Teachers´ Manual- How to Grow Mushrooms

Lead organisation:

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Background Information

Topic:

Valorisation of organic waste, sustainable nutrition, mushroom cultivation, used coffee grounds

Narrative:

- For a transformation towards a sustainable society, education about sustainable practices and bioeconomic principles is key.
- It is elemental that students understand early on that the success of a sustainable and circular economy depends on our actions and behaviour and how and what we consume daily.
- Organic (lignocellulosic) waste such as used coffee grounds can be used as mushroom cultivation substrate and valorised into food.

Relevance of topic:

Incorporating mushroom cultivation into classrooms offers a unique, engaging learning experience. It provides students with basic knowledge about the bioeconomy and teaches eco-friendly, low environmental impact practices. Additionally, students learn about culinary uses, reduced carbon footprints, circular concepts (food loop), nutritional value, and health benefits.

Didactic model used:

The following principles of learning for sustainable development are integrated in the assignments:

- Student-centered
- Action-oriented
- Project-based (experiential, experimental, participatory)
- Collaborative learning
- Connected to the daily life of the students

EU Mission: A Soil Deal for Europe (Reduced carbon and overall environmental footprint of the horticultural sector and more sustainable production systems)

SDG: 12 (Responsible consumption and production)

Age group: diverse (primary, lower secondary)

Curriculum:

Biology, nutrition education, environmental education, food loop, sustainable development

The following themes are addressed in this material:

	Interconnectedness ☒	**Interconnectedness** reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.
	Outdoor learning ☐	**Outdoor learning** is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.
	Food Loop ☒	**Food Loop** encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.
	Forestry ☒	Whilst **forestry** products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.
	Life Below Water ☐	**Life below water** refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.

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Introduction- Why Grow Mushrooms Using Coffee Grounds?

Pink oyster. ©Teaching Kitchen IBBA, TU-Berlin

Education about sustainable practices and bioeconomic principles is elemental for a transformation towards a more sustainable society. It is important that students understand early on that the success of a sustainable and circular economy depends on our actions and behaviour and how and what we consume daily. Incorporating sustainable mushroom cultivation on coffee waste into classrooms offers a unique, engaging learning experience. It provides students with basic knowledge about the bioeconomy and teaches eco-friendly, low environmental impact practices. Additionally, students learn about culinary, and non-food uses, reduced carbon footprints, circular concepts (food loop), nutritional value, and health benefits of mushrooms.

Using used coffee grounds as a substrate for mushroom cultivation exemplifies bioeconomy principles by transforming waste into a valuable resource. This method can significantly reduce environmental waste, with nearly 60 million tons of spent coffee grounds discarded worldwide [1] Rich in lignocellulosic content, used coffee grounds are ideal for mushroom cultivation. This approach leverages an abundant waste product, contributing to the bioeconomy by creating a sustainable food source.

Used coffee grounds (also called: spent coffee grounds) are the by-product of coffee brewing after coffee is prepared. One key advantage of using fresh used coffee grounds for mushroom cultivation is their inherent safety. The process of brewing coffee pasteurizes the grounds, making them a microbially safe substrate and ensuring the safety of the substrate used.

Edible mushrooms are gaining popularity in daily diets not only for nutritional reasons but also because of their nutraceutical and medicinal properties. They are recognized as a new superfood for the future because they are low in calories, fats, and cholesterol, while being rich in protein and packed with essential vitamins[2]. So, they also have the potential to address issues such as food and protein insecurity. Ideal for indoor urban cultivation, mushrooms do not require extensive infrastructure and can quickly grow in small pots or designated growing rooms. Urban indoor mushroom farming aligns with the bioeconomy concept by reusing waste materials such as used coffee grounds. The EU[3] reports that 91 grams of waste is produced for every 100 grams of coffee used, and mushrooms can thrive on this waste, using it as a nutritious substrate for growth.

This manual equips teachers with the essential knowledge how to grow mushrooms successfully at home or school using coffee waste as a class project. It contains a detailed step-by-step instruction while also providing background information on mushrooms in the chapter “Good to Know”. At the end of the manual, worksheets and exercises for students are ready to be printed or adapted as inspiration.

Learning Goals

After working on the topics and tasks in the manual, the students will acquire the following knowledge, skills and competencies:

Understanding Bioeconomy and Mushroom Basics

- Understand the definition of bioeconomy
- Engage students with practical knowledge about minimising organic waste
- Grasp the fundamental biology and life cycle of mushrooms
- Comprehend the ecological significance of mushrooms and their role in recycling organic matter

Sustainable Practices

- Recognise the environmental benefits of using used coffee waste as a substrate for mushroom cultivation
- Implement sustainable and eco-friendly practices in mushroom cultivation

Practical Cultivation Skills

- Prepare coffee waste effectively for use as a mushroom-growing medium
- Inoculate the substrate with mushroom spores or mycelium
- Maintain optimal conditions for mushroom growth, including temperature, humidity, and light
- Know ways of problem-solving and troubleshooting when cultivating mushrooms
- Diagnose and address common issues in mushroom cultivation, such as contamination and suboptimal growth conditions

Utilisation

- List various uses for mushrooms
- Know different culinary applications of mushrooms
- Prepare dishes containing mushrooms with the help of an educator

By mastering these competencies, students will be equipped with the practical skills and theoretical knowledge necessary to cultivate mushrooms sustainably on used coffee grounds, contributing to waste reduction and sustainable food production.

Aspects of Sustainability

Cultivating mushrooms on coffee waste offers numerous advantages in terms of sustainability including social, economic, environmental, and health-related benefits. The following table outlines the four dimensions of sustainability associated with the cultivation of mushrooms on spent coffee grounds.

Table 1 Exemplary sustainability aspects of mushroom cultivation on used coffee grounds

Sustainability aspects of mushroom cultivation on spent coffee grounds	
Social aspects 	• Providing nutritious food to communities • Community engagement- potential for collaboration with local coffee shops and businesses, thereby fostering a sense of community
Economic aspects 	• Job creation- It has potential for small-scale local employment and business start-ups in mushroom cultivation. • Niche Market- This type of cultivation has the potential to create a unique market for gourmet mushrooms grown using sustainable and eco-friendly techniques. • Potential to foster eco-friendly practices of mushroom farms • Local economy- Recycling coffee waste to produce mushrooms supports the local economy, such as local cafés. • Income generation- It generates potential income for growers and suppliers of mushroom spawn and equipment. • Potential to maximise the use of coffee waste to produce an additional marketable product such as mushrooms.
Environmental aspects 	• Climate impact mitigation- The reduction of a carbon footprint is facilitated by the conversion of waste containing lignocellulose into valuable by-products, which helps to mitigate the impact of climate change. • Reduce food waste and resource efficiency - Cultivating mushrooms on coffee waste effectively reduces household waste by repurposing used coffee grounds as a substrate, offering a practical solution for waste minimisation. • Mushrooms are a potential sustainable meat replacement.
Health aspects 	• Nutrition- mushrooms contribute to a healthier diet by having essential vitamins, nutrients, proteins, fibers, and minerals.

Good to Know

Food systems exert a substantial impact on the environment; however, the application of bioeconomy principles offers a pathway to mitigating these effects. The Food and Agriculture Organization (FAO) defines a bioeconomy as an economy that relies on the sustainable and circular use of ''biological resources and processes to produce food, feed, bio-based products, and services''[4].

The bioeconomy promotes sustainability by transforming biological resources into valuable products such as bioenergy, bioplastics and organic fertilisers. In addition, using by-products at household and local levels increases resource efficiency, reduces waste and minimises carbon footprints. By integrating bioeconomy principles into everyday practices, communities can contribute to a sustainable future while building resilience to climate change and resource scarcity. By emphasising the sustainable management of resources, minimising waste, and utilising renewable biological materials, we can develop food systems that are more efficient and environmentally sustainable.

The cultivation of mushrooms on spent coffee grounds represents an exemplary case of the practical application of the bioeconomy principles. It showcases how organic waste can effectively be transformed into valuable outputs, including food and soil improvers.

The following subchapters give background information and an overview of mushrooms, as well as their taxonomy, morphology, habitats, cultivation, applications, nutritional value, and carbon footprint. In addition, characteristics of the most important edible mushrooms are listed, and the poisonous potential of mushrooms, as well as false friends are mentioned.

Taxonomy- Mushrooms or Fungi

It is essential to remember that while all mushrooms fall under the category of fungi, not all fungi develop into the mushroom form; for instance, yeasts and moulds do not. Fungi are *heterotrophic eukaryotes* that inhabit various environments worldwide, including soil, water, air, and decaying organic matter. Fungi include a wide array of organisms, and the most known ones in our daily life are moulds, yeasts, edible mushrooms we use for food, bracket fungi, plant rusts, smuts, and puffballs (see Fig 1). Unlike plants, fungi cannot produce energy directly from sunlight using *chlorophyll*. Instead, they rely on absorbing nutrients from surrounding organic materials. This distinctive nutrition method sets fungi apart from plants, which rely on photosynthesis. Fig.1 illustrates the taxonomy of fungi[5] (orange) while highlighting in blue where mushrooms (including both edible and inedible mushrooms) are classified.

