I Am the Life of the Party because I’m a Fungi!

**Introduction to Fungi**

Eukaryotic cells are large diverse groups of organisms, which includes animals and plants. There is one large group eukaryotic cellular organism that contains a lineage filled with evolutionary development is fungi (plural for fungus) [4][7]. Mildew, yeast, molds, mushrooms, and smuts are all included in the kingdom Fungi [2]. The history of fungi plays a large role as to how it peaked interest in the science community, the characteristics of a fungus are unique. Fungi are distributed all over the world, they contribute to economic success from agriculture to medicine [3], they keep the environment balanced by decomposing organic matter into nutrients and recycling that back into the earth for other organism to utilize [3].

**History**

Fungi is a term that often times is mistaken for an organism with negative benefits or association to fungal infections that are not intriguing to the eyes. This is due to its musky nature that makes them seem as dangerous and dirty [7]. There is no strong scientific evidence to help support the age of fungi due to them not being able to be fossilized with all their structures intact. Although that has been the case within the past several years, technology in science is evolving. Scientist have been able to collect two hypotheses which include the following: one, fungi have been around way before plants or two, that they were around the same time as plants around the Pre-Cambrian era. The main modification between fungi and land plants is that fungi first evolved in water, and then they migrated into land making them successful land organisms like plants. While having both of these hypotheses, there is evidence that around the time 420 million years ago, both plants and fungi were simultaneously evolving around the same period [7].

**Structural Make Up of Fungi**

For several years since their discovery, fungi have been classified as a plant. This is due to fungi containing the same morphology as a plant and as well as the lack of research on the organism [7]. It was not until about the 20th century that scientist decided to deeply inspect its cellular components. It was concluded that genetic makeup of a fungi is closely more related to an animal than it is a plant. Fungi are classified as eukaryotic organisms. They contain a complex form of cellular components.

The fungal cells contain the following: cell wall, a true nucleus, mitochondria, and internal membranes, which includes the endoplasmic reticulum (ER) and Golgi apparatus. The cell wall of the fungus protects the fungal cell from any outside harm. Other roles that derive from the cell wall is that the cell wall maintains the fungal cell morphology and its ability to replicate fungal cells in a protected environment. The cell wall allows the fungal cell to produce high levels of turgor to help with the growth of the cells, or any form of penetration or invasion in the environment. **Turgor** is the rigidity of the fungus due the the pressure within the contents within the cell that is pushed against the cell wall leading to the fungus to wilt. A true nucleus contains DNA that is surrounded by a membrane, it is able to direct the synthesis of ribosomes and proteins (they are organelles that are responsible for protein synthesis). The mitochondria is an organelle that is membrane bound that is found in the cytoplasm of a large portion eukaryotic cells that is able to generate energy that leads to adenosine triphosphate (ATP). The endoplasmic reticulum is located in the cytoplasm of the cells and has a multitude of functions that involve synthesis, modifications, folding, and transportation of proteins. The Golgi apparatus induces secretion [8] and intracellular transport. Fungal cells do not contain a chloroplast or a chlorophyll. Fungi contains bright pigments of color that are associated within the cell wall, but they are helpful against radiation coming from ultraviolet light or predators. Fungi have thick cell walls unlike plants. Their cell walls contain complex forms of polysaccharides that are called chitin and glucans, Fun fact: Insects also contain chitin on their exoskeleton! Chitin in fungus prevents their cell from drying out and from harmful predators [9].

**Modern Contributions of Fungi in Agriculture**

 Most individuals do not think about how fungus contributes to economic growth or how they contribute to food [3][4]. Fungi can be cultured and non-cultured. **Culture** means that they are grown for a purpose, and **non-cultured** means that the fungi are harvested from the wild. Fungi that are cultured can be used in cultural dishes of food. Caution: do not eat mushrooms from the wild unless an expert has declared them safe to consume. Most mushrooms are known to be very harmful to humans. White buttom mushroom is the most common mushroom that is cultivated. This mushroom is able to be grown in a variety of places since they do not need any form of light to allow them to grow. The United States has mushroom houses that allows these white button mushrooms to grow. Organic waste, manure, and rotting hay are inoculated with the spores of the mushroom. This compost is kept in a cold and moistened environment. This allows them to grow appropriately. The button mushrooms are collected before their caps open up.

A **mycorrhizal**, term that refers to the role of the fungus in the plant's rhizosphere, in other terms for a relationship that involves fungi and plant roots. **Rhizosphere** is the plant’s root system. This is highly essential for agriculture because it helps farmers maintain a healthy ecosystem for trees and grasses. Supporters for organic agriculture heavily promote mycorrhizal fungal inoculants to be added to soil, this are commonly found in supply stores for gardening. Fungus goes from helping the farm maintain a healthy ecosystem to being food for humans. *Penicillium* is a common mold used to help cheese ripen. This mold is collected in its original environment. Sheep cheese is set out and stacked together to collect the molds that are responsible for creating the blue veins and the overpowering taste of the cheese. Beer is created by fermenting grains, and wine is produced by fermenting fruits. This is a common form of pratce that humans have developed and mastered over the centuries. Wild yeast was attained from its environment by humans within the past thousands of years. These wild yeast under anaerobic (absence of free oxygen) [1] were fermented from sugars to CO2 and ethanol. Louis Pasteur, French- microbiologist, developed a reliable strain for brewing yeast around the late 1850s [3]. Yeast plays a huge role in food, this is because it is the main and significant ingredient in bread. Bread has been around for centuries. When bread was first discovered, it was made by letting dough naturally collect yeast that floated in the air. Within a few hours to days, this allowed for the dough to contain the yeast and used as a starter to next time make bread. Sourdough is still constructed the same way in today’s time [3].

