KNOX GRAMMAR SCHOOL

STATE

DA VINCI DECATHLON 2019

CELEBRATING THE ACADEMIC GIFTS OF STUDENTS IN YEARS 9, 10 & 11

da Vinci Decathlon® EXCITE ENRICH CHALLENGE An initiative of Knox Grammar School

IDEATION

TEAM NUMBER _____

1	2	3	4	Total	Rank
/15	/10	/25	/10	/60	

Complete the above table with question numbers and marks as required.

IDEATION

OUT ON A LIMB

BACKGROUND

When we think of landscapes, **plants** are among the first things that come to mind. Grass, trees, bushes, ferns, cacti and much more. Plants are a **ubiquitous** part of our surroundings.

Moreover, plants serve a number of **vital roles** in our environment, and without them it would be impossible for **life** to be sustained on Earth. Our **modern lives** would also be very different in their absent. These roles include:

- Providing **oxygen** and absorbing carbon dioxide via **photosynthesis**;
- Providing **food** for humans and almost all other organisms;
- Recycling **water** into the atmosphere through **transpiration**;
- Acting as **bio-fuel**;
- Preventing **soil erosion** and maintaining **soil fertility**;
- Supporting **rainfall** through their cooling effect on the atmosphere;
- Creating **shelter**, **shade** and **habitats** for several organisms;
- Providing **materials** such as wood, dye, oil and rubber;
- Providing materials for **clothing** and many other products;
- Providing substances for use in **medicine**;
- Acting as **surfaces** for playing fields and other landscapes; and
- Acting as **aesthetic** elements in gardens and other locations.

This list is extensive, and yet it is **non-exhaustive.** Clearly, plants are absolutely essential to our planet, and with such a variety of roles, there is no surprise that the **diversity of species** is similarly great.

Over **320,000** species of plants currently exist across the world, and these are grouped into several categories including algae, mosses, ferns, cycads, conifers, gingkoes and flowering plants. The latter is the largest division, with over 250,000 species, while there is only one extant species of gingko surviving on Earth. Furthermore, millions of years of **evolution** means that we now have plants that live underwater, only bloom every twenty years, are carnivorous or parasitic, and grow to over 100m tall!

THE PROBLEM

Despite the unparalleled importance of plants to our existence, they face several **threats** and their numbers are slowly but steadily decreasing. **Deforestation** by humans is among the most significant of concerns, together with **climate change,** which is making certain areas uninhabitable for particular species. The **problems** that flow from this include:

- Shortages of **food**, **shelter** and other **materials** such as timber for humans and animals alike;
- Less stability and **sustainability** within **ecosystems**; and
- Accelerated **global warming** and decreased **rainfall.**

These trends need to be reversed, and it is **practical action** that is most likely to achieve such an effect. Fortunately, **technology** has advanced to a point where humans are able to devise ingenious solutions to these types of problems. However, action must be **swift** and **innovative,** lest we reach a point of 'no return'.

THE DESIGN CHALLENGE

There are many possible solutions to the problems above, one of which is **genetic engineering.** Now, **imagine** that a group of scientists have discovered a genetic code which allows for plants to survive in **any environment,** and to grow at **twice the normal speed. However,** they only have a **very limited amount of DNA**. How would you utilise this incredible scientific breakthrough? Would you combine a palm tree with a willow? Maybe an apple tree with grass? Or a baobab and seaweed? What would these look like??

Your task is to envisage and prototype a single **new species of plant** which is a **hybrid** of two or more (maximum four) existing species. Your new species should be useful to humanity in **a variety of different ways,** such as those listed on the previous page (food, shelter, other materials, etc.). The challenge is to design a species that will be the **most useful possible** in combatting the issues surrounding the loss of plant life on Earth, thus making **best use** of the extremely limited amount of DNA available to the group of scientists discussed above.

Thanks to the genetic code that has been discovered, your plant will be **propagated across the world,** and will hopefully grow rapidly to become the most **abundant** species on the planet. **Therefore**, **your genetic engineering choices need to be wise ones.**

There are a number of **design restrictions** that you must abide by. Your species must:

- Be a hybrid of **between two and four existing species;**
- Have **between three and five** uses and/or features, predominantly inspired by the list on the previous page; and
- **Contribute** to solving the issues noted in the 'Problem' section of this paper.

Apart from these restrictions, your plant can take any form that you wish. It can be any shape, size and type, so long as it is **realistic** (i.e. based on existing species). This requirement will be essential to scoring high marks, as will:

- Originality and **creativity**;
- Degree of **usefulness** of the species; and
- The **likelihood** that the species will be **adopted** by humans **worldwide**, thus contributing the solving the issues mentioned above – this is a product of **usefulness** and other factors such as **convenience** (in terms of planting the species, harvesting [if relevant], etc.).

Further marking guidelines are provided on the following page, as well as in your answer booklets. **Stimulus material** is also provided in this paper, following the marking criteria. Answers that provide the greatest reference to the stimulus will score highest.

You are required to follow the **four-step process of ideation.** This is outlined immediately below and is set out in your answer booklet.

EMPATHISE (Ethical Decision-Making Framework) (15 marks)

This involves evaluating what 'ought to be done', through considering rights, obligations, fairness, the benefits and detriments for societies and other virtues. Reaching a final decision involves a degree of conviction and belief in what is 'the right thing to do'.