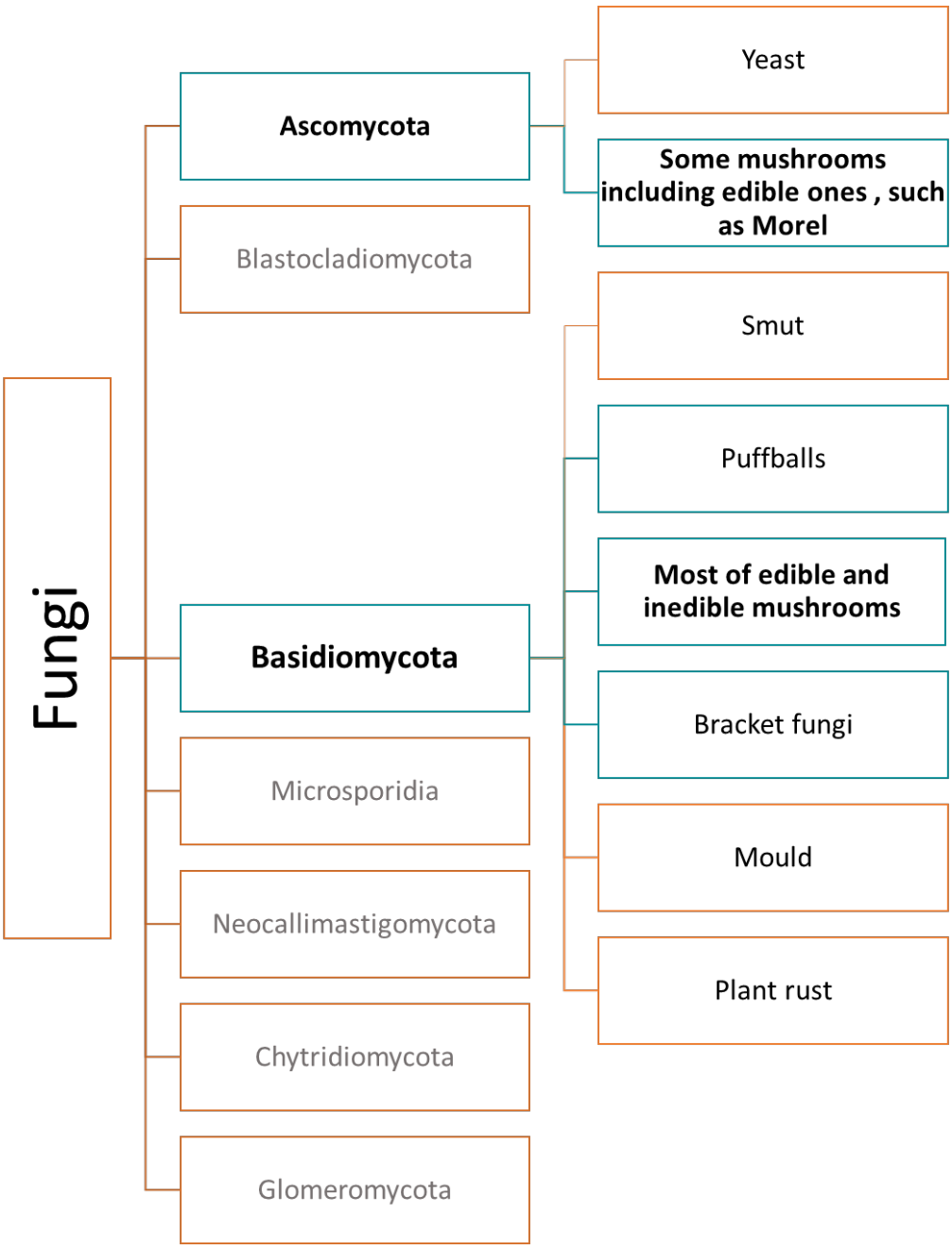

Figure 1 Kingdom of fungi [5].

Morphology and Lifecycle

Mushrooms are the most visible part and fruiting bodies of fungi. They are larger than 1 mm and produced by ascomycete and basidiomycete fungi (as shown in blue in Fig.1) during their sexual reproduction cycles. The most well-known species of edible mushrooms belong to Basidiomycota as depicted in Fig.1[6]. Mushrooms serve a function like flowers or fruits in plants, producing microscopic spores equivalent to pollen or seeds for reproduction. A mushroom is the fruiting body of fungi, comprising a stem, a cap, gills, and in some cases, a ring. It can vary widely in size and shape. The living body of fungi includes the hyphae and mycelium. The mycelium can be compared to roots in plants and is a body of filamentous thread-like tubes called hyphae. The hyphae are mainly responsible for the absorption and transportation of nutrients. Mushrooms can be classified as edible, inedible, medicinal, poisonous, or miscellaneous [7,8]. Figure 2 illustrates the structure of a mushroom[9].

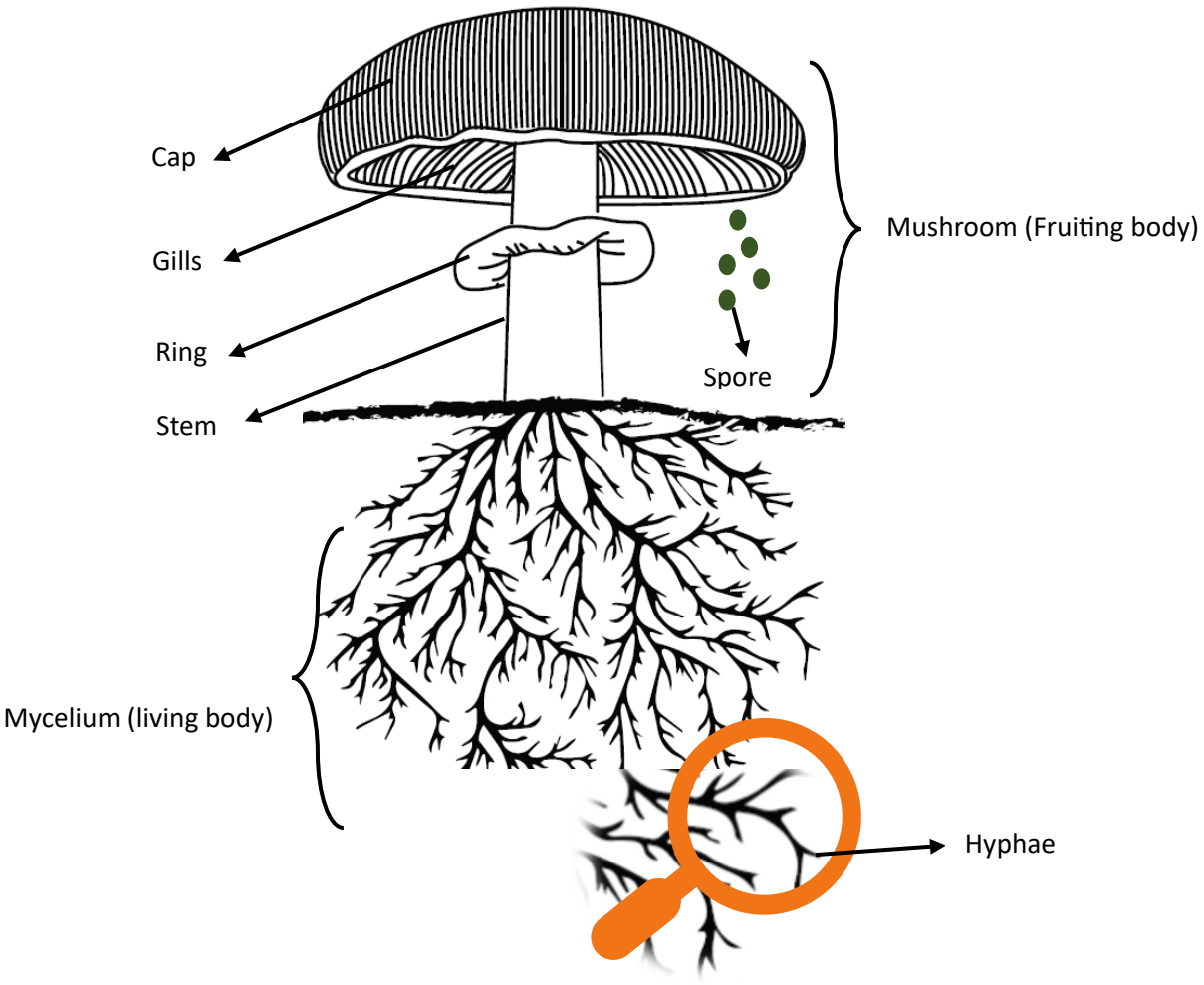

Figure 2 Anatomy of a mushroom based on Sağlam and Özgünler[9].

The Lifecycle of a Mushroom is demonstrated in Fig.3 and comprises the following phases:

- **Spore**: Mature mushroom releases spores.
- **Hyphae**: When the spore lands in a suitable environment, it germinates and produces thread-like structures known as hyphae. Hyphae grow and eventually meet other hyphae (this process is called plasmogamy), where they fuse to form a mycelium.
- **Mycelium** grows where the nutrients are available, for instance within dead, lignocellulosic-rich material. That is why they are usually in the soil and not visible on the surface. The mycelium continues to grow and eventually reaches the surface when conditions such as temperature, moisture, and nutrients are ideal. These conditions are essential for the mycelium's development.
- **Hyphal Knot Formation**: When two compatible hyphae meet and bond, they form a hyphal knot in the soil that will eventually develop into a fruiting body (mushroom) when the knot reaches the surface.
- **Mature Mushroom**: As the mushroom matures, it eventually releases spores, continuing the cycle[10]

