Faculty of Science
**Department of Botany,**
Telangana University
M.Sc Botany II Year, IV Semester
Paper: **Phytohormones and Plant Development**
**Question Bank**

1. Senescence is induced by plant growth regulators [e]
   a. Ethylene
   b. Jasmonic acid
   c. Abscisic acid
   d. Salicylic acid
   e. All of these
2. Senescence is induced by plant growth regulators [e]
   a. Auxin
   b. Gibberellic acid
   c. Cytokinin
   d. Polyamines
   e. All of these
3. The key hormone in regulating the onset of senescence [a]
   a. Ethylene
   b. Jasmonic acid
   c. Abscisic acid
   d. Salicylic acid
   e. All of these
4. In the cytoplasm the substances degraded through the ubiquitin pathway [a]
   a. Protein
   b. Sugar
   c. Chlorophyll
   d. Nucleic acid
   e. All of these
5. The substances degraded through the PAO [pheophorbide a oxygenase] pathway [c]
   a. Protein
   b. Sugar
   c. Chlorophyll
   d. Nucleic acid
   e. All of these
6. The substances used to eliminate the weeds [a]
   a. Herbicides
   b. Pesticides
   c. Insecticides
   d. Enzymes
   e. All of these
7. Majority of the herbicides exert their effects by inactivating [a]
   a. Protein
   b. Sugar
   c. Chlorophyll
   d. Nucleic acid
   e. All of these
8. The herbicide 'Roundup' active compound is [a]
   a. Glyphosate
   b. Chlorsulfuron
   c. Phosphinothricin
   d. Sulfometuron methyl
   e. All of these
9. The herbicide 'Oust' active compound is [d]
   a. Glyphosate
   b. Chlorsulfuron
   c. Phosphinothricin
   d. Sulfometuron methyl
   e. All of these
10. The herbicide 'Glean' active compound is [b]
    a. Glyphosate
    b. Chlorsulfuron
    c. Phosphinothricin
    d. Sulfometuron methyl
    e. All of these
11. The herbicide 'BASTA' active compound is [c]
    a. Glyphosate
    b. Chlorsulfuron
    c. Phosphinothricin
    d. Sulfometuron methyl
    e. All of these
12. The herbicide that inhibit 5-enolpyruvylshikimate-3-phosphate synthase [EPSP], a key enzyme in the biosynthesis of aromatic amino acids [a]
    a. Glyphosate
    b. Chlorsulfuron
    c. Phosphinothricin
    d. Sulfometuron methyl
    e. All of these
13. The glyphosate tolerant gene were first isolated from [a]
    a. *Salmonella typhimurium*
    b. *Nicotiana tabacum*
    c. *Lycopersicon esculentum*
    d. *Petunia hybrida*
    e. *Escherichia coli*
14. The glyphosate tolerant gene [a]
    a. *aro* A
    b. *aro* B
    c. *aro* C
    d. *aro* D
    e. *aro* E
15. The herbicide that inhibit acetolactate synthase [ALS] [d]
    a. Glyphosate
    b. Chlorsulfuron
    c. Phosphinothricin
    d. Sulfonylurea & Imidazolines
    e. All of these
16. The herbicide that bind chloroplast thylakoid membrane and block electron transport [e]
    a. Glyphosate
    b. Chlorsulfuron
    c. Phosphinothricin
    d. Sulfonylurea & Imidazolines
    e. Triazine
17. S**ynthetic compounds-** phenoxycarboxylic acids, benzoic acids, pyridinecarboxylic acids, aromatic carboxymethyl derivatives and quinolinecarboxylic acids **that act like [a]**
    a. Auxin
    b. Gibberellic acid
    c. Cytokinin
    d. Polyamines
    e. All of these
18. 1-naphthalene acetic acid (1-NAA), 2-methyl-4-chlorophenoxyacetic acid (MCPA) and 2,4-dichlorophenoxy acetic acid (2,4-D) are derivatives of [a]
    a. Indole acetic acid [IAA]
    b. Gibberellic acid
    c. Benzyl adenine
    d. Abscisic acid
    e. All of these