DEFINE (Design Brief) (10 marks)

Here, you must identify the problem, outline the ethical issues, evaluate the challenges and research findings, and identify possible solutions.

IDEATE (Reflection) (25 marks)

You must then reflect on their solutions and whether they will be viable. A preferable solution should be identified, and any unanswered questions should be addressed. Issues of implementation are also crucial to reflect upon.

CREATE (Prototype) (10 marks)

Finally, a design for how your ideas and solution will be disseminated must be produced. This could be a story-board, mind-map, diagram, model, narrative or any other appropriate medium. Critically, an audience must be able to understand the process of dissemination by examining this prototype.

MARKING GUIDELINES

1. Empathise (15 marks)

QUESTIONS	LIMITED	SOUND	OUTSTANDING	TOTAL
1: Factors contributing to the issue	0-1	2-3	4	
2: Consequences if not addressed	0-1	2-3	4	
3: Identify different perspectives	0-1	2	3	
4: Identifies barriers to addressing the issue and why they are barriers	0-1	2-3	4	
			TOTAL	/15

2. Define (10 marks)

ASPECT	LIMITED	SOUND	EFFECTIVE	OUTSTANDING	TOTAL
Vision Statement: What do you want to achieve?	0-1	2-3	4	5	
Importance of Vision Statement	0-1	2-3	4	5	
				TOTAL	/10

3. Ideate (25 marks)

ASPECT	LIMITED	SOUND	OUTSTANDING	TOTAL
Possible Solution #1	0-1	2-3	4	
Possible Solution #2	0-1	2-3	4	
Possible Solution #3	0-1	2-3	4	
Choice of solution	0	1	2	
Justification of solution	0-1	2-3	4	
Implementation: when, where, who?	0-1	2	3	
Dissemination: how to succeed with the solution	0-1	2-3	4	
			TOTAL	/25

4. Create (10 marks)

ASPECT	LIMITED	SOUND	EFFECTIVE	OUTSTANDING	TOTAL
Originality and creativity	0-1	2-3	4	5	
Clarity and communication of ideas	0-1	2-3	4	5	
				TOTAL	/10

TOTAL: /60

ADDITIONAL STIMULUS

The importance of plants to life on Earth **(Udemy.com, 2014)**

For all forms of life, plants form the basic food staples, and this is just one reason why plants are important. They are the major source of oxygen and food on earth since no animal is able to supply the components necessary without plants. The fish we eat consume algae and the cattle we eat as beef feed on grass, so even if you're not a fan of salads, your food source relies on plants.

Plants are used as state and national emblems as well, including state flowers and state trees. Trees from ancient times are famous and are revered. Plants hold world records as well. Often, plants prominently figure in literature, religion and mythology

Plants also provide animals with shelter, produce clothing material, medicines, paper products, reduce noise levels and wind speed, reduce water runoff and soil erosion. Coal is also produced from plant materials that were once alive.

Cash crops produce income for farmers. Peanut oil comes from peanuts, corn oil comes from corn and olive oil comes from olive. Cash crops also include typical products of agriculture like rice, rye, wheat and corn. Cocoa plants give us chocolate, coffee plants produce coffee and vanilla plants produce vanilla flavouring.

Many beverages and drinks like tea and cola come from plants. Other cash crops include cotton, vegetables, fruit, lumber and rubber from trees. For overall ecology, plants are also important. The roots prevent soil erosion and when plants undergo photosynthesis, they use up carbon dioxide and give off oxygen, just like herbal plants do in this article.

This course on the different types of plants is a great place to learn more about the importance of plants, but I'll get you started with some basic information – read on!

Plants are Food

Either indirectly or directly, human nutrition is dependent on plants. Throughout the history of human beings, about seven thousand various species of plants have been used as food for humans. To a large extent, human nutrition depends on corn or maize, rice, wheat and other cereals.

Other crop staples include legumes, cassava and potato. Human food also includes edible flowers, herbs, nuts, certain fruits, spices and vegetables. From plants, beverages produced include alcohol, beer, wine, tea and coffee.

We obtain sugar from sugar beet and sugar cane and from flowers comes honey. From olives, sunflowers, safflowers, rapeseed and soybean comes margarine and cooking oils. Additives in food include pectin, starch, locust bean gum, guar gum and gum Arabic.

Animals of livestock which are all herbivores include camels, goats, sheep, pigs and cows and most manly feed on grasses and cereal plants. Brewer's yeast and other fungi provide human beings with numerous beverages and foods including staples like beer and bread.

Brewer's yeast is not only important to producing great food but it is especially rich in vitamin B12 and is quite nutritious. In the maturation of cheese, some moulds are important such as the kind you see in blue cheese. Dietary fibre is found in edible mushrooms, which also happen to be complete proteins. Plus, some mushrooms used as food are medicinal, and provide a smattering of benefits to health. Mushrooms also make great ingredients in nutritious dishes that heal, as you can see in this course on healing foods.

Plants Provide Air and Regulate the Water Cycle

Plants bring you oxygen which is a by-product of photosynthesis. Carbon is also stored by plants and they help in keeping a lot of the produced carbon dioxide from burning fossil fuels out into the earth's atmosphere. also, the water cycle is regulated by plants. The help in purifying and distributing the water of the planet. They also help in moving water from the soil to the atmosphere through a method called 'transpiration.'