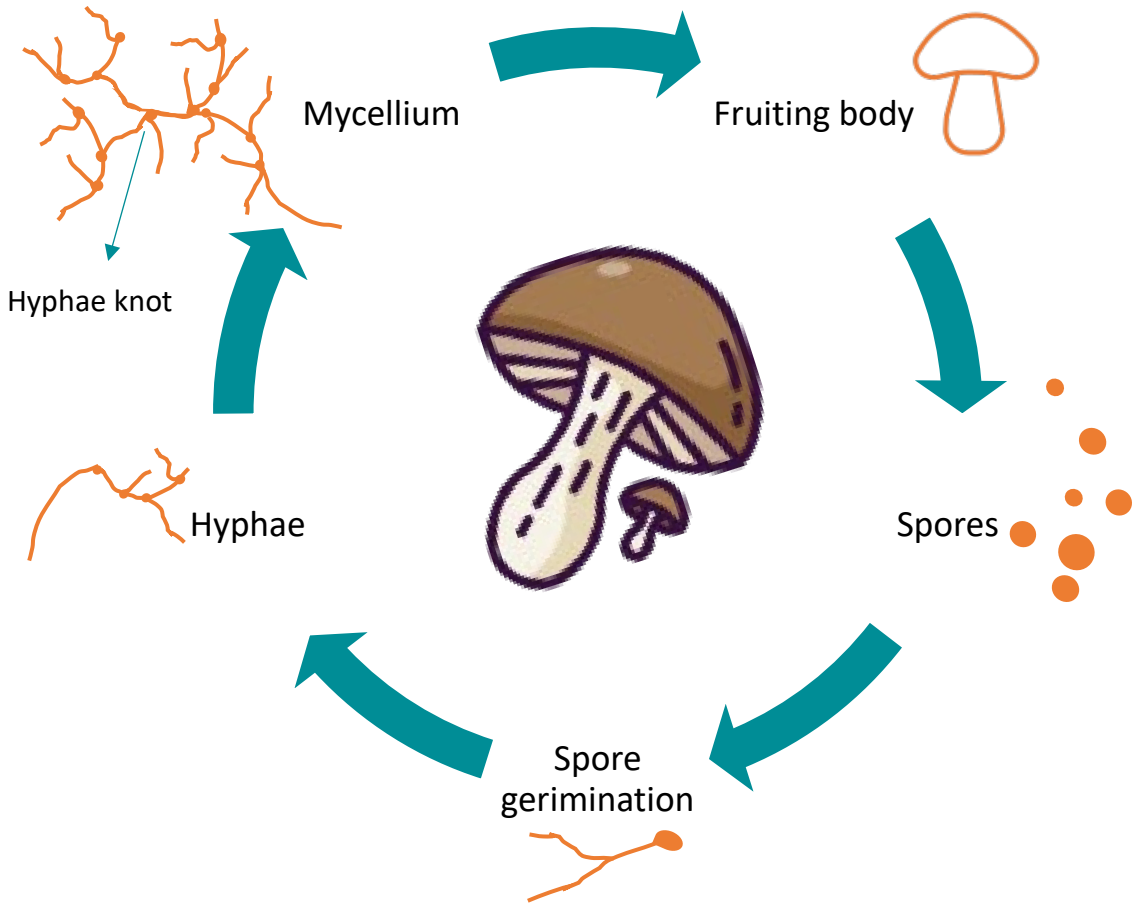

Figure 3 Schematic life cycle of a mushroom[10].

Function of Mushrooms in the Ecosystem

Mushrooms, with their diverse species, inhabit various environments, especially in forest ecosystems[11]. However, it's important to note that a mushroom species that thrives on decaying wood in forests is unlikely to be found in sandy environments, indicating their specific habitat preferences. This also suggests that each species may have limitations in the number of habitats it can occupy. Mushrooms support ecosystems in various way such as contributing to the cycle of nutrients and carbon, or providing a food source[12]. One of the most crucial ecological functions of mushrooms is decomposition, a process driven by their *mycelium*. The mycelium produces a diverse array of complex extracellular enzymes that efficiently break down lignocellulosic waste such as agricultural and food production side-streams (Fig 4), playing a vital role in the ecosystem[13].

Mushroom Cultivation: An Example of Bioeconomy

The bio-economy utilises renewable biological resources from land and sea to produce food, materials, and energy. A sustainable bioeconomy is necessary for a carbon-neutral future in line with the climate objectives of the Paris Agreement, while it plays a crucial role in the EU's economy and overall success. It generates €2.3 trillion turnover and provides 8.2% of the EU workforce [14]

As the bioeconomy develops, innovative practices are emerging to support sustainable food production while reducing waste and protecting the environment. One such practice is mushroom cultivation, which aligns well with the principles of the bioeconomy. Mushrooms can be cultivated with relative ease indoors, without the necessity for a greenhouse or garden, thus making them an ideal choice for urban farming. The ability of mushrooms to thrive on organic materials and waste further enhances their sustainability, providing a circular solution that transforms agricultural by-products into nutritious food. Certain varieties, such as *Pleurotus spp.*, demonstrate robust growth across a range of temperatures and can be cultivated using *lignocellulosic* waste, including agricultural by-products.

Lignocellulosic waste is a valuable resource, and coffee grounds are a significant example of this. It is estimated that 91 grams of coffee grounds is produced per 100 grams of coffee [3] contributing to nearly 60 million tons of spent coffee grounds discarded globally each year[1]. However, within the framework of the bioeconomy, coffee grounds can be repurposed into valuable materials. For instance, coffee can be used to absorb herbicides such as bentazone in agriculture from groundwater[15]. Given their nutrient-rich composition and the high global consumption of coffee, they serve as an excellent substrate for bioeconomic applications, including edible mushroom cultivation

By leveraging such waste streams, mushroom cultivation not only provides an efficient means of food production but also contributes to waste reduction and resource optimization within the bio-economy framework. Fig 4 summarises some examples of lignocellulosic materials suitable for mushroom cultivation. [16–19]

Figure 4 Examples of potential lignocellulosic waste as susbstrate for growing mushrooms[16–19].

Mushroom Applications

Mushrooms have been mentioned in ancient literature since the beginning of human civilisation because of their wide range of properties, from poisonous to beneficial and edible [20]. The first historical record of intentional cultivation of edible mushrooms is estimated to be around 600 AD in China. Among today's leading mushrooms (see Chapter "Common Varieties of Edible Mushrooms " (p. 16)) cultivated before 1900, *Agaricus bisporus* (button mushroom) is the only one not first cultivated in China[21].

The production of edible mushrooms is being recognised as an effective contribution to tackling various global issues, such as the depletion of natural resources, lower agricultural outputs, and increasing food insecurity. Additionally, their incorporation into regular diets is rising due to increased knowledge of their health-promoting, therapeutic qualities and desirable flavour profiles[16] as well as nutritional value.

Mushrooms and their by-products play various roles in daily human life. The bioactive compounds in mushrooms are used in creating pharmaceutical and nutraceutical products. Furthermore, they are used in bioremediation and as fertilisers. Mushrooms contribute to energy production, bio-based materials, cosmetics, and cosmeceuticals [22] (see table 2).

Table 2 Exemplary applications of mushrooms [22] (Images created by Flation and Microsoft icons)

Application	*Examples*
Medicine 	**Cancer Treatment**: Utilised for anti-inflammatory properties. **Pharmacological Benefits**: Anti-allergic, antibacterial, antifungal, antioxidative, antiviral, cytotoxic, immunomodulating, antidepressant, antihyperlipidemic, antidiabetic, hepatoprotective, neuroprotective, nephroprotective, osteoprotective, and hypotensive effects [2,23].
Nutrition/Food 	**Nutrient-Rich**: Contains antioxidants (polyphenols, ergothioneine), minerals (potassium, selenium), carbohydrates, fiber, plant proteins, chitin, and vitamins (A, C, D, E, K). **Culinary Uses**: Valued for nutritional benefits and flavor in various dishes [7,24,25].
Fertilisers 	**Soil Enhancement**: Spent mushroom substrate (SMS) can be used as a natural fertiliser, enriching soil fertility and sustainably recycling organic waste [26].
Energy 	**Biofuel Source**: Biomass from mushrooms can be converted into biofuels such as bioethanol, contributing to renewable energy solutions.
Bioremediation 	**Pollution Cleanup**: Mushrooms can degrade pollutants like oil spills, heavy metals, and pesticides, aiding environmental cleanup efforts.
Cosmetics and Skincare 	**Skincare Benefits**: Incorporated into products for anti-aging, moisturising, and antioxidative properties.
Animal Feed 	**Nutritional Supplement**: Added to animal feed, providing essential proteins, vitamins, and minerals to livestock for improved health.
Building 	**Mycelium** is used in bricks for building, exhibiting excellent thermal insulation properties and demonstrating better fire resistance [27].

Nutritional Value

Mushrooms have been a vital part of human diets for centuries and are valued for their rich nutritional content. They are low in calories yet packed with fiber and proteins, making them an excellent dietary choice. Additionally, mushrooms are abundant in essential micronutrients, vitamins, and minerals. Mushrooms can be cooked to be used in a dish or eaten raw, like in a salad.

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It is important to note that in some mushrooms, like the button mushroom, most of the vitamins are stored in the skin. So, it is recommended that you do not peel them. Below is a detailed table summarizing the key nutrients found in mushrooms [7,24,25,28].

Table 3 Nutritional values of mushrooms[7,24,25,28]

Nutrient Category	*Details*
Macronutrients	Low in calories Low in fat Rich in fiber
Vitamins	A → supports vision, cell growth, reproduction & immunity C → boosts immunity B → recovers nerves and improves metabolism D → supports bones and teeth E → has antioxidant activity (scavenging free radicals) K → supports bones, assists immunity, anti-cancer
Minerals	Potassium → cellular functions Selenium → antioxidative properties Zink → promotes collagen formation for hair, skin, and nails, enhances memory and improves mental development Copper → assists in building red blood cells, supports nerves and immune system
Special Considerations	Excellent source of calcium, vitamin B12, vitamin B3 (niacin)

Carbon Footprint

The food sector is increasingly prioritising to reduce greenhouse gas emissions associated with food production as a means of reducing overall emissions [29]. In comparison to numerous conventional protein sources, particularly to those derived from animals such as beef, mushrooms exhibit a markedly reduced carbon footprint. This not only makes them palatable and have a favourable nutritional value but also a sustainable food source. Figure 5 illustrates the comparative carbon footprints of mushrooms and beef [30,31].

