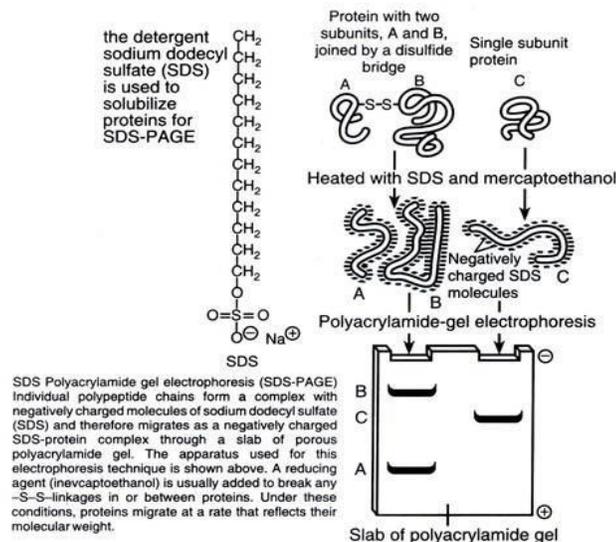


Polarity of a Pollen Grain in Plants

- In the development of a plant (and animals) growth does not proceed at random producing a formless mass of living cells but is an orderly process that gives rise to specific three dimensional forms of organ or body. Growth in one region or dimension is related to growth in the others and thus the plant becomes an integrated individual. A notable feature of these bodily forms is the presence in them of an axis which establishes a longitudinal dimension for an organ or the plant.
- Along the axis and symmetrically to it, the lateral structures develop. The two ends of poles or the axis are usually different both as to structure and physiological activity.
- Thus a typical vascular plant has a major axis with the root at one end and shoot at the other, with lateral appendages, e.g., leaves, branches and lateral roots arranged symmetrically around it. Growth is usually more rapid parallel to the axis than at right angles, resulting usually, but by no means invariably, in an elongate form. These patterns appear very early in the development of an organism as the result of differences in growth or in planes of cell division. This characteristic orientation of an organism, which is typically bipolar and axial, is termed polarity.



➤ **Fig. 8.18:** Principle of SDS-PAGE

- Polarity may manifest itself in a variety of ways. The structures at the two ends of the axis are very much unlike as in the cases of root and shoot, stem end and flowering end and petiole and leaf blade. The movement of certain substances may take place in one direction along the axis but not in the other, thus showing polarity in physiological activity. Individual

Cells show polar behaviour in the plane, of division and in the different characters of the two daughter cells formed.

- By axiate polarity is then understood as the property of the plant or an organ which determines the contrast between apex and base. In higher plants, this polarity is already determined in the fertilised egg cell and once established it seems to be strictly followed. When a piece of stem is cut off the plant this will usually reform roots and often shoots. The roots are always produced at the basal end of the axis whereas shoots develop near the apical end.
- This polarity seems to be due to polar transport of auxin in cells and tissues where it always moves from apex to base. This causes auxin accumulation at the base which favours root formation and a deficiency of auxin at the apex which favours shoot initiation. Thus it has never been possible to transform the shoot end into root end and conversely by simply inverting a plant or a piece of stem (except by treatment with morphactins).
- Polarity in rare cases may be determined by external factors, in *Fucus* zygotes, rhizoids always form on the side opposite to the direction of the source of light and the first wall is laid down at right angles to this direction. If the zygotes are, however, exposed to polarised light, the rhizoids tend to develop in the plane of polarisation.
- It has also been found that when *Fucus* zygotes are subjected to centrifugal force, rhizoids seem to grow out from the centrifugal pole. In *Fucus* eggs, even the shape of the egg-cell sometimes modifies egg polarity.

“Polarity is defined as the condition of having distinct poles in a pollen grain. Jackson in 1928 assumed that a pollen grain points to the poles like *Silphium*. *Silphium laciniatum*, also known as compass plant, has leaves that ‘turn their edges north and south and avoid the mid-day radiation’ —Willis.

- Pollen mother cell after meiosis forms four pollen grains that commonly remain in tetrads and later separate to form individual pollen grain. At tetrad stage the polarity of a grain is best detected.
- There are two poles in a pollen grain — proximal and distal. The proximal face is the part of a pollen grain and spore that faces inward/nearest or toward the centre of tetrad.
- The distal face is the part of a pollen grain and spore that faces distal, i.e. away from the centre of tetrad and opposite the proximal part. An imaginary straight line labeled as polar

axis connects the proximal pole (more precisely the proximal pole at the centre of the proximal face) to the distal pole (more precisely the distal pole at the centre of outer face) of a pollen grain.