They Are Important to Science

Plants and fungi in particular have industrial applications and many model organisms enable comprehension of fundamental biology such as development and genetics. Entrepreneurs apply plants such as fungi to provide biodegradable and sustainable products that are structural such as vehicle bumpers, packing materials and building materials. Enzymes produced by plants and fungi are valuable in the industry of paper pulp, for fashion and even bioremediation. Denim jeans are softened by enzymes from plants.

In the world of science, brewer's yeast and the mould Neurospora crassa are organism models used globally in applied and basic science laboratories. In the year 1996, the first eukaryole to have a sequenced genome was saccharomyces cerevisiae.Industrial synthesis basic chemicals include a fast array of organic chemicals that you can get from plants. These chemicals are utilized in vast varieties of experiments and studies.

The rings of trees serve as a record of climates from the past and are an important dating method in archaeology. Often, basic biological research has been done with plants such as the peas used for deriving the laws of genetics by Gregor Mendel. Space colonies or space stations may one day depend on plants for the support of life.

The ethnobotany field studies the use of plants by indigenous cultures which help in discovering new medicinal plants and in conserving species that are endangered. In the US, gardening is the most popular activity of leisure. Horticulture therapy or working with plants is beneficial for rehabilitating persons with disabilities.

Certain plants contain chemicals psychotropics which are ingested after extraction including opium, cannabis and tobacco. It is also from plants that we get pesticides such as pyrethrin, strychnine, rotenone and nicotine. Poisonous substances are also derived from plants including curare, hemlock and ricin.

Aesthetic Uses

For aesthetic purposes, thousands of species of plants are cultivated. In addition, plants can help prevent soil erosion, provide privacy, abate noise, reduce wind, modify temperatures

and provide shades. Often, people cut dried flowers to frame, and display house plants in greenhouses or indoors.

In gardens, bedding plants, herbaceous perennials, vines, shrubs, ornamental trees, shade trees, lawn grasses and outdoor gardens are planted. Often, in textiles, photography, language, humour, architecture and art, images of plants are used often.

These are also used on coats of arms, flags, stamps and money. There are art forms made of living plants as well including espalier, ikebana, bonsai and topiary. The course of history has sometimes been changed by plants such as the tulipomania.

Each year, plants are the reason for the existence of a multi-billion dollar per year industry of tourism which includes traveling to forests, rainforests, tulip festivals, national parks, historic gardens, botanical gardens and arboretums. In the National Cherry Blossom Festival, there are forests filled with colourful leaves of autumn. Plants that are sold as novelties include the resurrection plant, sensitive plant and the Venus flytrap.

Plants Are Used for Natural Products

It is from plants that you get natural products that include cork, amber, alkaloids, resins, gums, latex, tannins, waxes, pigments, natural dyes, essential oils and fibres. Other products also include hemp rope, chewing gum, inks, plastics, linoleum, lubricants, varnish, rubber, turpentine, cosmetics, perfumes, shampoos, paints and soaps.

Cotton is made from cellulose-derived synthetic fibres like acetate and rayon as well as flax and cotton. From plants, renewable fuel comes as well including biofuels like peat and firewood. From plants, you can derive fossil fuel like petroleum and coal.

Aside from its other myriad uses, the backbone of all habitats is also made up from plants. Other species of wildlife and fish also depend on pants for shelter and food. Wood is used for sports equipment, musical instruments, cardboard, paper, furniture and buildings.

Medicine

One fourth of the drugs that are prescribed is derivatives of or come directly from plants. In addition, 4 out of 5 people around the globe at the moment rely on plants for primary healthcare. Medicines derived from plants include vincristine, digitalis, colchicine, reserpine, quinine, morphine, taxol and aspirin. There are also herbal supplements by the hundreds such as Saint John’s wort, feverfew, Echinacea and ginkgo.

Plants are also important in the search for cancer drugs. Current therapeutics of cancer include paclitaxel, isolated from the Chinese happy tree camptothecin. It is also derived from the South African willow and the Himalayas and eastern US etoposide. There has been a long history for the search of anti-cancer drugs from plants and other natural sources.

Promising sources of drugs are found in algae, sea squirts and sea sponges, which are all drug sources undergoing studies at the moment. Plants are the anchor structures of these organism’s ecosystems. When there is rapid loss of plant life, the consequences are far-reaching and the losses will affect future cancer discovery of drugs adversely.

Also, extraordinarily powerful medicines are provided by fungi which have revolutionized massive economic worth (like cholesterol medicine, immuno-suppressants and antibiotics) and human health.

The cephalosporins, statins, cyclosporines and penicillin drugs are all based on fungi-produced natural chemicals. In TCM or Traditional Chinese Medicine, mushrooms are also important ingredients and myriad activities that are therapeutic such as anti-tumour, anti-viral and anti-inflammatory effects have been attributed to them. Plants can be a part of natural approaches to chronic conditions like obesity, heart disease and cancer just like this course on medicinal food shows you.