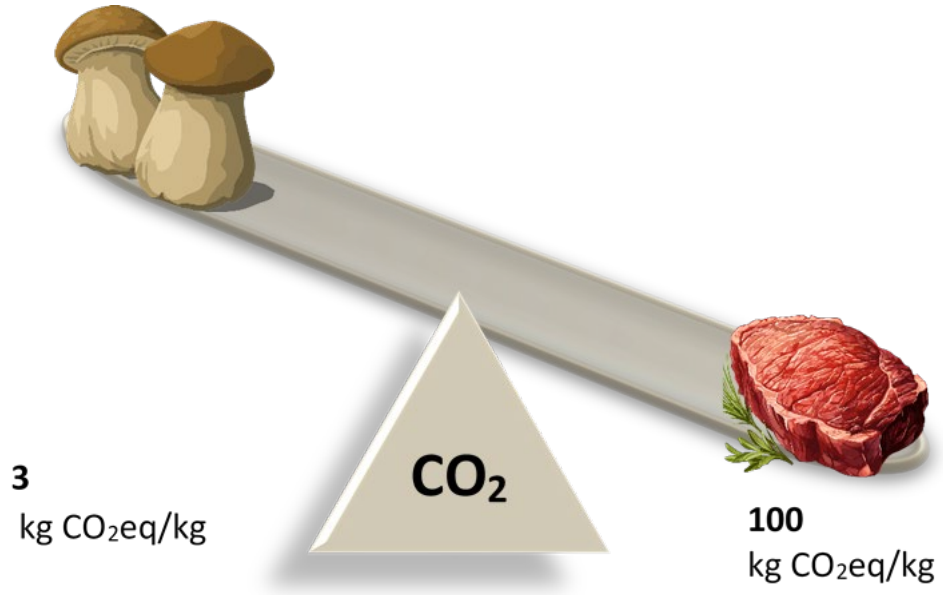


Figure 5 Carbon footprint [kg CO2eq/kg] of mushrooms and beef. Numbers are rounded and approximate[30,31]. (Image source: Pixabay).

Common Varieties of Edible Mushrooms

Mushrooms come in various shapes, sizes, and flavours, making them an adaptable and nutritious complement to any diet. Understanding the different types of edible mushrooms is essential for beginners and experienced growers, as each variety has different growing requirements. Again, just like the mushrooms that are one out of many in the kingdom of fungi, the given varieties of mushrooms are also only one out of many in each genus. For example, the *Agaricus* genus contains around 434 species worldwide, of which about 60 are reported consumed. Of these 60 species, the most well-known is *Agaricus bisporus*, also known as the button mushroom[32]. Below we summarized the most popular cultivated edible mushrooms with their raw nutritional value based on the g/100 g fresh weight[25,33–35].

Common name	Golden Chanterelle mushroom
Scientific name	*Cantharellus cibarius*
Energy (kcal/100g)	32
Fat	0.53g/100g
Protein	1.49g/100g
Carbohydrates	6.86g/100g
Fiber	3.8g/100g

Golden Chanterelle

Common name	Enoki
Scientific name	*Flammulina velutipes*
Energy (kcal/100g)	37
Fat	0.29 g/100g
Protein	2.66 g/100g
Carbohydrates	7.81 g/100g
Fiber	2.7 g/100g

Enoki

Common name	Maitake
Scientific name	*Grifola frondosa*
Energy (kcal/100g)	31
Fat	0.19 g/100g
Protein	1.94 g/100g
Carbohydrates	6.97 g/100g
Fiber	2.7 g/100g

Maitake

Common name	Morel mushroom
Scientific name	*Morchella esculenta*
Energy (kcal/100g)	31
Fat	0.57 g/100g
Protein	3.12 g/100g
Carbohydrates	5.1 g/100g
Fiber	2.8 g/100g

Morel mushroom

Common name	Oyster mushroom
Scientific name	*Pleurotus ostreatus*
Energy (kcal/100g)	33
Fat	0.41 g/100g
Protein	3.31 g/100g
Carbohydrates	6.09 g/100g
Fiber	2.3 g/100g

Oyster mushroom

Common name	Shiitake
Scientific name	*Lentinula edodes*
Energy (kcal/100g)	34
Fat	0.49 g/100g
Protein	2.24 g/100g
Carbohydrates	6.79 g/100g
Fiber	2.5 g/100g

Shiitake

Common name	Button mushroom
Scientific name	*Agaricus bisporus*
Energy (kcal/100g)	22
Fat	0.34 g/100g
Protein	3.09 g/100g
Carbohydrates	3.26 g/100g
Fiber	1.0 g/100g

Button mushrom

Common name	King bolete or porcini
Scientific name	*Boletus edulis*
Energy (kcal/100g)	45
Fat	0.87 g/100g
Protein	2.27 g/100g
Carbohydrates	7.37 g/100g
Fiber	n.a.

King bolete

Poisonous Mushrooms

While some mushrooms are known for their nutritional value and beneficial applications, others are poisonous and can prove fatal. The mention of mushrooms in ancient literature from the earliest days of human civilisation provides evidence of both their wide range of beneficial and edible properties and their poisonous nature [9]. For example, hallucinogenic mushrooms, such as magic mushrooms, have been consumed for millennia for ritual or religious purposes. While they are relatively less toxic than other addictive drugs, they can be dangerous if consumed by individuals of a certain age or emotional state. The active substances in hallucinogenic mushrooms resemble the serotoninergic system. They can interact with other neurotransmitter systems of the brain, leading to poisoning symptoms that persist for a relatively long period [36].

A total of 56,679 mushrooms have been identified across the globe, with approximately 350 classified as edible mushrooms and approximately 1,000 species estimated to be poisonous [37]. In Europe, approximately 150 of the identified mushrooms have been determined to be toxic.[38]. Poisoning often occurs when mushroom foragers mistake poisonous varieties for edible ones due to ignorance or confusion or misuse them as recreational drugs [38]. This underscores the need for proper education and awareness when it comes to foraging for mushrooms and the need to empower people to consider safety measures. Although a prepared edible mushroom spawn is used for mushroom cultivation in class, and one does not have to collect mushrooms in the wild in this class project (although a walk through a local forest in fall with a mushroom specialist would be a great complementary school excursion!), we provided some symptoms of mushroom poisoning below for additional information. Educating students on the potential dangers of consuming wild unknown mushrooms is crucial, emphasizing that they should never eat unknown mushrooms found in nature. Ingesting poisonous mushrooms can result in serious health issues, such as gastrointestinal disturbances and hallucinations, and, in some cases, can be fatal. Table 4 provides a detailed comparison of various poisonous

mushrooms and the edible mushrooms they closely resemble. Due to their resemblance to edible mushrooms, the term “false friends” is used[38].

Table 4 Exemplary false friends in the mushroom world[38]

Poisonous Mushroom Species	***Edible Mushroom Species***
Livid Pinkgill (*Entoloma sinuatum*)  *Pixabay*	Cloued Funnel (*Clitocybe nebularis)* 
Yellow Stainer (*Agaricus xanthoderma*) 	Field mushroom (*Agaricus campestris*) 
Jack o'lantern mushroom *(Omphalotus olearius)* 	Chanterelle (*Cantharellus cibarius*) 

Recap

1. Fungi are neither plants nor animals. They form their own group of living organisms.
2. Mushrooms are fruiting body of fungi.
3. Not all fungi develop mushrooms.
4. The most popular cultivated edible mushroom in the world is the button mushroom (white and brown button mushrooms).
5. Mushrooms grow very quickly.
6. Most of the vitamins in button mushrooms are in the skin. That's why you should not peel them.
7. Some fresh edible mushrooms can also be eaten raw, e.g. in a salad.
8. Mushrooms are a good source of vitamins, minerals, and fiber
9. Mushrooms can be used in a variety of fields, including medicine, cosmetics and animal feed.
10. Compared to many animal protein sources such as beef, mushrooms have a significantly lower carbon footprint.
11. Mushrooms provide ecosystem services by cycling nutrients, providing food and feed, and decomposing materials.

Step-by-Step Instruction

Required Material

1. Eco-friendly flowerpot with hole in the bottom (impermeable material)
2. Clay shard (it can be a broken piece of clay material to partially cover the drainage hole at the bottom of the pot to aid drainage and prevent leaching).
3. Used coffee grounds (mushroom to coffee ratio- 1:5)
4. A biodegradable protective cover that helps to retain moisture (e.g. cardboard).
5. Mushroom spawn (can be ordered online)
6. Fresh water (reusable water bottle to spray water)

Suggested Mushrooms for Beginner Growers

White button

Oyster

Shiitake

Lion’s Mane

Pleurotus djamor

Preparation

1. **Remember that Everything Must Be CLEAN!**

   Why: Maintaining cleanliness is essential for successful mushroom cultivation due to the constant competition with moulds or other fungi. The cleaner the setting, the better.
   How: Therefore, to enhance the chances of growing mushrooms successfully, develop a rigorous cleaning routine:

   - Sterilize everything, including container surfaces and work areas.
   - Remember to wash your hands and tie your hair back.
   - Keep frequently touched, unclean items, like cell phones, away from the growing area.

2. **Sterilise Spent Coffee Grounds:**

   Why: Sterilizing used coffee grounds removes any contaminants that might hinder mushroom growth.
   How: Preheat your oven to 80°C. Spread the coffee grounds evenly on a baking tray and bake for 60 minutes.

3. **Sterilise Flowerpot and Clay Shards:**

   Why: Ensuring all materials are sterile prevents unwanted bacteria or mould.
   How: Boil the flowerpot and clay shards in water for 10 minutes. Allow them to cool.
   Put the clay shard on the bottom of the pot to loosely cover the hole in the pot.