19. Natural auxins like IAA are subjected to rapid inactivation through [a]
    a. Conjugation
    b. Dehydrogenation
    c. Carboxylation
    d. Decarboxylation
    e. Condensation
20. The common dicot weed among the given below [a]
    a. *Galium aparine* L.
    *b. Nicotiana tabacum*
    *c. Lycopersicon esculentum*
    *d. Petunia hybrida*
    e. *Arabidopsis*
21. The time course of events auxin herbicides can be divided into _______ phases [a]
    a. Three
    b. Four
    c. Five
    d. Six
    e. Seven
22. The ethylene biosynthesis through induction of1-aminocyclopropane-1-carboxylic acid (ACC) synthase in the shoot tissue occurs in [a]
    a. Stimulation phase
    b. Inhibition phase
    c. Decay phase
    d. Senescence
    e. Programmed cell death [PCD]
23. Stomatal closure, paralleled by reduced transpiration, carbon assimilation and starch formation, and overproduction of reactive oxygen species (ROS) are observed in [b]
    a. Stimulation phase
    b. Inhibition phase
    c. Decay phase
    d. Senescence
    e. Programmed cell death [PCD]
24. accelerated foliar senescence with chloroplast damage and progressive chlorosis, and by the destruction of membrane and vascular system integrity, leading to wilting, necrosis and finally to plant death [c]
    a. Stimulation phase
    b. Inhibition phase
    c. Decay phase
    d. Senescence
    e. Programmed cell death [PCD]
25. The auxin herbicide quinclorac that control grass weeds in rice [e]
    a. *Echinochloa*
    b. *Digitaria*
    c. *Setaria*
    d. *Brachiaria* spp.
    e. All of these
26. The hypersensitive response [HR] by plants prevent the infection by [e]
    a. Bacteria
    b. Viruses
    c. Fungi
    d. Protozoa
    e. All of these
27. The hypersensitive response is triggered by specific genes [a]
    a. R
    b. A
    c. B
    d. E
    e. Z
28. The hypersensitive response characterized by rapid cell death in _____ phases [a]
    a. Two
    b. Three
    c. Four
    d. Five
    e. Six
29. Superoxide, hydrogen peroxide, hydroxyl radicals, nitrous oxide produced in hypersensitive response are [a]
    a. Reactive oxygen species [ROS]
    b. Antioxidants
    c. Inhibitors
    d. Suppressors
    e. All of these
30. The Reactive oxygen producing enzymes [e]
    a. Cooper amine oxidase
    b. Xanthine oxidase
    c. Peroxidase
    d. Oxalate oxidase
    e. All of these
31. The activation R genes trigger an ion flux, involving an efflux of [a]
    a. Potassium
    b. Sodium
    c. Magnesium
    d. Calcium
    e. Iron
32. The activation R genes trigger an ion flux, involving an influx of [d]
    a. Potassium
    b. Sodium
    c. Magnesium
    d. Calcium
    e. Iron
33. The antimicrobial compound synthesized by plants that accumulate at the area of pathogen infection [a]
    a. Phytoalexin
    b. Reactive oxygen species
    c. Inhibitors
    d. Ethylene
    e. All of these
34. The first compound isolated from garlic as a phytoalexin [a]
    a. Allixin
    b. Alkaloid
    c. Terpenoids
    d. Glycosteroids
    e. Phenols
35. The molecules that signal plants to begin the process of phytoalexin synthesis are called [a]
    a. Elicitors
    b. Reactive oxygen species
    c. Inhibitors
    d. Ethylene
    e. All of these
36. Molecules with elicitor activity could be [e]
    a. Polysaccharides
    b. Glycoproteins
    c. Lipopolysaccharides
    d. Lipids
    e. All of these

37. Abiotic elicitors could be [e]
    a. Fungicides
    b. Salts of heavy metals
    c. Detergents
    d. Polylysine
    e. All of these
38. Pisatin is phytoalexin accumulated due to infection with [a]
    a. *Aphanomyces eutiches*
    b. *Nectria hematococca*
    c. *Peronospora parasitica*
    d. *Leptosphaeria maculans*
    e. *Pseudomonas syringae*
39. Spirobrassinin is phytoalexin accumulated due to infection with [d]
    a. *Aphanomyces eutiches*
    b. *Rhizopus stolinfer*
    c. *Peronospora parasitica*
    d. *Leptosphaeria maculans*
    e. *Pseudomonas syringae*
40. Camalexin is phytoalexin accumulated due to infection with [e]
    a. *Aphanomyces eutiches*
    b. *Nectria hematococca*
    c. *Salmonella typhimurium*
    d. *Leptosphaeria maculans*
    e. *Pseudomonas syringae*
41. Stilbene, phytoalexin in *Vitis vinifera* is synthesized due to infection with [e]
    a. *Aphanomyces eutiches*
    b. *Nectria hematococca*
    c. *Salmonella typhimurium*
    d. *Leptosphaeria maculans*
    e. *Botrytis cinerea*
42. The phytoalexin hypothesis was proposed in the year [a]
    a. 1940
    b. 1942
    c. 1945
    d. 1946
    e. 1948
43. Borger and Muller were first to propose the compounds synthesized during the plant-pathogen interaction were [a]