Plants Relieve Stress

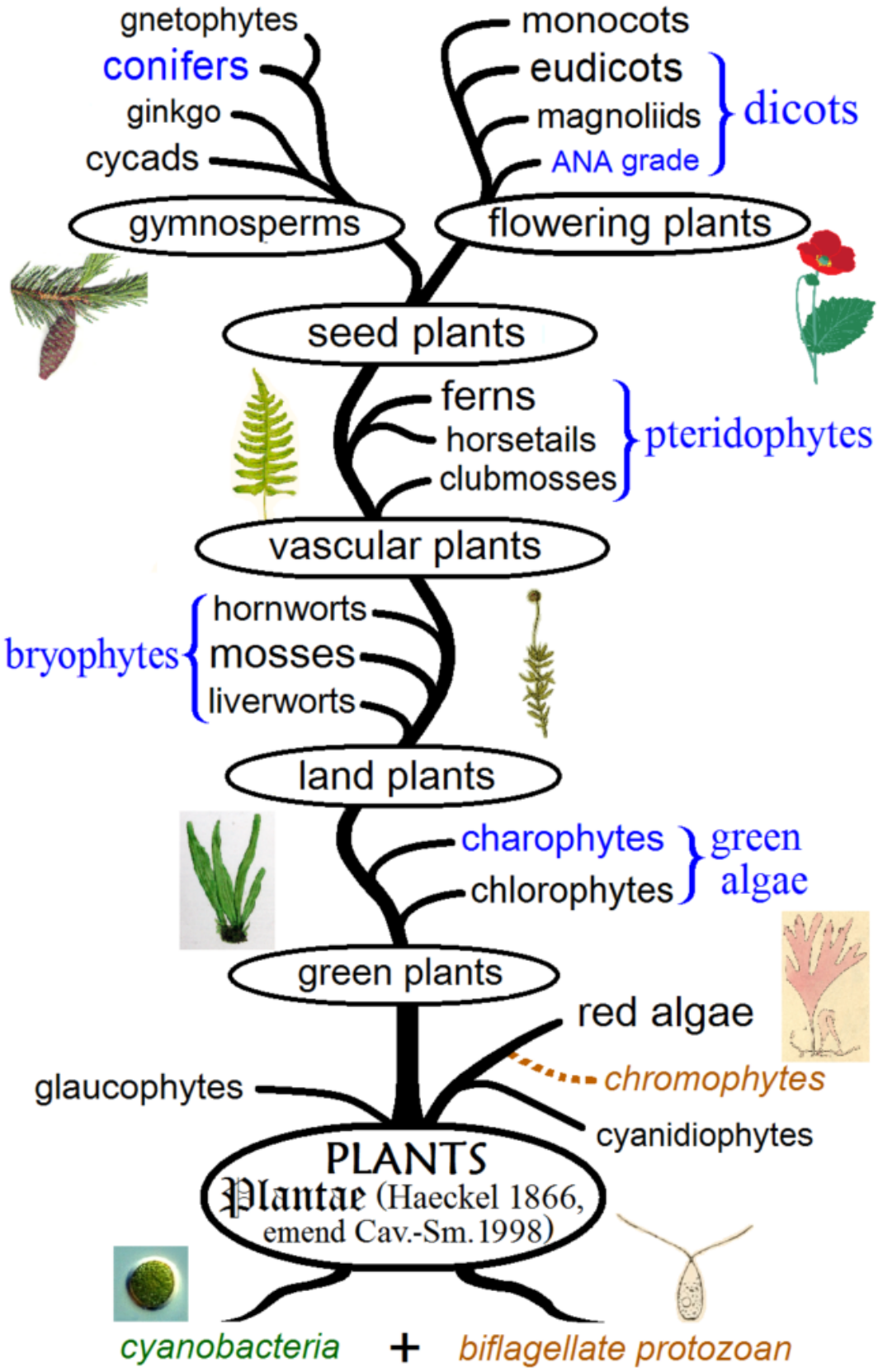
To our living spaces, plants bring natural beauty. By creating balance and texture, a patio or room can be transformed instantly into a welcoming, comfortable environment. Just like beauty pageant queens, however, plants can do so much more than just look beautiful. They clean the air we breathe by acting as oxygen factories and absorbing toxins.

They are also proven for reducing stress. Generally, plants simply make people feel better. By improving air quality and easing mental fatigue, plants manage to find themselves an indispensable part of life at home. Plants reduce stress-related muscle tension, lower blood pressure and calm the heart rate. No matter where they are located, you will find that plants are full of countless benefits, as you will see in this course on plants from China.

Plants also help us focus and relax, leading to increased capabilities of solving problems, idea generation, creativity and increased productivity. Plants also help surgery-recovering patients and ease Alzheimer’s symptoms. As a matter of fact, the existence of plants is so significant that they have even been shown to relieve the experienced symptoms of children with ADD.

At this point it is clear that our ancestors were on to something and that plants are so much more than just ornamental. We are deeply connected to plants on some level that just living with them in our home brings us repose and health.

Diagram of types of plants (ZME Science, 2018)



Types of plants **(Apse, W., 2016)**

We don't always pay too much attention to what makes some living things similar and what makes them different. It is not easy to see that an oak tree and a geranium are near relatives until you start to look closely.

The way we look at plants now has a lot to do with the work of Carl Linnaeus. He was a 17th Century Swedish scientist, and he wanted to work out just how many different kinds of living things there were.

He separated living things into plants and animals—in the same way that people had done for a very long time—but then went much further. He proposed groups and families where living organisms could be placed with their closest relatives. This was the beginning of modern scientific classification.

Classification has changed as science has advanced, but the Linnaean system is still in pretty good shape. On this page you will find the main groups of plants according to that system.

The Main Kinds of Plants

Plants without seeds

Algae: green, brown and red (see discussion below: "Are algae really plants?")

