids are shown in *blue*. $^{+}H_3N$ indicates the N-terminus of a protein; COO^{-} indicates the C-terminus.

to ER. Similarly, protein that will have +vely charged AA alternating with hydrophobic ones, All sorting signals are recognized by sorting receptors that are complementary to the sorting signals then guide proteins to their appropriate destination, where they unload their cargo. The receptors function catalytically: after completing one round of targeting, they return to their point of origin to be reused. Most sorting receptors recognize classes of proteins rather than just an individual protein species. They therefore can be viewed as public transportation systems dedicated to delivering groups of components to their correct location in the cell. will be sent to mitochondria. Some of the specific signals are given in the below.

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Container Gardening in Small Home Areas

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Introduction

The simple concept of growing plants in bags, buckets, or even in food grade plastic bottles offers many ways to enjoy gardening. In containers such as the right growing medium, a good choice of plants and a window, balcony and containers will give us the pleasure of growing plants in an area. Where traditional gardening is impossible, plants can be easily grown even with limited space such as a window sill, a door, a balcony, a courtyard, a staircase, even ceiling and hanging baskets etc.

Fig. 1.0 Container gardening

Benefits of container gardening

- Smaller gardens result in lower costs
- Costs are extremely limited
- Less growing medium
- Less fertilizer and
- Less water

Choice of containers

almost any type of container can be used for growing plants such as planter boxes, plastic baskets, gallon cans and tubs with drain holes in the bottom. Containers can be purchased, built from all kinds of materials. It is always important to choose containers that best accommodate the sel. plant species. Containers come in a varies of sizes, and shapes. The choice will depend upon the type of plant and the location. The size of the container will vary according to the crops. and space available.

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Growing media

First, we have to choose the container growing media for planting of herb plants in containers, choosing before the various characters, visual seen those media *viz.*,a light in weight, well-draining, highly porous medium is needed for container growing. Some growing medium is as under - loamy garden soil and peat moss with coarse (1:1:1), and other medium are sand, peat moss, compost, peat moss, sawdust, wood chips, coir, bark, perlite and vermiculite etc. Their pH value of medium is highly & water holding capacity *viz*. 6.5-7.0.

Filling the container

When filling a container, leave at least a 5 cm space between the top of the soil and the top of the container to adding some mulch (about four/fifths full). Keep it 10 cm for plants that need a lot of water. and when watering the plant in the container, it will automatically the growing medium will settle.

Seeding and trans-planting

Seeds can be germinated in any container filled with a good growing medium. Cover most seeds to adepth of 0.5–1.5 cm for good germination. Seedling production should be started in a warm room with sufficient light. It takes 4 to 8 weeks before trans-plantation date into the final container.

Suitable plant for container gardening

1. Periwinkle
2. Portulaca

3. Salvias
4. Verbenas
5. Ornamental paper
6. wax begonias

Planting

Plant at the same time as in a regular garden. after planting, water the soil gently. Should stakes or other supports be needed, provide them when the plants are very small to avoid later root damage.

Sunlight

The amount of light the container plants will need varies with the plant species. It will determine which crops can be grown. Most plants require a minimum of 5-6hours of direct sunlight per/day.

Fertilizing

Since potting mix drains water rapidly, nutrients will be washed out of the container(leaching)with frequent watering. Therefore, it is necessary to supplement growth of container plants with fertilizer. after the first month of growth, add a diluted organic fertilizer (manure tea or compost tea, seaweed extract) when watering. One can apply such a diluted fertilizer every two weeks and adjust fertilizer levels as necessary, but remember to provide the plants with a variety of nutrients (mineral and organic, also trace elements). a slow-release fertilizer (14-14-14) in the right dosage per volume.

Watering

Timely watering is essential for successful container gardening. Container plants in an open space lose moisture very quickly from heat or wind. Therefore, it should be given water at regular intervals with the help of water cane.

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Haber, ES 1930. The effect of various containers on the growth of vegetable plants. Bull., 24(1930): 279.

Upcoming Issue