a. Phytoalexin
b. Reactive oxygen species
c. Inhibitors
d. Ethylene
e. All of these

44. Sesquiterpenes, such as, capsidiol, rishitin and gossypol are phytoalexins synthesized the members of [a]
    a. Solanaceae
    b. Fabaceae
    c. Malvaceae
    d. Orchidaceae
    e. Euphorbiaceae
45. Furanocoumarins, isocoumarins and chromones are synthesized by the members of [e]

a. Solanaceae
b. Fabaceae
c. Malvaceae
d. Orchidaceae
e. Umbellifereae

46. *Cicer aeritinum* [chick pea] synthesize, medicarpin, maackian in response to infection with [e]

a. *Aphanomyces eutiches*
b. *Nectria hematococca*
c. *Peronospora parasitica*
d. *Leptosphaeria maculans*
e. *Ascochyta rabiei*

47. 6,7-dimethoxycoumarin in various citrus plants is synthesized due to infection with [e]

a. *Aphanomyces eutiches*
b. *Nectria hematococca*
c. *Peronospora parasitica*
d. *Leptosphaeria maculans*
e. *Phytophthora citrophthora*

48. Glyceollin, a phytoalexin seen in soybean due to infection with [e]

a. *Aphanomyces eutiches*
b. *Nectria hematococca*
c. *Peronospora parasitica*
d. *Leptosphaeria maculans*
e. *Phytophthora megasperma*

49. 6-methoxymellein inhibited both nucleic acid and protein synthesis in [a]

a. *Candida albicans*
b. *Nectria hematococca*
c. *Peronospora parasitica*
d. *Leptosphaeria maculans*
e. *Phytophthora citrophthora*

50. The terpenoid phytoalexin rishitn cause decrease in rate of respiration in [a]

a. *Erwinia carotovora*
b. *Nectria hematococca*
c. *Peronospora parasitica*
d. *Leptosphaeria maculans*
e. *Phytophthora citrophthora*