4. **Mix Spent Coffee Grounds with Mushroom Spawn:**

   Why: The mushroom spawn needs a nutritious substrate to grow.
   Mushroom spawn, is a substance containing mushroom mycelium inoculated into a nutrient-rich substrate such as sawdust or wood chips and etc.
   How: Once the spent coffee grounds are cooled down, mix them with the mushroom spawn in a 5:1 ratio (e.g. 1000 ml coffee grounds with 200 ml spawn).

5. **Fill the Flowerpot:**

   Why: Proper layering ensures even growth and aeration.
   How: Place the clay shard at the bottom of the pot to cover the drainage hole loosely. Fill the pot with the coffee and spawn mixture, lightly pressing it down.

6. **Fruiting:**

   The fruiting bodies (the visible part of the mushrooms on the top of the soil) are formed. At this stage, **groove** some holes.

7. **After Ten Days:**

   The fruit bodies grow. Remember to **water daily.** It is better to use a spray to avoid overwatering as mushrooms need moisture but not wet soil.

8. **Harvest the Mushrooms After 2-3 Days:**

   How: To do this, carefully twist the ripe mushrooms out of the soil so that no small fruiting bodies are pulled out with them. When all the ripe mushrooms have been harvested, water lightly for 2-3 days before the next ones are ripe. You
   can repeat this after each harvest for as long as mushrooms continue to grow.

It is important to

1. Cover the pot loosely with foil so it is protected against external germs.
2. Use fresh tap water for watering – of course GERM-FREE!
3. **Water Lightly Every Day:**
   Why: Mushrooms need humidity to grow.
   How: Keep the humidity properly and do not overwater them. For this you can use a spray bottle to spray water every day.

Maintenance and Troubleshooting

Growing mushrooms can present various challenges, such as mould and unpleasant odors. To address these issues, several recommendations for effective problem-solving are given. The following table outlines common problems and their corresponding solutions[39–41].

Table 5 Potential problems and solutions[39–41]

Problem	*Cause*	*Solution*
Mushrooms has bad smells or discolored or mites	High humidity combined with poor air circulation can lead to fungal diseases like bacterial blotch or mushroom rot.	• Improve ventilation to reduce humidity • Maintain proper air circulation and cleanliness around the growing area • Ensure adequate spacing between mushroom pots or trays • Regularly check the mushrooms and their condition to see if there is a bad smell or mites or too much moisture
Mushrooms not fruiting	Incorrect temperature or humidity levels, improper light conditions Old or bad spawn	• Monitor and adjust environmental conditions regularly • Provide appropriate lighting if growing indoors
Presence of pests such as flies or other fungi	Poor hygiene practices, presence of decaying organic matter, high humidity, spawn contamination	• Practice good hygiene and sanitation in the growing area • Remove decaying mushrooms promptly • Properly store and handle substrate materials to prevent contamination • Re-sterilise the equipment
Slow growth or delayed fruiting	Suboptimal growing conditions, aging or contaminated spawn,	• Ensure that substrate is fresh and properly prepared • Use high-quality mushroom spawn • Maintain ideal temperature, humidity, and light conditions for the specific mushroom species
Abnormal mushroom shapes (e.g., curled caps, splits)	Fluctuations in temperature or humidity, or exposure to drafts can cause stress and affect mushroom development.	• Maintain stable environmental conditions • Protect growing area from drafts or sudden temperature changes • Ensure consistent watering practices

Culinary Inspiration – Mushroom Recipes

In this section, several recipes are provided as potential options and inspiration for students to try in class with their teacher or at home with their parents.

Vegan Mushroom Roast on a Stick

- Side dish, Main course, Lunch & Dinner
- 4 servings
- Preparation time: 1 hour
- Level of difficulty:

Quantity	*Ingredients*	*Preparation*
600 g **4 tsp***	Oyster mushrooms Rapeseed oil.	cut the mushrooms to thin strips and fry in a heated pan with the oil
3 tsp **1 tbsp*** **2 tbsp** **1 - 2** **1 tsp** **½ tsp** **1 tsp**	Tamari sauce Maple syrup Paprika powder Garlic cloves (finely chopped) Cumin Ginger powder Cayenne pepper	are mixed together and added to the oyster mushroom strips in the pan. Sauté for about 3 minutes, then reduce the heat and simmer with the lid on for about 5 minutes.
3 tbsp **75 ml** **25 ml**	Cornflour Water Lemon juice	are stirred and added to the pan. Continue to sauté until the mixture thickens. Then remove from the heat and leave to cool. Preheat the oven to 180°C (bake mode: upper and lower heat).
20 pcs*	Rice paper	are dampened with water. Put some mushroom filling in the center.
10	Wooden chopsticks	are inserted into the filling from below and close the rice paper around the filling so that it takes on the shape of a vegan mushroom leg on a stick. Wrap another moistened rice paper around the “leg”. Repeat this process until all of the filling has been used up.
2 tbsp **1 tbsp** **½ tbsp** **1 ½ tbsp** **1 tsp**	Peanut oil** Tamari-sauce Maple syrup Tomato paste Dijon mustard	

1 tsp **½ tsp** **½ tsp**	Paprika powder Salt Pepper	are mixed and use to generously coat the legs from all sides.
		Arrange the coated legs on a baking tray and bake in the preheated oven for about 35 minutes.
	Fresh thyme Fresh rosemary	use the herbs as a garnish.

* pcs = pieces; tbsp: table spoon; tsp: tea spoon;

**Instead of peanut oil, another vegetable oil can be used e.g. rapeseed oil or sunflower oil

This recipe was developed in a seminar at IBBA, TU Berlin and inspired by: https://biancazapatka.com/en/vegan-chicken-drumsticks/.

Caramelised Oyster Mushrooms with Crumble and Vanilla Ice Cream (Vegan)

- Vegan dessert
- 6 servings
- Preparation time: approx. 2 hours
- Level of difficulty:

* tbsp: table spoon; tsp: tea spoon;
The recipe was developed by students in a seminar at IBBA, TU Berlin.

Quantity	*Ingredients*	*Preparation*
Vanilla ice cream		
200 g	Cashew	are placed in a bowl. Pour hot water over them and leave to stand for 1 hour. Then drain the water using a sieve. Purée the cashews in a blender until smooth.
300 ml **80 ml** **1**	Oat drink (cold) maple syrup vanilla pod	are blended into the mixture for a few minutes until it gets smooth. Pour the mixture into the ice cream maker and prepare according to the instructions. If you don't have access to an ice cream maker: mix the cashew puree with iced oat drink, maple syrup and vanilla pod and freeze until hardened.
Crumbles		
125 g **50 g** **60 g** **20 g**	Wheat flour Ground almonds Brown sugar Vanilla sugar	are mixed in a bowl.
110 g	Vegan butter (cold)	is cut into pieces. Add butter pieces to mixture and mix everything into crumbles. Preheat the oven to 180 °C (bake mode: upper and lower heat). Spread the crumbles evenly on a baking tray and bake in the oven for 15-20 minutes until lightly brown.
Caramelised mushrooms		
300 g	Oyster mushrooms	are cut into fine strips.
250 ml **6 tbsp***	Apple juice Brown sugar	is added to a heated pan. Add and melt the sugar in the juice. The cut mushrooms are added and fried till they get light brown.
1 tsp*	Apple vinegar	is added and simmer.
Arrange ice cream, caramelised mushroom strips and crumbles in a dessert bowl or on a plate.		

Shawarma Wraps with King Oyster Mushrooms

- Main dish
- 4 servings
- Preparation time: 35 min
- Level of difficulty:

Quantity	*Ingredients*	*Preparation*
Salad		
½	Iceberg lettuce	is cut into thin strips.
4	Tomatoes	are cut into small cubes and mixed with the iceberg lettuce.
Mushrooms		
250 g	King oyster mushrooms	are sliced and put in a bowl.
5 tbsp* 1 tsp* 1 tsp 1 tsp 2 pin*	Olive oil Ground cumin Ground coriander Smoked paprika powder (sweet) Cinnamon	are added to the mushroom slices. Mix well.
1	Garlic clove	is finely chopped, added to the mushrooms and mixed.
½	Lemon	is squeezed and the juice is added to the mixture and mixed.
Yoghurt sauce		
1 250 g	Garlic clove Yogurt	finely chop and mix
½	Lemon Salt Pepper	is squeezed and add the juice. Stir well and use to season.
Homemade Arabic Flatbread		
1 packet 1/2 tsp 1/2 tsp 275 ml 500 g	Dry yeast Salt Sugar Water Wheat flour (Type 550)	are placed in a bowl and knead until a uniform dough is formed. Cover the dough and let it rise for about 30 minutes. Divide the dough into 12 equal portions, shape into balls, and roll them out according to the size of your pan. Cook the flat dough in a hot pan until they reach the desired level of browning
Fill the flatbreads with yogurt sauce, salad, and mushrooms, then carefully roll them up. Enjoy!		

* pin – pinch; tbsp: table spoon; tsp: tea spoon. The recipe was developed by students in a seminar at IBBA TU-Berlin.

Dumplings with a Potato-Mushroom Filling

- Main dish
- 4 servings
- Preparation time: 2 hours
- Level of difficulty:

Quantity	*Ingredients*	*Preparation*
Yeast Dough		
100 ml ½ cube	Milk Yeast	 are mixed.
200 g 1 pin* 1 tsp* 20 g	Wheat flour Salt Tahini Liquid butter	 are placed in a bowl together with the yeast milk and kneaded into a dough.
		Cover the dough and let it rise for about 30 minutes.
Filling		
2 stems	Parsley	are washed and finely chopped.
30 g	Feta cheese	is diced.
50 g	Mushrooms	are cleaned and finely chopped.
50 g	Potatoes	are peeled, cooked and diced (or mashed).
½	Onion	is finely chopped.
1 tbsp*	Vegetable oil Salt, pepper, paprika	is heated in a pan. Sauté the onions. Add the mushrooms and sauté together. Then mix in the potatoes, parsley, and feta cheese. Season to taste using
Dumplings		
		Roll out the dough and cut it into circles/squares.
		Place some filling on one half of the dough pieces, fold over the other half, and seal.
1 tbsp 1 tbsp	Milk Sesame seeds	is applied on the dumplings with the milk on a brush. Sprinkle them with the seeds.
		Place the dumplings on a baking sheet lined with parchment paper and bake in a convection oven at 160°C (320°F) for about 20-25 minutes. Enjoy!