- Equatorial axis/diameter (= equator) is also an imaginary straight line that occurs perpendicular to polar axis of a pollen grain midway between the poles. The term meridional is used to indicate the surface of a pollen grain that is oriented 'in a pole-to-pole direction at right angles to the equator' – Erdtman.
- By axiate polarity is then understood as the property of the plant or an organ which determines the contrast between apex and base. In higher plants, this polarity is already determined in the fertilised egg cell and once established it seems to be strictly followed.

The following common terms are used in connection with polarity:

i. Apolar:

- A pollen grain is said to be apolar in which the proximal pole, distal pole, proximal region and distal region cannot be distinguished. Pollen grains that occur in linear tetrads are apolar because they exhibit no polarity.

Example:

Periploca ephedriformis and *Typha* etc.

ii. Cryptopolar:

- Pollen and spores are said to be cryptopolar spore that appears to be apolar, i.e. poles and polar region cannot be distinguished, 'but on closer examination they reveal a more or less distinct polarity.

Polar:

- A pollen grain is said to be polar in which proximal and distal pole can be distinguished in individual state. Isopolar, heteropolar and subisopolar/paraisopolar belong to this category.

iii. Isopolar:

- A pollen grain is said to be isopolar (Fig. 4.32B) in which the proximal — and distal half have similar appearance. A uniform plane that occurs halfway between the poles and at right angles to polar axis divides a pollen grain into two halves — proximal and distal.

- The half that faces proximal pole is labeled as proximal half and the half that faces distal face is referred to as distal half. The two halves of pollen are equal with regard to apertures and surface ornamentation etc. ex. *Calluna* (Ericaceae).
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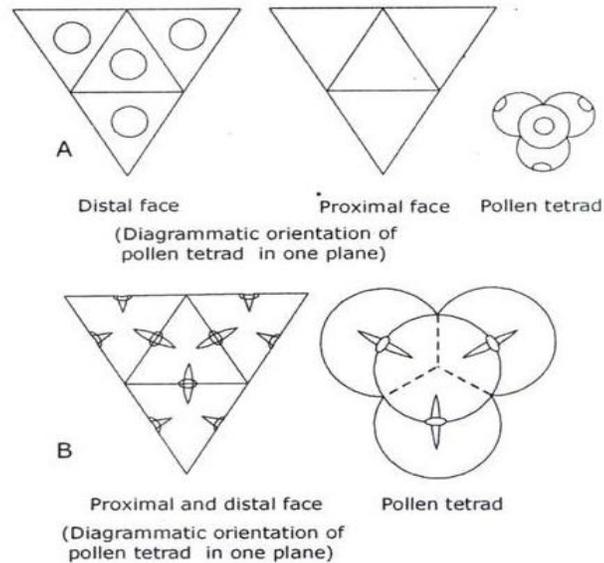


Figure 4.32

Diagrammatic illustrations of polarity in pollen tetrad. A. *Drimys* with heteropolar pollen. B. *Calluna* with isopolar pollen. The central pollen grain has apertures at '2, 6 & 10 o'clock' position.

iv. **Heteropolar:**

- A pollen grain is said to be heteropolar (Fig. 4.32A) in which the proximal — and distal half is essentially dissimilar to each other with regard to apertures. As for example *Lilium* exhibits distal colpus and *Elaeis* has three-lobed distal furrow etc.

v. **Subisopolar or Paraisopolar:**

- A pollen grain is said to be subisopolar/paraisopolar that is + intermediate between isopolar and heteropolar pollen grains. As for example *Diastella*, *Nivenia* and *Ulmas* etc. have small differences in surface details between proximal and distal half.
- The polarity of a pollen grain forms the basis of aperture terminology and the followings are few examples. A circular aperture that occurs equatorially or globally is called porus. The circular aperture that occurs distally is termed as ulcus. An elongated aperture that occurs equatorially or globally is called colpus.

- When an elongated aperture occurs distally it is called sulcus. The polarity gives a pollen grain two views: a proximal polar and a distal polar. It is the polarity that distinguishes a spore from pollen. Emergence of pollen tube from distal pole is the characteristic of a pollen grain. Proximal germination is restricted to spores that germinate at tetrad scar termed laesura.
- It is to note that polarity exists throughout megasporogenesis. But during microsporogenesis the time of initiation of polarity varies. Usually microspore mother cell is non-polar. Microspore mother cell undergoes reduction division.
- It is observed that polarity is established during the appearance of spindle at the time of first meiotic division. The aperture sites (in *Lilium longiflorum*) develop in each microspore tetrad in the face away from the centre. Following the first meiotic division all events in the development of microspore are polarized and occur in pre-determined way.
- Polarity can be disturbed by colchicine treatment or by centrifugation. Both treatments disturb spindle formation. By colchicine treatment, in *Lilium longiflorum*, the spindles of first and second meiotic division can be blocked.
- In this case microspore mother cell, as a whole, develops with regular exine patterning but in it the colpus may not be developed at all or if develops, it may be with random distribution and irregular form.

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