**Fill in the Blanks**

1. Senescing cells and tissues are metabolically very active and an ordered series of cytological and biochemical events occur during senescence.
2. Senescence is characterised by increased respiration, declining photosynthesis and an orderly disintegration of macromolecules.
3. At the cellular level, chloroplasts are the first organelles to be disintegrated. Nuclei remain structurally and functionally intact until the last stage of senescence. Meanwhile, other cell organelles and bio-membranes also gradually deteriorate.
4. Expression of senescence down-regulated genes (SDGs) decreases. Such genes encode proteins in photosynthesis and other biosynthetic processes. Concentration of growth promoting hormones especially cytokinins decline.
5. Expression of senescence associated genes (SAGs) increases. Such genes encode hydrolytic enzymes such as proteases, ribonucleases and lipases as well as enzymes involved in biosynthesis of deteriorative hormones such as abscisic acid (ABA) and ethylene.
6. Some of the SAGs have secondary functions in senescence that are useful to plant. These genes encode enzymes that are involved in conversion and remobilization of nutrients and substrates from senescing tissues and their reallocation to other parts of the plant that survive (i.e., not senescing).
7. Leaf yellowing is the first visible symptom of leaf senescence
8. The biochemical mechanism responsible for the rapid disappearance of chlorophyll in aging leaves - every autumn approximately $9x10^9$ t chlorophyll are broken down
9. Chlorophyllase, which removes phytol from chlorophyll, is the only enzyme which has been proved to be involved in chlorophyll breakdown
10. The bright red colour of aging tree leaves is caused by anthocyanins, usually by the anthocyanidin cyanidin
11. The formation of anthocyanin in aging leaves is stimulated by high day temperatures and by light
12. Chlorophyll degradation starts with the release of chlorophyll from its association with pigment-binding proteins in the thylakoid membranes. This process is aided by a gene called stay green (SGR).
13. Phaeophytin a is hydrolyzed by the enzyme phaeophytinase to yield pheophorbide a
14. Pathways of chlorophyll breakdown and anthocyanin biosynthesis are specifically upregulated during senescence.
15. 2,4-Dichlorophenoxyacetic acid (2,4-D) was the first synthetic herbicide to be commercially developed and has commonly been used as a broadleaf herbicide
16. Auxinic herbicides have been widely used to control dicot weeds in domestic lawns, commercial golf courses, and crops
17. 2,4-D was one of the first synthetic auxin herbicides to be widely and commonly used to control annual and perennial weeds
18. 2,4-D was commercially released in 1946 becoming the first successful selective herbicide and allowed for greatly enhanced weed control in wheat, maize, rice
19. Aryloxyalkanoate dioxygenases (AADs) can efficiently cleave 2,4-D into non-herbicidal dichlorophenol and glyoxylate
20. The symptoms induced in plants by auxinic herbicides are similar to those induced by high exogenous doses of the natural auxin, IAA.
21. At low doses auxinic herbicides, it promotes plant growth while at high doses it drives plant overgrowth, including cupping and stunting of leaves, brittleness, stunting and twisting of stems, and general abnormal growth
22. 2,4-D mainly kills plants in three ways: altering the plasticity of the cell walls, influencing the amount of protein production, and increasing ethylene production
23. The pyridine and pyrimidine classes are herbicides with selective toxicity to broadleaf weeds. These herbicides are used to control weeds in both agricultural and non-agricultural settings
24. Glyphosate inhibits the enzyme enolpyruvyl shikimate-3-phosphate synthase (EPSPS) (EC 2.5.1.19) which is a key enzyme in the biosynthesis of aromatic amino acid
25. The enzyme enolpyruvyl shikimate-3-phosphate synthase is nuclear-encoded and is involved in the biosynthesis of plastid-localized Shikimic Acid Pathway (SAP)
26. EPSPS uses two substrates phosphoenol pyruvate (PEP) and shikimate-3- phosphate (S3P) to form EPSP (5-enolpyruvylshikimate-3-phosphate).
27. To develop glyphosate tolerance in plants were overexpressed for EPSPS
28. The glyphosate oxidoreductase, which degrades glyphosate to glyoxylate and AMPA (aminomethylphosphonic acid)
29. A phytoalexin is a compound which inhibits the development of the fungus in hypersensitive tissues and is formed or activated only when the host plants come in contact with the parasite.
30. The first phytoalexin; this waspisatin, a pterocarpan derivative produced by pods of *Pisum sativum* inoculated with conidia of the brown rot funus, *Monilinia fructicola*.
31. Most phytoalexins produced by the Leguminosae belong to six isoflavonoid classes: isoflavones, isoflavanones, pterocarpans, pterocarpenes, isoflavans and coumestans .
32. Some pterocarpan phytoalexins are especially well known: pisatin, phaseollin, glyceollin, medicarpin and maackiain.
33. Pisatin was the first phytoalexin to be isolated and characterized from garden pea, Pisum sativum
34. More than 350 phytoalexins have been chemically characterized from approximately 30 plant families.
35. The greatest number 130 have been characterized from the Leguminosae
36. Plant hypersensitive response (HR) is a rapid localized cell death that occurs at the point of pathogen penetration and is associated with disease resistance.