* pin – pinch; tbsp: table spoon; tsp: tea spoon;

The recipe was developed by students in a seminar at IBBA TU-Berlin.

Glossary

Bagasse	Fibrous residue left after juice has been extracted from sugar cane.
Bioremediation	The use of biological activity to reduce or eliminate the harmful effects of environmental pollutants in specific areas, such as soil or water.
Chlorophyll	Plant green pigment essential for photosynthesis
Corncob	A corncob is the central core of an ear of maize (corn) to which the kernels are attached.
Cosmeceuticals	Cosmetic products containing bioactive ingredients
Eukaryote	Eukaryotes are organisms made up of eukaryotic cells. Eukaryotic cells have a nucleus and organelles, all surrounded by a plasma membrane.
Heterotrophic	When an organism cannot produce its own food by carbon fixation and instead obtains its food from other sources of organic carbon, mainly from plants or animals.
Lignocellulosic material	Structural material of cell walls in plants
Mycelium	An interwoven network of microscopic, tubular, fibrous chains of cells (hyphae) that form the vegetative part of saprophytic fungi.
Nutraceutical	A food, or part of a food, that provides a medical or health benefit to the body, including the prevention or treatment of disease.
Sawdust	Sawdust is the fine particles or small chips of wood produced as a by-product of cutting, grinding, drilling or sanding wood with tools or machinery.
Sugarcane	A tropical grass grown for its sweet liquid, which is processed into sugar.

Exemplary lesson plans and worksheets

Title: Edible mushrooms in our lives and their morphology

Time (min)	*Content /Method*	*Media/Tools*	*Instructions for students / Course of the lesson*
90	*Morphology of mushrooms and different types of edible mushrooms* *Introduction into the topic / Review of prior knowledge* *Class discussion, Individual work* Student presentation (exhibition-style) <u>Further Info:</u> Subchapter "Common Varieties of Edible Mushrooms" (p. 16), Figure 2 (p. 10) <u>For optional</u>: Subchapters "Morphology and Life-Cycle" (p. 10f), "Function of Mushrooms in the Ecosystem" (p. 12)	A4 paper or worksheet "Draw your favourite mushroom" (p.38), Pencil, Colors, Figure 2 (p. 10) <u>Optional</u>: Worksheet "Mushroom morphology" / "Function of the mycelium" (p. 39), Worksheet "Shop and snapshot" (p. 36), Worksheet "Fun check" (p. 37), Store-bought edible mushrooms, Photos of mushrooms, upload tool for photos	<u>Optional: homework beforehand</u>: "*Check out the mushrooms from your local supermarket or farmer´s market. Make a list of all the mushrooms you can find and post/upload at least two photos in the school cloud (or another upload tool).*" <u>*or*</u> Worksheet "Shop and snapshot" *Make a short trip to your local supermarket and while you're there, search for mushrooms. Take photos of the mushrooms you find there and let's see what varieties they have! Make a list of all the mushrooms you can find and bring at least one (digital) photo."* *Let the students tell about their supermarket visit and look together at photos of the mushrooms they found. Point out distinct parts of their morphology. Make a list of all edible mushrooms they found in plenum.* <u>*or*</u> *Worksheet "Fun check"* *"Check the boxes beside each mushroom to indicate whether you have heard about or seen it before, have eaten it, or don't know it. Check if you can find (or found) them in your supermarket."* *Ask the students what kind of mushroom they know and collect them in a list together. Pass around store-bought mushrooms or photos of common edible mushrooms. Point out distinct parts of their morphology and introduce terms (cap, gill, stem, ring, mycelium) and explain the function of the mycelium.*

			<u>Optional</u>: Worksheet "Mushroom morphology" *"Label the mushroom on the worksheet correctly. Assign the terms to the correct parts of the mushroom." / "Explain the function of the mycelium."* *Compare the answers in class together.* *Worksheet* *"Draw your favourite edible mushroom."* *Display the drawn mushroom pictures in class and let the students present them in plenum or exhibition-style in groups.*

Title: Mushroom morphology, function of mycelium and reproduction cycle

Time (min)	*Content / Method*	*Media/Tools*	*Instructions for students / Course of the lesson*
45	Morphology of mushrooms, reproduction cycle, function of the mycelium, *Class discussion,* Individual work <u>Further Info:</u> Subchapters "Morphology and Life-Cycle" (p. 10f), "Function of Mushrooms in the Ecosystem" (p. 12),	Worksheet "Mushroom morphology" / "Function of the mycelium" (p. 39), Worksheets "Collage" (2 parts) (p. 40-41) Or Worksheets "Life cycle of mushrooms" (two different levels of difficulty; p. 42 or 43)	*Pass around store-bought mushrooms or photos of a common edible mushroom. Point out distinct parts of their morphology and introduce terms (cap, gills, stem, ring, mycelium). Explain the function of the mycelium.* *Worksheet "Mushroom morphology" /* "Function of the mycelium" *"Label the mushroom on the worksheet correctly. Assign the terms to the correct parts of the mushroom." / "Explain the function of the mycelium."* *Compare the answers in class together.* *Explain the reproduction cycle* Worksheets "Collage"

			"Cut out the four mushroom fragments (worksheet part 2) and assign them correctly by pasting them in the boxes below the correct term." or Worksheet "Life cycle of mushrooms" *"Write the name of each stage in the space provided in the diagram."* *"Cut out the five different stages of the mushroom life cycle and stick them in the correct order next the corresponding term."*

Title: Applications of mushrooms / health benefits

Time (min)	*Content / Method*	*Media/Tools*	*Instructions for students / Course of the lesson*
45	Non-food applications and health benefits of mushrooms Mindmap, Think-pair-share Further info: "Mushroom Applications" (p. 13f), "Nutritional Value" (p. 15)	Worksheet "Health benefits of mushrooms" / "Mushroom applications" (p. 44)	Input on mushrooms, their function in nature and their nutrient and other contents. Worksheet "Health benefits of mushrooms" *"Name three reasons why mushrooms are good for our health."* Share the health benefits of mushrooms in class (e.g. making a mindmap together) Worksheet "Mushroom applications" • *"List three applications for mushrooms other than food.* • *Compare them with a classmate next to you and add their additional applications to your list – if there are any.* • *Afterwards, share the applications of mushrooms in class (e.g. written list, cards, digitally on a padlet) and complete your list."*

Title: Quiz

Time (min)	*Content / Method*	*Media/Tools*	*Instructions for students / Course of the lesson*
15	To check the competence gain after working through the topics of this manual Quiz	Worksheet ''Quiz'' p.45f	Hand out quiz on page 45-46. Discuss answers with students.

Title: Mushroom growing experiment

Time (min)	*Content / Method*	*Media/Tools*	*Instructions for students / Course of the lesson*
10-12 days	Cultivation of mushrooms, Valorisation of spent coffee grounds Experiment, class project, group work Further info: Chapter "Step-by-Step Instruction" (p. 21ff) Also: Chapters "Introduction - Why Growing Mushrooms" (p. 5), "Aspects of Sustainability" (p. 7),	Flowerpot, Clay shard, Used coffee grounds, Foil as a cover, Mushroom spawn (can be ordered online) Oven and baking tray for sterilising coffee grounds, Stove and pot for sterilising flowerpot and shard, Watering can / spray	Intro into the topic Preparation of the materials, start of the growing experiment (See: "Step-by-Step Instruction") Support during the growing experiment For documentation during and reflection after the experiment: Worksheets "Growth check", "Water check", "Mushrooming", "Looking back" <u>Optional:</u> Cooking and eating the self-grown mushrooms together (See "Culinary Inspiration – Mushroom Recipes")

	“Culinary Inspiration – Mushroom Recipes” (p. 26ff)	Dark, cool place for mushroom growing Optional: Worksheets “Growth check”, “Water check”, “Mushrooming”, “Looking back” (p. 45ff)	

*Name*_____ *Date*_____ *Class*_____

Shop and snapshot

Make a short trip to your local supermarket and while you're there, search for mushrooms. Take photos of the mushrooms you find there and let's see what varieties they have!

I found these mushroom species at the supermarket:

_____ _____

_____ _____

_____ _____

_____ _____

Stick you photo here:

*Name*_____ *Date*_____ *Class*_____

Fun check!

Check the boxes beside each mushroom to indicate whether you have heard about or seen it before, have eaten it, or don't know it. Check if you can find them in your supermarket.

