Understandings:

1. Explain what meristems are.

- Animals have a set period of growth and have a set number of stem cells and once they are differentiated, there is no coming back. So embryonic stem cells are said to be pluripotent, and somatic stem cells are said to be multipotent (limited choices to differentiate into).

Plants however have special stem cells called meristems. These are totipotent which means that they can develop into a whole new organism (from one cell! What is this magic?). Meristems can be on the tip of the shoot and tip of the root (apical meristems) and they can also be on the stem for lateral growth (lateral meristems).

Extra notes

- I think we should clarify the terminologies with all these "potent". (Taken from Wikipedia)

Totipotent/omnipotent stem cells can differentiate a single organism. As mentioned, meristems are totipotent, but also the zygote after few divisions (maybe four?).

Pluripotent stem cells can differentiate into nearly all cells, but not enough to develop into a single new organism. Embryonic stems cells are pluripotent.

Multipotent stem cells can differentiate into a number of cell types of similar "family". For instance, blood stem cells can differentiate into leukocytes, lymphocytes, etc.

Oligopotent stem cells can differentiate into few cell types.

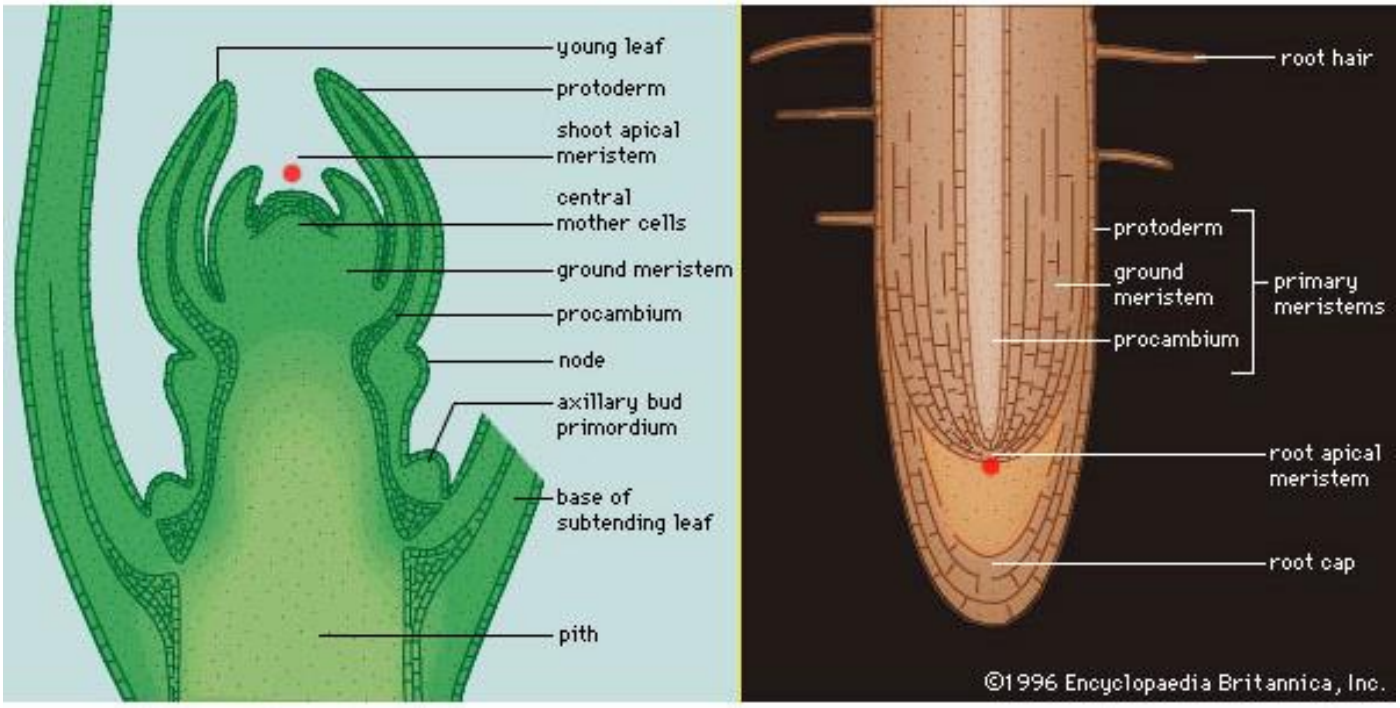
Unipotent cells can produce only one cell type which is their own. These have the property of self-renewal, which distinguishes them from non-stem cells, like muscle stem cells.

So theoretically, plants can live forever assuming that they have sufficient food and no external forces kill them? If that is the case, well then we have found the fountain of youth.

2. Explain the role of mitosis in plant growth.

- It is the meristem that undergoes mitosis and cell division. What happens is that when meristem splits into two, one stays in the "meristem region" and one gets pushed away to differentiate. This way, plants can sustain meristem throughout their lives.

Root apical meristems just grow into roots. But in shoot apical meristems, they must grow into buds, leaves and flowers.



Things to note are leaf primordia (young leaf), apical meristem, procambium (for vascular bundles), axillary bud, protoderm (epidermis of leaf) and ground meristem (for pith).

3. Explain how plant hormones control growth in the shoot apex.

- A group of hormone under the name Auxin is very prevalent in plants.