**Fungi in the Medical World**

 Many individuals are familiar with molds and yeast, but they often times forget that importance of fungus in the medical field. Fungi can often times be a source of medical chemicals. It could be derived from the mold on a decaying piece of a fruit, cultivated and non-cultivated mushrooms which are useful for creating medicine to deal with health issues. Fungi are able to naturally create antibiotics that kill and inhibit any potential growth of bacteria [6]. Looking at this though evolutionary aspect, this is so fungi can strive in the environment while bacteria diminishes. This is to limit any form of competition.

Penicillin and cephalosporin are medications obtained and isolated from fungi [5]. Cyclosporine is an immunosuppressant that decreases any form of risk of rejections after an organ is donated. Cyclosporine is a very valued drug in medicine. Cyclosporine is able to enable to stop bleeding by using antecedents of steroid hormones, and alkaloids containing ergot. **Ergot alkaloids**: are drugs that narrow the blood vessels that are surrounding the brain. Penicillin is medication that is derived from mold. Penicillin is able to kill bacteria and is an antibiotic. The first ever antibiotic to be founded is penicillin. The reason why penicillin became a great scientific discovery is that penicillin is able to kill bacteria by preventing the bacteria from creating a cell wall. When a bacterial cell is growing, the cell wall is reconstructed to accommodate the new developed size. When penicillin is involved in this process, a gap is developed in the wall when the cell is growing. Since there is a lack of new material of the cell wall, the contents spill out of their container causing the cell to die.

Fungi have greatly contributed to research, especially in genetics. The red bread mold, *Neurospora crassa,* has allowed a road of many scientific advances in modern genetics. Scientist discovered that *S. cerevisae* created a starting point for comparable human genes to this species of fungi. *S. cerevisae* is able to modify proteins that are in the same manner as human cells. *Escherichia coli* is commonly used in research, but since it lacks an internal membrane structure and enzymes that tag proteins to enable exportation out of the cell, this is what makes yeast a better alternative to use for experimenting with recombinant DNA. Bacteria and yeast both have in common that they can easily grow in culture, can be genetically be modified with ease, and do not have a long generation time.

**Keeping Balance to Ecosystems**

Fungi are able to strive in environments that are moist [4]. When ecosystems decompose organic matter into nutrients it is with the help of fungi. Cellulose and lignin are tough organic compounds that fungi are able to break down due to their ability to metabolize their complexity of organic material to soluble nutrients that include simple sugars, nitrates and phosphates. Fungi are able to digest their food outside their bodies since they are able to soak up nutrients into their cells. Plants rely on decomposers, like fungi, to obtain soluble nutrients that are found in the soil that are then taken in by their roots. Nitrogen is an important nutrient for a plant, but nitrogen is not easily absorbed by plants, therefore this leads fungi to metabolize proteins in the nitrogen to release inorganic forms of it which is nitrite. Nitrate is then easily absorbed by the plants [4]. There are animals who depend on fungi as a source of food. Opportunistic fungus feeders eat fungus if they ever come across it. Caribou heavily rely on lichens on trees during winter, this is due to the lack of leafy foods since they are not available during the cold time of the year. An A long-nosed potoroo, which is a mammal in Australia, mostly eats fruiting fungi (these are a type of fungi that contains spores that are used for reproducing) [4].

**Potential Negatives of Fungi**

 Even though there are positive contributions that fungi contribute to, they are negative contributions that also occur. Molds can lead to food being spoiled and they can release spores and toxins that create a public health risks, for example includes difficulties with breathing. Fungi can also be pathogenic and can destroy farmer’s crops and create diseases in plants that can ruin an entire season of food. Mushrooms are edible and are important sources of food, but not all mushrooms are edible. Some are poisonous and can be lethal if they are consumed. There are limited amounts of medicine and antidotes to combat a health issue lead on by a mushroom [5].

**Positive Contributions of Fungi and Conclusion**

The history of fungi leading to modern scientific discoveries is amazing. The structural make up of fungi has allowed for scientist to fully understand them that they are their own kingdom. They are not the same as plants. Fungi are made up of molds, yeast, mushrooms, etc, and they are crucial to the agricultural business. Breweries, bakeries, and food processing factories benefit from the development of fungi and yeast because it allows the beer to be richer (due to the enhancement of yeast) and food to be created in more clever ways. Molds and fungi allows for the cycle of life to be completed by being the decomposers of the ecosystem. **Decomposers:** are organisms that are able to break down organic matter into nutrients. They are able to cycle food to plants by assisting them on breaking down organic matter that is too large for plants to do on their own.

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