Type of mushroom	I have heard about or seen it before	I have eaten it	I don´t know it	Available in the supermarket?
Button mushroom 				
Oyster mushroom 				
Shiitake 				
King oyster mushroom 				
Pink Oyster 				

*Name*_____ *Date*_____ *Class*_____

Draw your favourite mushroom

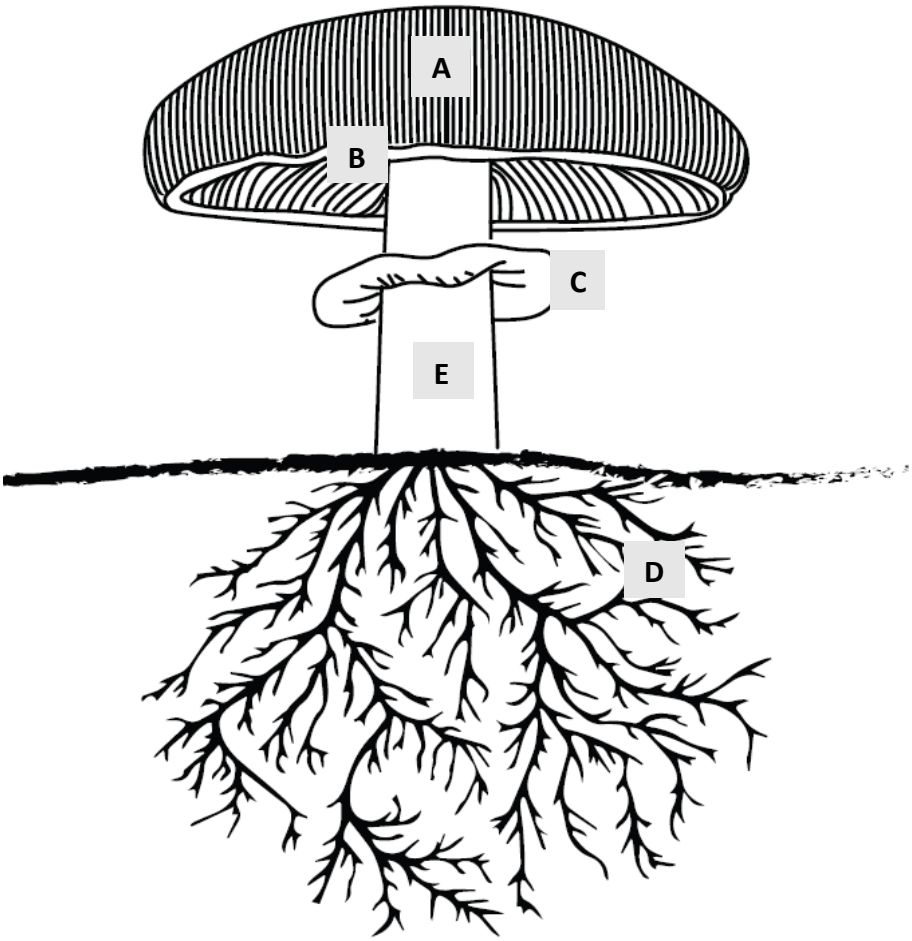
Draw your favourite edible mushrooms. Feel free to use any colors you want!

*Name*_____ *Date*_____ *Class*_____

Mushroom morphology

Assign the five terms in the box below to the correct parts of the mushroom (A, B,C,D,E).

Cap	*Mycellium*	*Stem*
Ring	*Gills*	



Function of the mycelium

Describe the function of the mycelium

*Name*_____ *Date*_____ *Class*_____

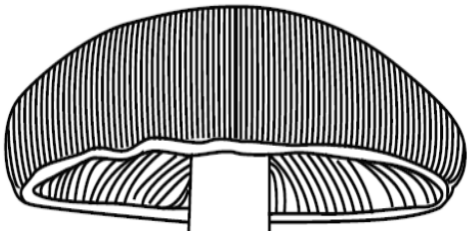
Collage

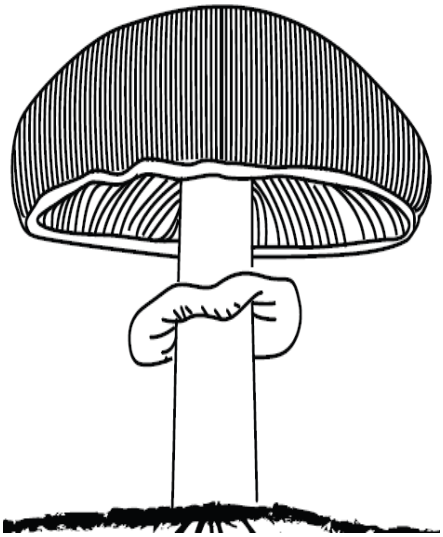
Cut out the four mushroom fragments (worksheet part 2) and assign them correctly by pasting them in the boxes below the correct term.

Spores	Hyphae forms mycelium
Fruiting body	Gills

*Name*_____ *Date*_____ *Class*_____

Collage (part 2)

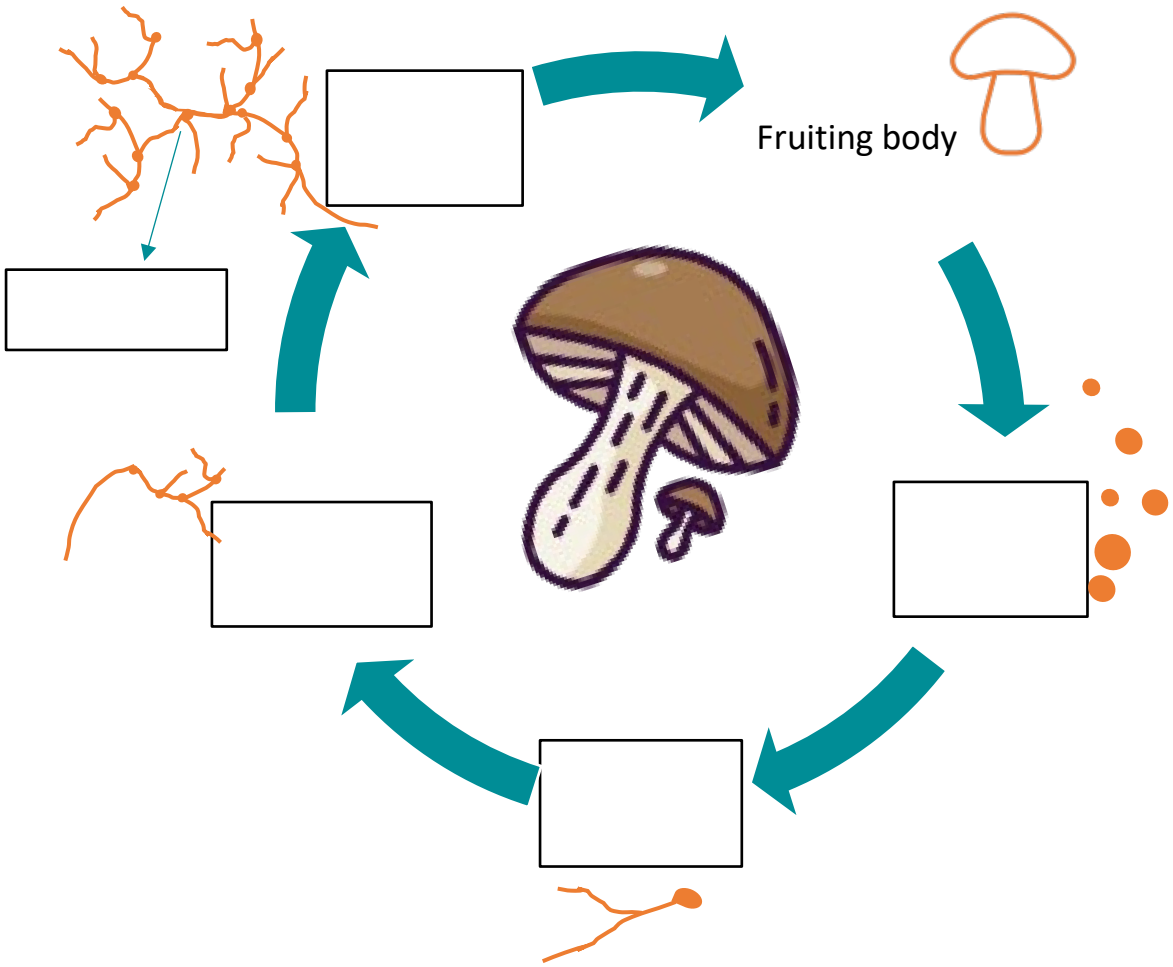




*Name*_____ *Date*_____ *Class*_____

Life cycle of mushrooms

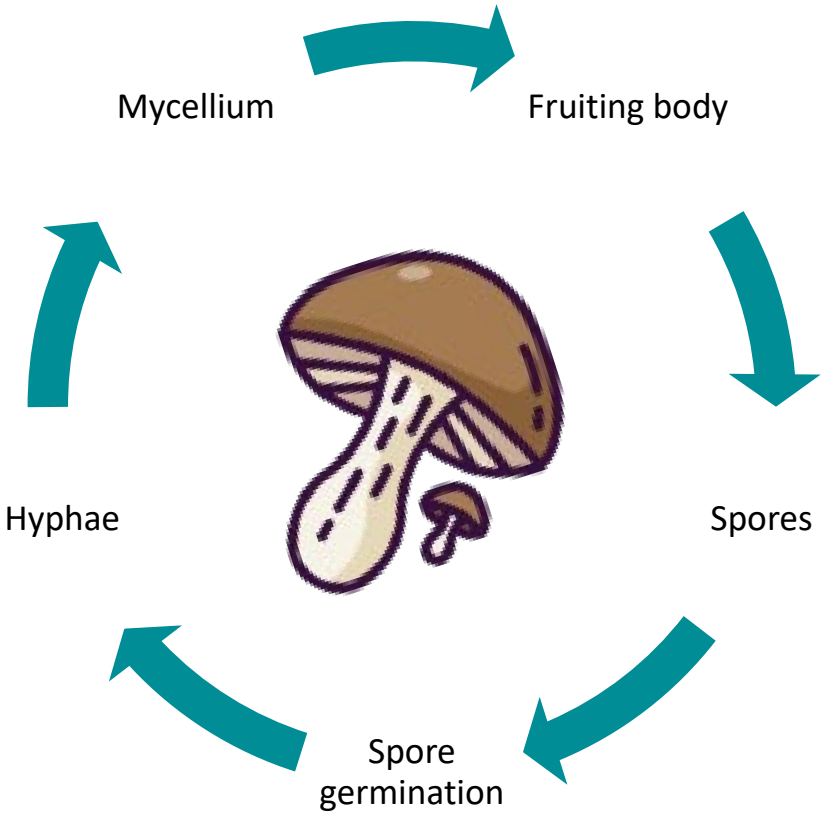
Write the name of each stage in the space provided in the diagram.