A type of hormone we have to know is auxin indole-3-acetic acid (IAA). What this does is that this controls growth by moving laterally. This is produced at the shoot apical meristem and it is moved down to the stem. Then they are actively pumped by auxin efflux pumps that move auxin from one side to the side where there is less sun.

4. Define tropism and explain what it is.

- Tropism is a phenomenon where an organism responds to changes in environment. We have two in the plant world. Phototropism is the growth response towards light and gravitropism is the growth response in the direction of gravity. Shoots have positive phototropism with negative gravitropism (assuming position of sun and direction of gravity is opposite). Roots have negative phototropism with positive gravitropism.

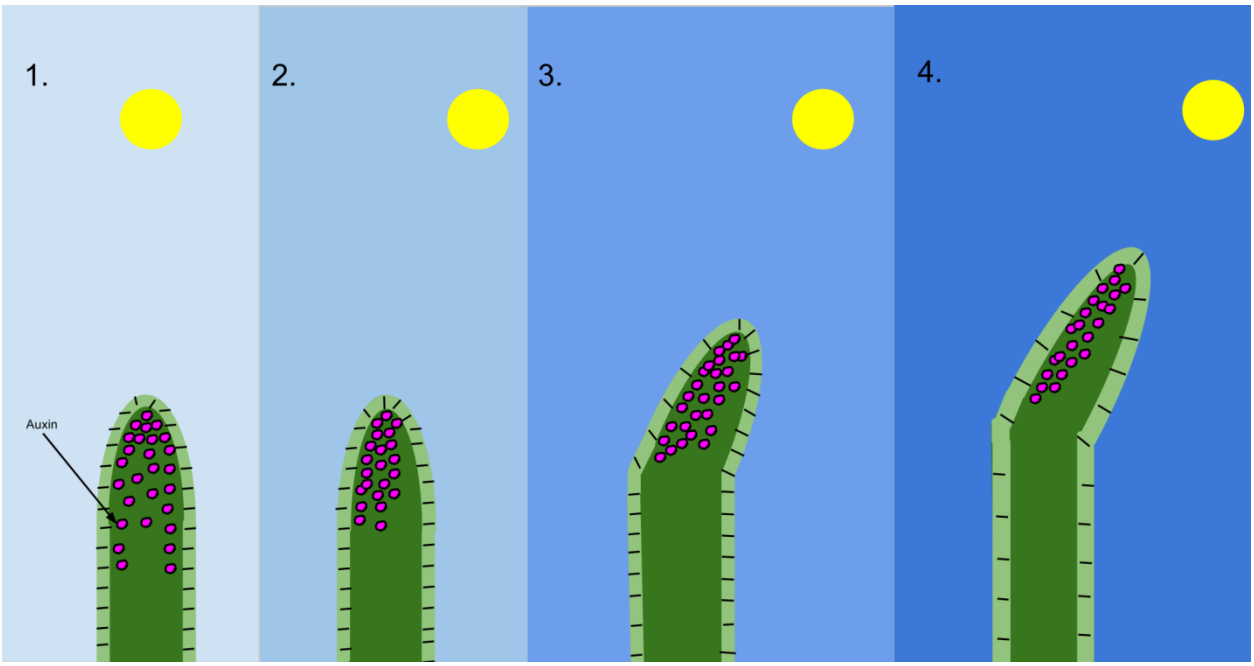
5. Explain what auxin does to control growth.

- As mentioned, “auxin” is not a hormone. It is a class of hormones.

When a plant sees light, their photoreceptors (like in our retina) change the gene expression to produce PIN3 proteins. These proteins transport IAA to the opposite side of the sun.

6. Explain how auxin works.

- As mentioned, IAA is transported to the opposite side of the sun. Where there is high concentration of IAA, these makes plant cells elongate. It looks something like this.



When it comes to roots, there are special cells called statocytes with a special molecule called statoliths. This enables them to sense gravity. The cell then transports auxin towards gravity. But hey, I thought auxin exhibited growth, so if it is transported towards the gravity, then when it is bent, it will grow upwards!

Yes it is true but interestingly, when there is high concentration of auxin, it actually inhibits growth. Hmm! Whether IAA will inhibit or exhibit depends on the relative ratio of cytokinin (another hormone). If IAA : Cytokinin = 10:1 and above, roots develop. If IAA : Cytokinin is less than 10:1, shoots develop!

Applications and skills:

1. Describe micropropagation of plants using tissue from the shoot apex, nutrient agar gels and growth hormones.

- Since plants have meristems, they are totipotent. This is advantageous when we want to produce the same plant. This can be done in vitro in an agar gel with hormones to aid the growth.

2. Explain the use of micropropagation.

- So why would we want to produce the same plants over and over?

Well, when plants are traded, they may carry viruses. So, one would kill the plants with viruses and produce the ones without viruses so no pathogens are spread.

Also, micropropagation is useful when reviving endangered species.

Extra notes

- Why do plants have vascular bundles/tissues anyway? There are several reasons.

It gives a structural rigidness. Bryophytes do not have this upright structure because they don't have vascular bundles! This then enables plants to become tall and get sunlight and more oxygen. And obviously, vascular bundles are efficient transporters of water and sugar from sources to sinks.

TOK:

1. Plants communicate chemically both internally and externally. To what extent can plants be said to have language?