Liverworts

Mosses

Ferns and horsetails

Plants with seeds

Cycads: palm-like plants with cones

Ginkgo: a living fossil

Conifers: spruce, fir, larch and so on

Flowering plants: from oak trees to geraniums

This list covers most of the plants on our planet, but if you want a really exact understanding you will need to dig into the science. This bibliography is one place to start.

Green Algae

This is a very varied group of living things with many thousands of individual species. Most green algae live in water. Others live where it is very damp all the time; they hate being dried out.

If you see a pond where the water is green, it will probably be because millions of tiny green algae have grown there. Each alga is invisible to the naked eye. On a seashore, you might come across kinds of green algae that are very big indeed: the green seaweeds.

Brown Algae

Brown algae are more common in the ocean than in fresh water. Some of the tallest plants in the world are brown algae. Giant kelp, for example, is common in shallow oceans, especially off the coast of California. It can be as tall as 250 feet!

Are Algae Really Plants?

To a scientist, the answer is "no." To most people, the answer is "yes."

Close study suggests that algae have more in common with bacteria than plants, and scientists have removed them from the plant kingdom.

Algae photosynthesise (make food from water and carbon dioxide), as do all plants, but they lack the distinctive structures of true plants like roots and leaves.

Liverworts

Liverworts are small plants that you see in damp places. They can stand being dried out a little better than algae, but not much. You usually see this kind near waterfalls or in woods with a lot of rain. The picture has a high magnification. These plants are pretty small!

Liverworts are believed to have evolved soon after plants made the transition from water to the land. In this sense they are more advanced than algae. They do not have the sophisticated vessels that transport water from roots to leaves found in more advanced plants.

Mosses

Mosses are close relatives of liverworts. They also like damp places and they need a lot of water to make offspring. Often mosses and liverworts fight for space around rivers and streams. Mosses don't need soil to grow, so rocks and trees can be covered in moss.

Mosses are the first plant group which show 'apical' growth. This means individual stems grow from the tip or special points along the stem, just as flowering plants do. Liverworts simply expand, growing outwards from every point.

Sphagnum Moss

Sphagnum moss is an especially successful moss that will grow on water. It can form floating mats many feet deep. In places, it is possible to walk on these floating mats, sometimes called "quaking bogs."

One of the strangest experiences I ever had was walking across one of these bogs. Small trees grew in the sphagnum and trees leaned to the side as I passed—my weight on the moss was enough to cause this! This is why they are called "quaking bogs."

Ferns

Ferns are far better at coping with dry periods than either algae or mosses, but still need very wet conditions to reproduce. This limits where they can grow. You will not find a fern in a desert!

Bracken is an especially successful kind of fern in countries with a cool, wet climate. It spreads quickly by using underground "creeping rhizomes" and can cover many acres very quickly.

In Devonian times, many millions of years ago, ferns were the dominant land plant on our planet. Instead of forests of fir trees or oaks, there were forests of huge tree ferns. Later on, many familiar dinosaurs like the Triceratops would be happy to dine on ferns.

Plants with seeds

Seeds have an outer layer that helps protect against drying out, infection, or consumption by animals.

Cycads

Cycads mostly grow in Central America, Africa, Southeast Asia and parts of Australia. They are the kinds of exotic-looking plants you see in jungle movies, though some are popular house and garden plants. They like moisture and heat. They can be tall and often have woody trunks. The leaves tend to be long and thin.

If you have grown up in a northern climate, cycads can be strange plants to encounter. Quite suddenly unfamiliar and fascinating structures will grow out of a cycad in my garden, for example, and have me hunting through my books to find out exactly what is happening. These structures are usually cones of some kind, similar to the cones that conifers produce.

Cones bear exposed seeds rather than the kinds of seeds that you find in flowering plants, which are well protected until they are released. The seeds are often pollinated by special kinds of beetles rather than bees or other insects.

Ginkgo

There is only one species of Ginkgo in the world today: Ginkgo biloba. When you look at the fossils of this plant, it seems that there only ever was one kind of ginkgo; the modern plant looks a great deal like its ancient relatives, who date back to the Permian period (a time well before the dinosaurs).

Despite its lack of diversity, the ginkgo once covered huge areas of the world. Now it is only found naturally in Central China. Most scientists think that flowering trees have been outcompeting the ginkgo, and so the ginkgo has gradually been dying out. It is sometimes called a living fossil. At the same time, the tree's beauty has meant that gardeners and park keepers have carefully planted and tended ginkgo trees around the world.

Conifers

Conifers are close relatives of cycads. They have cones with seeds and they also have woody trunks. The most noticeable difference is that conifers like cold, northern climates where they can form huge forests that can stretch from one side of a continent to the other.

The typical conifer shape is excellent at shedding snow. They also have many ways of coping with freezing at the cellular level. Conifers are popular garden plants too. They are evergreen and most grow very quickly.

Flowering Plants

Some people think of plants and trees as very different. The truth is that trees are plants, just as much as a row of lettuce or a fine rose. Flowering plants are the most familiar kind of plant for anyone who lives in a temperate climate (not too hot, not too cold).

The thing that makes a geranium so similar to an oak tree is the flowers that they both produce. Flowering plants protect the female parts of the plant inside thick walls of tissue. The male parts of the plant produce pollen, and this needs to burrow its way through this tissue to produce an embryo that then develops into a seed.