*Name*_____ *Date*_____ *Class*_____

Life cycle of mushrooms

Cut out the five different stages of the mushroom life cycle at the bottom of the page and stick them in the correct order next to the corresponding term.



*Name*_____ *Date*_____ *Class*_____

Health benefits of mushrooms

Name three reasons why mushrooms are good for our health.

1. ……

2. ……

3. ……

Mushroom's application

List three applications for mushrooms other than food.

Compare them with a classmate next to you and add their additional applications to your list.

Share your applications with the class and complete your list.

……

……

……

……

……

*Name*_____ *Date*_____ *Class*_____

Quiz

Answer the following question.

1. What group of living organisms do fungi belong to?

2. What part of a fungus is commonly known as a mushroom?

3. Which is the most commonly cultivated edible mushroom in the world?

4. Home grown mushrooms: After how many days can you usually harvest them?

5. Where are the majority of vitamins found in button mushrooms?

6. What nutrients do mushrooms provide?

7. In what fields can mushrooms be used besides food?

8. How does the carbon footprint of mushrooms compare to many animal protein sources?

9. What ecosystem services do mushrooms provide?

10. Some fresh edible mushrooms can be eaten raw.

True ☐ False ☐

11. All fungi develop mushrooms.

True ☐ False ☐

*Name*_____ *Date*_____ *Class*_____

Worksheet on mushroom growing

Growth check

Capture the growth of your mushrooms every day starting from day 6 with daily photos. Let's document their progress together!

*Name*_____ *Date*_____ *Class*_____

Water check

Example: Day X ☒
Day 1 ☐
Day 2 ☐
Day 3 ☐
Day 4 ☐
Day 5 ☐
Day 6 ☐
Day 7 ☐
Day 8 ☐
Day 9 ☐
Day 10 ☐
Day 11 ☐
Day 12 ☐

Water check for re-growing
Day 1 ☐
Day 2 ☐
Day 3 ☐
Day 4 ☐
Day 5 ☐
Day 6 ☐
Day 7 ☐
Day 8 ☐
Day 9 ☐
Day 10 ☐
Day 11 ☐
Day 12 ☐

*Name*_____ *Date*_____ *Class*_____

Mushrooming

Describe your observations during the mushroom growing experiment and point out the differences between days one to five and six to ten.

DAYS 1-5:

DAYS 6-10

*Name*_____ *Date*_____ *Class*_____

Looking back

Reflect on the mushroom growing experience.

What worked well?

What did not work so well? Why?

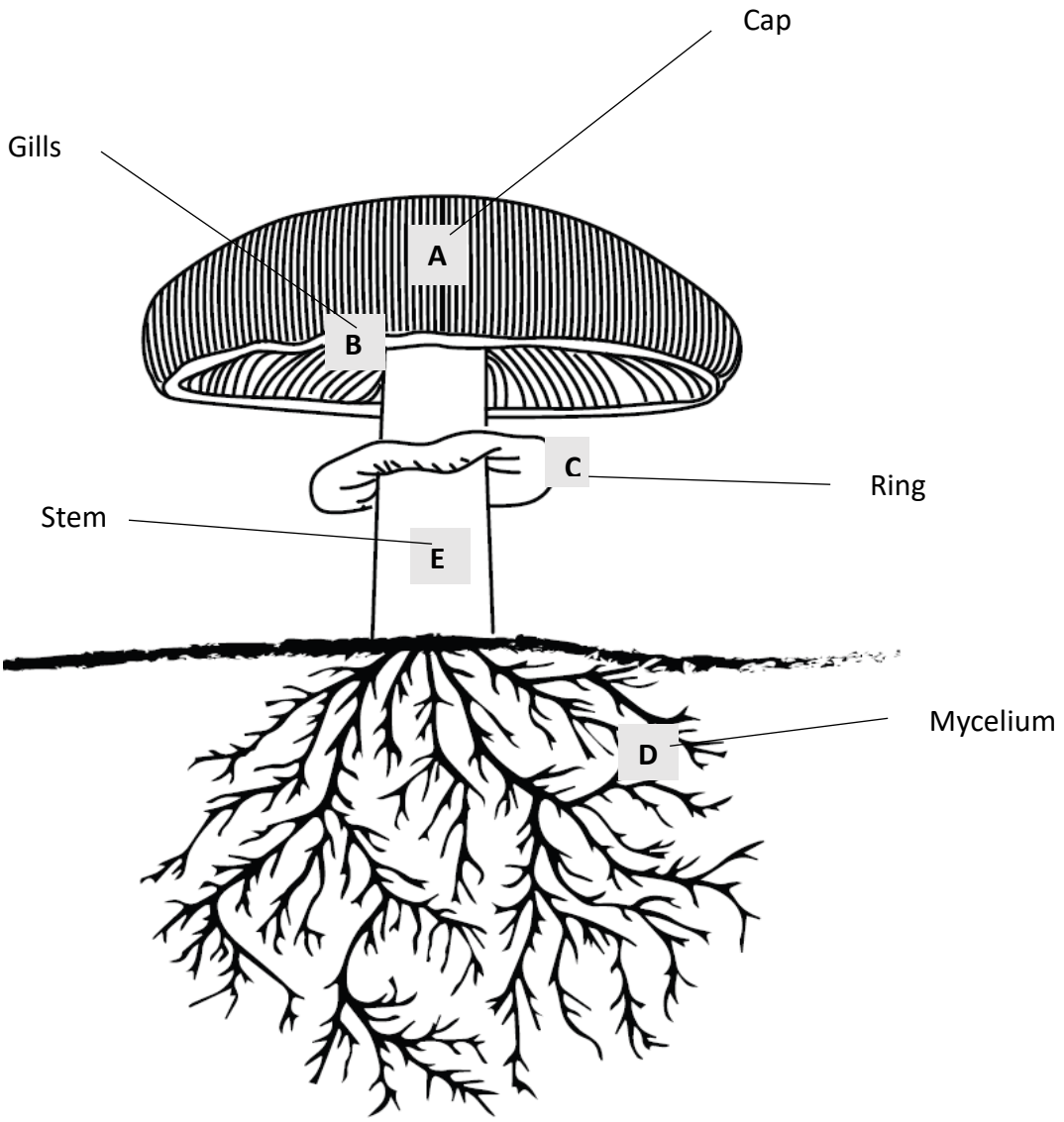
What did you learn?

What was the most exciting part in your opinion?

Answer key

Assign the five terms in the box below to the correct parts of the mushroom (A, B,C,D,E).

Cap A	Mycelium D	Stem E
Ring C	Gills B	



Function of the mycelium

Describe the function of the mycelium.

Mycelium is a network of hyphae that increase the mushroom absorption of nutrients and transport it through the mushrooms.

Health benefits of mushrooms

Name three reasons why mushrooms are good for our health.

1. Rich in fiber

2. Rich in mineral

3. Rich in vitamins such as:

- A → Vision, cell growth, reproduction and immunity
- C → Immunity
- B → Nerves and metabolism
- D → Bones and teeth
- E → Antioxidant (scavenging free radicals)
- K → bones, anti-cancer, immunity

Mushroom's application

Name three applications mushroom other than food.

1. Energy production

2. Medicine

3. Animal feed

4. Bioremediation

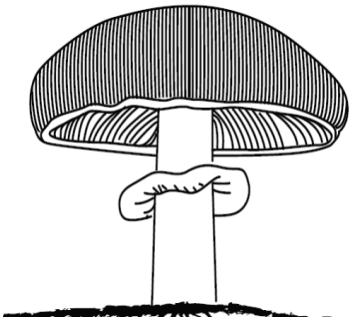
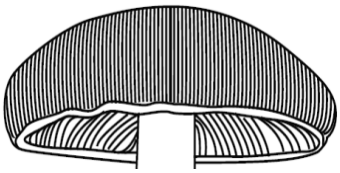
5. Fertilizer

6. Cosmetics and skincare

7. Building

Collage

Cut the picture and paste it to the correct name in the table in activity.

Spores 	Hyphae forms mycelium 
Fruiting body 	Gills 

Quiz

Answer the following questions.

1. What group of living organisms do fungi belong to?

Fungi are *heterotrophic eukaryotes* that inhabit various environments worldwide, including soil, water, air, and decaying organic matter.

2. What part of a fungus is commonly known as a mushroom?

The fruiting body of fungi is called a mushroom and consists of a stem, a cap, gills and in some cases a ring.

3. Which is the most commonly cultivated edible mushroom in the world?

Agaricus bisporus, also known as the button mushroom.

4. Home grown mushrooms: After how many days can you usually harvest them?

It depends on the variety of mushroom, however. the *Pleurotus djamor* mushroom cultivated in our manual, takes form 12days to two weeks.

5. Where are the majority of vitamins found in button mushrooms?

Most of the vitamins in button mushrooms are stored in skin.

6. What nutrients do mushrooms provide?

Vitamins A, C, B, D, E, K, minerals such as potassium, selenium, zinc, copper and an excellent source of calcium, vitamin B12, vitamin B3 (niacin).

7. In what fields can mushrooms be used besides food?

Medicine, nutrition/Food, fertilisers, energy, bioremediation, cosmetics and skincare, animal feed, building.

8. How does the carbon footprint of mushrooms compare to many animal protein sources?

Mushrooms have a much lower carbon footprint of 3 compared to 100 for beef, for example.

9. What ecosystem services do mushrooms provide?

Mushrooms contribute to ecosystem services by cycling nutrients, decomposing organic matter, and providing food and feed.

10. Some fresh edible mushrooms can be eaten raw.

True ☒ False ☐

For example: *Agaricus Bisporus* (Button mushroom)

11. All fungi develop mushrooms.

True ☐ False ☒

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