**Dr. Rima Kumari: Date: 25/08/2020**

Online class and e- content for BSc IIIrd year students

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| Date and Time | Online class medium | E. content topic |
| 25/08/2020  01:30 p.m to 2.20 p.m | Via Google meet  Link: Meeting URL: https://meet.google.com/use-vaid-qmd | **Vernalization,**  **Physiological changes during seed germination** |

**Vernalization**

(from [Latin](https://en.wikipedia.org/wiki/Latin) *vernus*, "of the [spring](https://en.wikipedia.org/wiki/Spring_(season))")  term given by Trofim Lysenko. It is the induction of a plant's [flowering](https://en.wikipedia.org/wiki/Flower) process by exposure to the prolonged cold of winter, or by an artificial chilling treatment equivalent. After vernalization, plants have acquired the ability to flower, but they may require additional seasonal cues or weeks of growth before they will actually flower. **Vernalization** is the normal or artificial exposure of plants (or seeds) to low temperatures in order to stimulate flowering or to [enhance](https://www.merriam-webster.com/dictionary/enhance) seed production. By satisfying the cold requirement of many temperate-zone plants, flowering can be induced to occur earlier than normal or in warm climates lacking the requisite seasonal chilling. Knowledge of this process has been used to eliminate the normal two-year growth cycle required of [winter wheat](https://www.britannica.com/plant/winter-wheat). By partially germinating the seed and then chilling it to 0° C (32° F) until spring, it is possible to cause winter wheat to produce a [crop](https://www.britannica.com/topic/crop-agriculture) in the same year.

Many plants grown in [temperate](https://en.wikipedia.org/wiki/Temperate) climates require vernalization and must experience a period of low winter temperature to initiate or accelerate the flowering process. This ensures that reproductive development and seed production occurs in spring and winters, rather than in autumn. The needed cold is often expressed in [chill hours](https://en.wikipedia.org/wiki/Chilling_requirement). Typical vernalization temperatures are between 1 and 7 degrees Celsius (34 and 45 degrees Fahrenheit). For many [perennial plants](https://en.wikipedia.org/wiki/Perennial_plants), such as [fruit tree](https://en.wikipedia.org/wiki/Fruit_tree) species, a period of cold is needed first to induce dormancy and then later, after the requisite period of time, re-emerge from that dormancy prior to flowering. Many [monocarpic](https://en.wikipedia.org/wiki/Monocarpic) winter [annuals](https://en.wikipedia.org/wiki/Annual_plant) and [biennials](https://en.wikipedia.org/wiki/Biennial_plant), including some [ecotypes](https://en.wikipedia.org/wiki/Ecotype) of [*Arabidopsis thaliana*](https://en.wikipedia.org/wiki/Arabidopsis_thaliana) and winter [cereals](https://en.wikipedia.org/wiki/Cereals) such as [wheat](https://en.wikipedia.org/wiki/Wheat), must go through a prolonged period of cold before flowering occurs.

Many seeds of temperate region need a minimum period of pre-chilling (cold-treatment) for breaking the dormancy period. For example, seeds of lettuce (of a variety called Grand Rapids) exhibit dormancy because they are unable to overcome the physical restraint imposed by seed coat. The seed coat is hard like that of a shell of a nut. The seeds require light for germination. They also germinate in dark if pre-chilled at 2OC. These observations suggest that there is a single on and off switch that can turn to the 'on' position by light or by chilling.

**Devernalization**: It is possible to devernalize a plant by exposure to sometimes low and high temperatures subsequent to vernalization. For example, commercial [onion](https://en.wikipedia.org/wiki/Onion) growers store sets at low temperatures, but devernalize them before planting, because they want the plant's energy to go into enlarging its bulb (underground stem), not making flowers

**Physiological changes during seed germination:**

one of the initial events during seed germination is to produce large number of hjldrolytic enzymes to degrade stored food material into small molecules that can be utilised by the embryo for growth. The degradation of food material takes place in the endosperm or storage tissue (cotyledons) and the energy and raw material formed are mobilised to the developing embryo for its 'nourishment'. Sugars are catabolised via respiration to yield ATP and NADH. It has been found in some cases that initially ATP is produced on breakdown of phosphorus rich compound inositol6-phosphate or phytin stored in the seeds by an enzyme called phytase.

Let us now examine the changes that occur in the seeds after they imbibe water. In general, the most important metabolic events are:

i) degradation of stored food material through the activity of various enzymes,

ii) changes in hormonal levels, and

iii) synthesis of new proteins and enzymes.

Seeds store food material in the form of fats, proteins and starch. These cannot be

used directly by the embryo. In order to make them usable, they need to be degraded.

Fats are broken down by the enzyme lipase into fatty acids and glycerol. You know

that fatty acids are converted to acetyl CoA by P-oxidation. acetyl CoA through glyoxylate cycle produces succinate which forms glucose via gluconeogenesis. Starch is hydrolysed by a-amylase to maltose units which are converted to glucose.

In seeds, proteins are stored as protein bodies. Different plants have different type

of proteins. For example, the proteins in maize seeds are called **zein** and in barley

**hordeins.** In seeds of soya bean different sizes of protein bodies are present. Plants

cannot use these proteins for the growth of seeds. These are hydrolysed by proteases

into amino acids which are used for the synthesis of proteins of functional importance to the embryo. Similarly, in some cases nucleic acids are also degraded by nucleases to form nucleotides which are reutilised as building blocks for the synthesis of DNA.

During seed germination many changes also occur in the hormonal levels. As

mentioned in the previous unit that the embryo of barley seed releases gibberellic

acid which acts on the aleurone layers and induces the synthesis of the enzyme

a-amylase. AS you know a-amylase degrades starch. Clearly the enzyme was not

present in the seeds but is synthesised de novo. Experiments show that gibberellin

specifically affects synthesis of mRNA of a-amylase (i.e. transcription of a-amylase

gene). As we have mentioned before there are some enzymes which are already

present in the seed while others are produced in response to hormones. Some of the

changes that occur in a barley seed are shown in Fig 17.2.

A number of other cellular changes like changes in membrane organisation e. k. endoplasmic reticulum, development of mitochondria are also triggered in the seed

d8ring germination. The net result of all these changes is to provide nutrition to the

'embryo in order to make it divide add grow. The visible outcome of these events is

the emergence of radicle.(the root) followed by the plumule (the shoot). The shoot

groys and develops primary leaves and with chloroplasts the plant becomes

autotrophic and begins its life by establishing itself firmly by its roots on the ground.