Pollen can be transferred from one plant to another by the wind or by insects like bees. Plants that use wind pollination usually have small, drab and inconspicuous flowers. Flowers that use insects for pollination are often big and bright so that the insects can see them from a long way off.

Flowering plants are the plants most able to cope with dry conditions. Cacti can flourish in places where there is no rain for many years at a time. While flowering trees grow more slowly than conifers, their hard wood is more resistant to insect damage. This means they do better in warmer places.

25 types of tree species with their names and uses **(Hayati, 2018)**

Note: this article is only about trees in India, and yet the diversity is incredible!

Trees are the most essential living component in our nature. Trees help to maintain a balance in the ecosystem. They make the environment look lush and green while supplying sufficient coolness to the surroundings. Unfortunately, the rate at which they are being cut down is rather alarming and sad. However, some of the giant trees are difficult to forget or not notice. Take a look at some of the different types of trees in India.

Here are top 25 types of trees list that you may have most definitely noticed.

1. Banyan Tree:

Banyan trees are mostly seen in different regions of country and is the national tree of India that grows in special type of soil. The oldest Banyan tree is present in Kolkata. This huge type of tree has extensive branches in order to provide support to it, having height more than 21 m. Leaves are of 10-20 cm long. Leaves are used as plates in India. Wood is used for making furniture, door, etc. Leaf, seeds and bark are useful for various diseases and disorders.

2. Neem Tree:

The most common and popular tree of probably every household is the neem tree that has bright leaves and goes up to the height of 100 feet. A straight and rough trunk is seen in neem trees. Each and every part of the Neem trees are essential for different purposes. They are used to treat chicken pox and used in various medicines. Wood is also used in south India for furniture making. Neem can be used as fertilizers for different plants.

3. Peepal Tree:

It is a fast-growing tree having heart-shaped leaves with a large crown. It sheds its leaves in the month of March and April. Peepal tree is used for various purposes, as ear drop, heals wounds, root bark cleans ulcers, prevent gum diseases, urinary troubles, fruit is useful for asthma and many more. The leaves are also used as decorative items.

4. Aloe Vera Tree:

Aloe Vera plant usually grows to a height of about 12 to 16 inches. It has thick and fleshy leaves with sharp edges but does not have a stem. Long leaves are mainly in triangular fashion inside which contains the aloe vera gel. It grows in sandy soil in sunny location though need to be watered in a regular basis. Aloe Vera is useful to hair to remove dandruff and the itchy effect. Though they are essential in cosmetic products, they are equally important to the food industry.

5. Tulsi Plant:

Tulsi plant is considered as a holy and religious plant in India. Height reaches about 75 cm to 90 cm. The leaves are round oval shaped which contain essential oils. It has high medicinal value. It provides relief in fever, cold and cough, effective against insomnia, indigestion, etc.

6. Amla Plant:

Amlaki' is the household name very commonly used for amla. This type of tree is a medium deciduous plant of height about 8-18 meters. Spreading branches and crooked trunk are the prominent features of this plant. Feathery and linear-oblong shaped leaves mostly smell like lemon. In extreme heat, it wraps and splits. Amla is highly rich in Vitamin C, thus used in common cold. This improves the immunity of our body and is useful for healthy hair. Other than that, amla is used in shampoo and many food items like jellies, pickle, etc.

7. Eucalyptus:

The leaves of this evergreen kind of tree are of 6-12 inches long and 1-2 inches broad when they are adult. Height is nearly about 300 feet or more. Prominent bark appears as it ages. Fruit comes in a capsule. One of the main use of this kind of tree is plywood for the manufacture of the paper and its poles are also used for the construction of houses. It also lowers the sugar level in blood and purifies it. It acts as an antiseptic and also provides a remedy for asthma patients.

8. Mahagony:

Mahogany is basically used as astringent for wound obtained from the bark. This is used as a remedy in diseases like anemia, fever, dysentery, others. Furniture, boat, casket, musical instruments are generally made from the wood of mahogany. Indian mahogany trees are found mostly all over India. They have symmetrically round crown growing up to 30-40 feet height.

9. Indian Rosewood:

The rosewood is a kind of tree grows up to an altitude of about 25 m and has a diameter of about 3 m. This rosewood is a deciduous tree which grows straight. Flowers are of white and pink colours. The fruit is brown coloured and is of very dry and hard. Crown part is oval in shape. This tree works as a fuel wood. It is used in furniture making, plywood, musical instruments, etc. It is a remedy for acne treatment and helps to balance oily and dry skins. The rosewood oil stimulates the growth of a new cell.

10. Tulip Tree:

Indian Tulip is found in lower dry to wet forest. The height of Indian tulip tree is usually more than 40 feet. The flowers are cup shapes and the leaves are of heart shaped. This evergreen tree is very fast growing. Main branches of the tulip tree grow in straight along with thick bark. As the tree gets older it thins out, though it was bushy while it was young. Flowers, fruits and the young leaves are edible. Timber is used for making paper, paddles and also used to make gums and oils. Leaves are also used for swollen joints.

11. Sal Tree:

Sal trees is a rare tree variety that is mainly found in the eastern regions of India like Bengal, Assam and others. It is a sub deciduous tree up to 30 m height. This Sal tree has a tough texture and leathery leaves. They never go completely leafless. Medicines as of astringent are received from the resin and also given during diseases like dysentery and diarrhoea. Also, used as an ointment for skin disease and foot cream. Powered seeds are basically used for dental issues. Tribal peoples use leaves for making bowls, baskets, platters, etc. The Sal butter extracted from the seeds is edible.