37. Hypersensitivity is a natural defense for plants in response to a variety of pathogens such as viruses, bacteria, fungi and is characterized by a programmed cell death (PCD) accompanied by an accumulation of toxic compounds within the dead cell.
38. There are two types of hypersensitive responses: structural and induced.
39. Programmed cell death (PCD) is seen in both structural as well as in induced hypersensitive response.
40. PCD is extreme resistance shown by the plants in which it kills its cells (suicidal death), upon a perception of the pathogen to deprive it of nutritional supply and stops its growth.
41. Induced hypersensitive response comes out when the plant recognizes specific pathogen-produced signal molecules known as elicitors.
42. Recognition of elicitors by the host plants activates an army of biochemical reactions.
43. Induced hypersensitive reactions include an oxidative burst of reactive oxygen species (ROS), alterations in plant cell wall also including cell wall immunity (CWI) and damage-associated molecular patterns (DAMPs), induction of phytoalexins and synthesis of PR proteins.
44. Induced hypersensitive response comprised under the first line of defense of plants which come into action after recognition of conserved molecules characteristic of many microbes. These are called elicitors
45. Elicitors are known as microbe associated or pathogen-associated molecular patterns (MAMPs or PAMPs).
46. The second line of defense of plants is the recognition of effectors through plant resistance gene products known as R genes, which result in effector-triggered immunity (ETI).
47. Effector-triggered immunity is supported by the gene for gene hypothesis.
47. Avirulence gene encodes a protein which is specifically recognized by genotypes of the host plant harboring the matching resistance genes.
48. Necrotic lesions may develop but are not required for triggering SAR and systemic gene activation
49. Local HR is often associated with the onset of systemic acquired resistance (SAR) in distal plant tissues
51. Systemic acquired resistance (SAR) is type of resistance is generally effective against a broad range of pathogens and it is associated with the transcriptional activation of whole set of marker genes many of which encode pathogenesis-related proteins such as chitinases and 1,3-β-glucanases.
52. The sites of HR the infection sites proper are invariably the focal points for transcriptional activation of a large variety of plant defence genes in neighbouring cells.
53. A proteinaceous elicitor of the plant defense reaction known as the hypersensitive response was isolated from Erwinia amylovora, the bacterium
54. Abscisic acid (ABA) and ethylene are the major regulators of ripening and senescence in both dry and fleshy fruits

**Functions of Auxins**

1. Facilitate flowering in plants
2. Used in the process of plant propagation.
3. Used by gardeners to keep lawns free from weeds.
4. Involved in the initiation of roots in stem cuttings.
5. Prevention of dropping of leaves and fruits at early stages.
6. Regulate xylem differentiation and assists in cell division.
7. Auxins are widely used as herbicides to kill dicot weeds.
8. Used to produce fruit without preceding fertilization.
9. Promote natural detachment (abscission) of older leaves and fruits.
10. Apical dominance may occur in which the growth of lateral buds is inhibited by the growth of apical buds. In such cases, the shoot caps may be removed.
11. These are produced by the apex of root and shoot.

**Functions of Gibberellins**

1. Delay senescence in fruits.
2. Involved in leaf expansion.
3. Break bud and seed dormancy.
4. Promote bolting in cabbages and beet.
5. Facilitate elongation of fruits such as apples and enhance their shape.
6. Used by the brewing industry to accelerate the malting process.
7. Used as the spraying agent to increase the yield of sugarcane by elongation of the stem.
8. In young conifers, utilized to fasten the maturity period and facilitate early seed production
9. Helps in increasing the crop yield by increasing the height in plants such as sugarcane and increase the axis length in plants such as grape stalks.
10. Gibberellins are acidic in nature.
11. It also delays senescence.

**Functions of Cytokinins**

1. Break bud and seed dormancy.
2. Promotes the growth of the lateral bud.
3. Promotes cell division and apical dominance.
4. They are used to keep flowers fresh for a longer time.
5. Used in tissue culture to induce cell division in mature tissues.
6. Facilitate adventitious shoot formation and lateral shoot growth.
7. Promotes nutrient mobilization that in turn assists delaying leaf senescence.

8. Helps in delaying the process of ageing (senescence) in fresh leaf crops like cabbage and lettuce.
9. Involved in the formation of new leaves and chloroplast organelles within the plant cell.
10. Used to induce the development of shoot and roots along with auxin, depending on the ratio.

**Functions of Abscisic acid**

1. Stimulates closing of stomata in the epidermis.
2. Helps in the maturation and development of seeds.
3. Inhibits plant metabolism and seed germination.
4. It is involved in regulating abscission and dormancy.
5. It is widely used as a spraying agent on trees to regulate dropping of fruits.
6. Induces seed-dormancy and aids in withstanding desiccation and various undesired growth factors.

**Functions of Ethylene**

Ethylene is the most widely used plant growth regulator as it helps in regulating many physiological processes.

1. Induce flowering in the mango tree.
2. Promotes sprouting of potato tubers.
3. Breaks the dormancy of seeds and buds.
4. Enhances respiration rate during ripening of fruits.
5. Applied to rubber trees to stimulate the flow of latex.
6. Facilitates senescence and abscission of both flowers and leaves.
7. Used to stimulate the ripening of fruits. For example, tomatoes and citrus fruits.
8. Affects horizontal growth of seedlings and swelling of the axis in dicot seedlings.
9. Increases root hair formation and growth, thus aids plant to expand their surface area for absorption.

**Role of Auxin**

| | | |
|---|---|---|
| 1 | Cell divisions and enlargement Eg. cambial growth in diameter | .IAA + GA |
| 2 | Tissue culture | Shoot multiplications (IBA and BAP),callus Growth (2,4,-D), root multiplication IAA and IBA (1-2 mg) |
| 3 | Breaking dormancy and Apical dominance | NAA |
| 4 | Shortening internode | Apple trees (NAA) (dwarf branch-fruit) |
| 5 | Rooting of cuttings | (10-1000 ppm - NAA, IAA, phenyl acetic acid) |
| 6 | Prevent lodging | NAA- develop woody and erect stem |
| 7 | Prevent abscission | Premature leaf, fruit, flower fall (NAA, IAA and 2,4-D) |
| 8 | Parthenocarpic fruit | Grapes, banana, orange - (IAA) |
| 9 | Flower initiations | Pine apple -uniform flowering - fruit ripening (NAA). Delay flowering (2,4-D) |
| 10 | Weed eradications | 2,4,D and auxin compounds |

**Fruit ripening: the role of hormones**

Fruits result from complex biological processes that begin soon after fertilization. Among these processes are cell division and expansion, accumulation of secondary metabolites, and an increase in carbohydrate biosynthesis. Later fruit ripening is accomplished by chlorophyll degradation and cell wall lysis. Fruit maturation is an essential step to optimize seed dispersal, and is controlled by a complex network of transcription factors and genetic regulators that are strongly influenced by phytohormones. Abscisic acid (ABA) and ethylene are the major regulators of ripening and senescence in both dry and fleshy fruits, as demonstrated by numerous ripening-defective mutants, effects of exogenous hormone application, and transcriptome analyses. While ethylene is the best characterized player in the final step of a fruit's life, ABA also has a key regulatory role, promoting ethylene production and acting as a stress-related hormone in response to drought and pathogen attack.

**Phytoanticipins**

Phytoanticipins are described as "low molecular weight, antimicrobial compounds that are present in plants before challenge by micro-organisms, or are produced after infection solely, from pre-existing precursors". They include primarily the saponins, avenacin and tomatine. One saponin, avenacin A-1, is localized in the epidermis of oat roots and another saponin, a-tomatine, is produced in tomato and has antimicrobial activity against many fungi.

**Elicitors**

The molecules that signal plants to begin the process of phytoalexin synthesis are called elicitors. Elicitors of biotic origin may be involved in the interaction of plants and potential pathogens

Biotic elicitors may originate in the invading organism, in which case they are referred to as "exogenous", whereas "endogenous" elicitors are of plant origin and are generated by the interaction between micro-organism and plant.
Molecules with elicitor activity have been identified across a wide range of structural types including polysaccharides, glycoproteins, lipids, lipopolysaccharides, oligosaccharides and even enzymes, though their activity can be attributed to their effect in releasing elicitor-active components from the cell walls of the pathogen or host

**Auxinic herbicide**
The auxinic herbicide family contains four major chemical groups, including quinolinecarboxylic acids (quinmerac and quinclorac), pyridinecarboxylic acids (fluroxypr, triclopyr, clopyralid, and picloram), a benzoic acid (dicamba), and phenoxyalkanoic acids (2,4-D, 2,4-DP, 2,4-DB, 2,4,5-T, MCPA, MCPB, and mecoprop).

**Types of senescence patterns**
Leopold (1961) has recognised 4 types of senescence patterns in whole plant which are as follows:
**1. Overall Senescence:**
This type of senescence occurs in annuals where whole of the plant is affected and dies.
**2. Top Senescence:**
This is represented by perennial herbs where senescence occurs only in the above ground parts, the root system and underground system remaining viable.
**3. Deciduous Senescence:**
This type of senescence is less drastic and takes place in woody deciduous plants. Here senescence occurs in all the leaves simultaneously but the bulk of the stem and root system remains alive.
**4. Progressive Senescence:**
This is characterized by gradual progression of senescence and death of leaves from the base upwards as the plant grows. (The senescence of the entire plant after a single reproductive cycle is also known as monocarpic senescence) Senescence can best be studied in leaves or similar other organs of plants e.g., cotyledons, sepals, petals etc. or cell organelles like isolated chloroplasts.