12. Cork Tree:

In India, cork tree grows mainly in Central India. This tall deciduous tree can grow near about 25 meters. The flowers are white tubular and consist fragrance. The characteristic feature of this is that the flower grows at night and by itself shed it in the early morning. The corky bark and strong trunk are used mainly for its medicinal value. It’s a remedy for lung and cough diseases.

13. Turmeric Tree:

The other commonly used name, colloquially used, is Haldi. It is also called Indian saffron and is widely cultivated in India. The stem of turmeric plant is very short which is of 60-90 cm. Flowers are of yellow white and pink. It is highly antiseptic, thus, it is used for internal injuries, wound, pimples, etc. It acts as a remedy for cold and cough and also given in jaundice.

14. Teak Tree:

The teak trees are very tall having height near about 30 meters and are evergreen. The larger leaves are of same the size of tobacco trees. The flowers are of white to bluish coloured and the fruit is of papery and light brown in colour. They normally have uneven texture by growing straight and have slight lustre. Teak is widely used in making furniture,

boats, doors and windows of a house. Its bark is considered very useful for a headache, stomach problem, fevers and digestion.

15. Black Willow Tree:

Black willow is one of the species of the willow tree. Another name used for black willow is ‘swamp willow’. The bitterly tasted roots previously used as an alternatively for quinine. Salicylic acid which is similar to the compound aspirin is present. They are used for the treatment of cold and cough, fever and headache.

16. The Maple Tree:

Maple is a common type of shrub. There are as many as 125 species of maple trees which are present in nature. The main types of maple trees are sugar maple, red maple, silver maple, Japanese maple, Norway maple and paperbark maple. The trees are deciduous trees which mean they lose their leaves in each fall but some are there that do not shed the leaves. Canadian flag depicts a maple leaf on it. It is used as an art of bonsai and is extensively used as ornamental tree due to its different vibrant colours.

17. The Oak Tree:

Oak tree falls under the group of flowering plants. There are different types of oak trees present in nature. It has simply spiral arranged leaves. Some leaves have lobate margins and others have serrated leaves or have smooth margins. Bark of the white oak tree is usually dried and used for medical purposes. Manuscript inks were previously made from oak galls for many centuries. The bark of cork oak is used as a bottle stopper. The wood of this tree is used as valuable timber.

18. Cucumber Tree:

Cucumber is popularly used as a food item world widely and known by several names. It is deciduous tree whose leaves are oblong in shape and are down sided on the underside. The leaves have fine and smooth margins. It is under the magnolia group but unlike the magnolia, in cucumber tree flowers are not showy. This tree basically refers to unripe fruit. They provide perfect shade but not preferable to plant this street tree. Often grow in deep moist soil with slightly acidic in nature.

19. Black Walnut:

The black walnuts are mostly used commercially. This type of tree is also a species of deciduous tree. Trees are often cultivated for walnuts and fruits. On the other hand, these trees do have high medical importance. Improved quality of wood and nuts are in high demand to various parts of the world. Black walnut is sometimes undesirable since it used to harm grasses and plants. Leaves have many leaflets with the largest leaflets in the center and that have pointed long tip and round base. The fruit has a semi-fleshy husk which falls in October and November months. The ripening fruits are seen during the autumn season.

20. Cedar:

Cedar tree is mainly known as Cedar wood all over. This tree has conical shape with branched trunk and has flat leaves. This tree acts as a medicine in case of cold, flu and fevers. Leaves of cedar tree are used to make tea which is high in Vitamin C.

21. Beech Tree:

The nuts and leaves of beech trees are edible. It can also be used for firewood and act as a very good source. This tree is very large in size as it grows but the wood of this tree is not so strong enough. As a result, large beeches are found to be falling apart. New beech leaves come out from the buds in spring which can be eaten and tastes differently. These can be eaten raw but the cooked item has greater nutritional value.

22. Apple Tree:

Apple is widely grown and cultivated all over the world as a fruit. These types of trees grow as a deciduous tree. They mainly grow from the seeds but can also be grown using grafting process by planting the small grafted portions. Apple is highly rich in vitamins and minerals. The bark of the root of this tree is used for fevers. Apples are baked which can be eaten for a sore throat. Regularly eating an apple controls the body metabolism and helps in restful sleep. Apple cider, has medicinal properties and is commonly available in markets acts as an antibiotic.

23. Hazel:

Hazel tree provides edible nuts and hence it’s a common tree of waysides. It is a shrub type which generally has multiple stems. The leaves of hazel are elongated in shape which looks like racket shaped with a rough texture. Fruits of this tree can be identified easily. It normally grows in a straight and unobstructed way. It also consists of a nice structure as the leaves grow and take a proper structure. Some of its uses are in making of camp gadgets, strong straight poles and tent pegs.

24. Common Ash:

This is almost the tallest tree among the all trees. The uses of this tree are well known from the ancient periods. It is used to make bows in bow-arrow, simply excellent for firewood and also used for many various tools and its handles. Ash tree has a relatively higher diameter as compared to the other trees. It has seeds which are flattened in its outlook and form dense clusters. Each sub-branches of the tree usually consist of numerous opposite pair of leaflets which is the key feature of this tree.