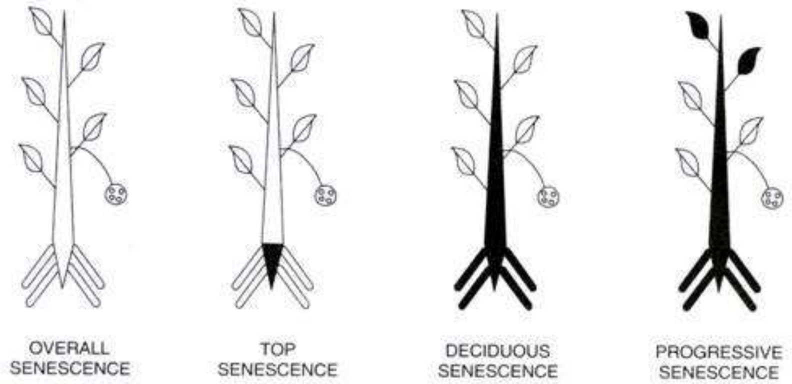


**Fig. 17.41.** Different senescence patterns in plants. Dying parts are unshaded.

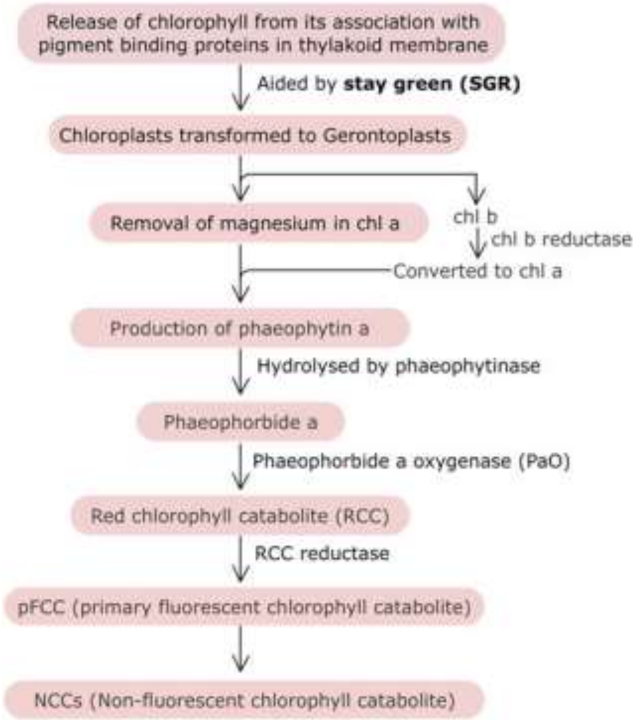
| Type | Characteristics |
|---|---|
| Monocarpic senescence | The plant dies entirely after the formation of seeds and fruits, e.g. annual plants |
| Polycarpic senescence | This group includes perennial herbs, shrubs and trees with periodic and generally synchronous leaf fall, e.g. deciduous trees with autumnal leaf fall |
| Sequential senescence of leaves | In this group belong leaf ageing of conifers and senescence of older leaves of monocarpic plants; this proceeds from unit to unit of the organism ("hierarchical senescence") |
| Senescence of above-ground plant parts | This group contains cryptophytes with their perennating buds below the earth's surface (rhizomatous plants, bulbous plants) |

**Leaf senescence**
Leaf senescence which consists of three distinct phases: (1) Initiation phase: at this stage, the decline in rate of photosynthesis takes place. Blebbing, a process that occurs in healthy cells, stops in senescing cells. In this process, membrane turnover takes place by the removal of lipid metabolites by forming lipid-protein particles which are shed by blebbing. This process stops during senescence. As a result lipid-protein particles accumulate between lipid bilayers, causing the membrane to become leaky. (2) Degenerative phase: this phase is marked by autolysis of cellular organelles and macromolecules. Many new genes are expressed, while those involved in photosynthetic activity are "turned off." (3) Terminal phase: during this phase, autolysis is completed, and cell separation takes place at the abscission layer

**Phases of leaf senescence**

| Phase | Factor/event |
|---|---|
| Initiation phase | **Internal factors**: sugars, phase change, hormones (auxin, cytokinins, salicylic acid, jasmonic acid, ethylene, abscisic acid) |
| | **External factors**: shading, heat or cold, pathogen attack or wounding, UV or ozone, drought, nutrient limitation |
| Degenerative phase | **Cell degeneration**: salvage and translocation of nutrients (e.g., nitrogen and lipids), detoxification and defense (e.g., antioxidant production and activation of defense-related genes), chlorophyll loss, macromolecule degradation |
| Terminal phase | **Cell death**: disruption of nucleus and mitochondria, DNA laddering, breakdown of plasma and vacuolar membranes |

**Steps in chlorophyll degradation during senescence**




**Phytoalexins**:-

Phytoalexins can be described as low molecular weight antimicrobial compounds that accumulate in plants as a result of infection or stress. The term - Phytoalexins�much was introduced by Muller and Boerger (1940) to describe the substances that inhibit fungus development. These substances are formed when living plant tissues are invaded by a fungal parasite.

**The hypersensitive response**

Plants have evolved a large variety of sophisticated defence mechanisms to resist the colonisation by microbial pathogens and parasites. These can be divided into three major categories: (i) immediate, early defence responses of the directly invaded plant cells, starting with signal recognition and transduction and frequently leading to rapid cell death, the so-called hypersensitive response (HR); (ii) local gene activation in the close vicinity of infection sites, resulting in the de novo synthesis of numerous secondary products, including phytoalexins, in the reinforcement of structural barriers, such as the cell wall, or in indirect inhibition of the pathogen; (iii) systemic activation of genes encoding pathogenesis-related (PR) proteins, including chitinases and 1,3-β-glucanases, which are directly or indirectly inhibitory towards pathogens and have been associated with the phenomenon of systemic acquired resistance (SAR). This classification is mainly based on the distinct temporal and spatial expression patterns of different defence responses as observed in several systems.

**Responses of pathogen-invaded or elicitor treated plant**

The initial responses of pathogen-invaded or elicitor treated plant cells occur within a few minutes and are rapidly followed by local gene activation. They include rapid and transient changes in inorganic ion fluxes across the plasma membrane; the accumulation ¨ of reactive oxygen intermediates (ROI) referred to as oxidative burst, and changes in the phosphorylation status of various proteins

**Pathogenesis-related (PR) proteins**

Systemic gene activation, followed by the accumulation of a large variety of proteins, collectively referred to as PR proteins, is tightly correlated with the phenomenon of induced or systemic acquired resistance (SAR). PR proteins are considered to be ubiquitous in the plant kingdom and are presently grouped into 14 different families

## Phytohormones and Fruit set

Fruit set is known as the initial step of fruit development in sexual reproduction of flowering plants, a process by which the flower turns into a fruit. The transition from flower to fruit corresponds to a developmental shift that is naturally triggered upon flower fertilization and leading to the activation of a high number of metabolic pathways and anatomical transformations that result in the change in organ identity. Fruit set relies on successful pollination of the stigma, followed by pollen germination and subsequent growth of the pollen tube towards the ovule. Then, the fertilization of the ovule triggers the division and expansion of the cells surrounding the embryo , and it is widely accepted that the whole process is regulated by plant growth substances, such as phytohormones, with auxin playing a pivotal role in the regulation of this developmental shift.

## Phytohormones and Abscission

Abscission of organs occurs widely in plants. Organs that have served their function, are ripe, or are no longer wanted are shed. It is a controlled process that, in most cases, is initiated during the development of the organ by the formation of an abscission zone. In the AZ, abscission actually is confined to cells in the separation layer. The separation is affected by the secretion of polygalacturonases and cellulases that are specific to abscising organs and dissolve the middle lamella and disrupt the hemicellulose network in the primary walls between two layers of cells. The newly exposed cell surfaces are protected from pathogenic attack by the synthesis of many defense-related proteins and from water loss by the formation of a periderm and plugging of lumens of broken xylem vessels and tracheids. Ethylene accelerates the rate of abscission in many plants by inducing the synthesis of wall hydrolases in the AZ. IAA moving basipetally from the leaf blade is thought to retard abscission by maintaining the AZ in an ethylene-insensitive state. It also inhibits the expression of genes encoding abscission-specific cellulases and PGs. As leaves age, the concentration of auxin drops below the threshold required, and the ethylene-induced abscission syndrome commences. Ethylene also induces the expression of at least some genes encoding pathogenesis-related proteins.