25. Hawthorn:

Hawthorn is a tree which widely used in rural areas to make the fences. From the name, it can be understood that it has thorny and prickly character. The tree has characteristic red bright berries during the latter half of the summer months. Deeply lobed leaves are the distinct feature of this tree. This tree has several uses like it is used for firewood; thorns are used for fish-hook and fences prevention to livestock and also the leaves, flowers and berries are edible used for survival.

Genetic engineering and GM Crops **(International Service for the Acquisition of Agri-Biotech Applications, 2018)**

Over the last 50 years, the field of genetic engineering has developed rapidly due to the greater understanding of deoxyribonucleic acid (DNA) as the chemical double helix code from which genes are made. The term genetic engineering is used to describe the process by which the genetic makeup of an organism can be altered using "recombinant DNA technology." This involves the use of laboratory tools to insert, alter, or cut out pieces of DNA that contain one or more genes of interest.

Developing plant varieties expressing good agronomic characteristics is the ultimate goal of plant breeders. With conventional plant breeding, however, there is little or no guarantee of obtaining any particular gene combination from the millions of crosses generated. Undesirable genes can be transferred along with desirable genes; or, while one desirable gene is gained, another is lost because the genes of both parents are mixed together and re-assorted more or less randomly in the offspring. These problems limit the improvements that plant breeders can achieve.

In contrast, genetic engineering allows the direct transfer of one or just a few genes of interest, between either closely or distantly related organisms to obtain the desired agronomic trait. Not all genetic engineering techniques involve inserting DNA from other organisms. Plants may also be modified by removing or switching off their own particular genes.

The "sharing" of DNA among living forms is well documented as a natural phenomenon. For thousands of years, genes have moved from one organism to another.

For example, *Agrobacterium tumefaciens*, a soil bacterium known as 'nature's own genetic engineer', has the natural ability to genetically engineer plants. It causes crown gall disease in a wide range of broad-leaved plants, such as apple, pear, peach, cherry, almond, raspberry, and roses. The disease gains its name from the large tumor-like swellings (galls) that typically occur at the crown of the plant, just above soil level. Basically, the bacterium transfers part of its DNA to the plant, and this DNA integrates into the plant's genome, causing the production of tumors and associated changes in plant metabolism.

Genetic engineering techniques are used only when all other techniques have been exhausted, i.e. when the trait to be introduced is not present in the germplasm of the crop; the trait is very difficult to improve by conventional breeding methods; and when it will take a very long time to introduce and/or improve such trait in the crop by conventional breeding methods (see Figure 2). Crops developed through genetic engineering are commonly known as transgenic crops or genetically modified (GM) crops.

Modern plant breeding is a multi-disciplinary and coordinated process where a large number of tools and elements of conventional breeding techniques, bioinformatics, molecular genetics, molecular biology, and genetic engineering are utilized and integrated.

Although there are many diverse and complex techniques involved in genetic engineering, its basic principles are reasonably simple. There are five major steps in the development of a genetically engineered crop. But for every step, it is very important to know the biochemical and physiological mechanisms of action, regulation of gene expression, and safety of the

gene and the gene product to be utilized. Even before a genetically engineered crop is made available for commercial use, it has to pass through rigorous safety and risk assessment procedures.

The first step is the extraction of DNA from the organism known to have the trait of interest. The second step is gene cloning, which will isolate the gene of interest from the entire extracted DNA, followed by mass-production of the cloned gene in a host cell. Once it is cloned, the gene of interest is designed and packaged so that it can be controlled and properly expressed once inside the host plant. The modified gene will then be mass-produced in a host cell in order to make thousands of copies. When the gene package is ready, it can then be introduced into the cells of the plant being modified through a process called transformation. The most common methods used to introduce the gene package into plant cells include biolistic transformation (using a gene gun) or *Agrobacterium*-mediated transformation. Once the inserted gene is stable, inherited, and expressed in subsequent generations, then the plant is considered a transgenic. Backcross breeding is the final step in the genetic engineering process, where the transgenic crop is crossed with a variety that possesses important agronomic traits, and selected in order to obtain high quality plants that express the inserted gene in a desired manner.

The length of time in developing transgenic plant depends upon the gene, crop species, available resources, and regulatory approval. It may take 6-15 years before a new transgenic hybrid is ready for commercial release.

Transgenic crops have been planted in different countries for over twenty years, starting from 1996. About 189.8 million hectares was planted in 2017 to transgenic crops with high market value, such as herbicide tolerant soybean, maize, cotton, and canola; insect resistant maize, cotton, potato, and rice; and virus resistant squash and papaya. With genetic engineering, more than one trait can be incorporated or stacked into a plant. Transgenic crops with combined traits are also available commercially. These include herbicide tolerant and insect resistant maize, soybean and cotton.

To date, commercial GM crops have delivered benefits in crop production, but there are also a number of products in the pipeline which will make more direct contributions to food quality, environmental benefits, pharmaceutical production, and non-food crops. Examples of these products include: rice with higher levels of iron and beta-carotene (an important micronutrient which is converted to vitamin A in the body); long life banana that ripens faster on the tree and can therefore be harvested earlier; tomatoes with high levels of flavonols, which are powerful antioxidants; arsenic-tolerant plants; edible vaccines from fruit and vegetables; and low lignin trees for paper making.