Senescence and Aging

B. Sc III Sem V Sec-I

“Plant Biochemistry and Stress Physiology”

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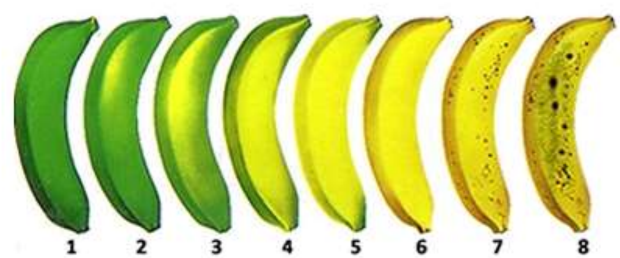
Presentation on: Physiological and Biochemical changes during Senescence



Senescence is a genetically regulated process that involves decomposition of cellular structures and distribution of the products of this degradation to other plant parts.

Three phases may be distinguished in a typical senescent process

1. Storage mobilization: A phase of selective degradation of certain molecules. This degradation does not cause a major impairment of the physiological functions. The mobilized molecules may be considered as nutrient storage materials.

2. Generalized breakdown: Extension and generalization of breakdown to components which are central in maintaining physiological function. As a result of this breakdown a physiological function is consequently lost. During this phase the senescence process becomes irreversible and death of the cells becomes inevitable.

3) Abscission: The final phase of senescence is abscission and death.

Physiological and Biochemical changes

1. Loss of membrane compartmentation

2. Ultra structural changes in chloroplast

3. Chloroplasts are converted into Chromoplasts

4. Loss of Chlorophyll content

5. Reduction of Soluble protein content

5. RuBisCO activity decreased

6. Reduction of Photosynthetic rate

7. Rate of Respiration generally decreases

8. Nucleic Acid content of leaves declines

9. Biosynthetic Enzymes activity decreases

10. Hydrolytic Enzymes activity increases

11. Increased content Ethylene and ABA

(Deteriorative Hormones)

12. Decreased content Auxin and Cytokinin

(Growth promoting Hormones)

Physiological changes……..

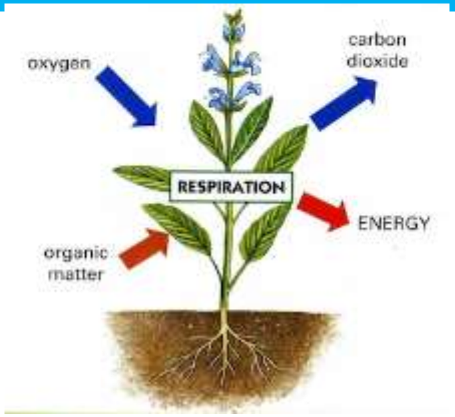
Respiration

➢Fruit was the first organ where the rate of respiration during senescence was described

➢Climacteric and nonclimacteric

➢Increased rate of respiration in climacteric fruits due to their ability to produce and response to ethylene. **It appears that the rise in respiration is a consequence of ethylene action and not of senescence as such**. The main reason for this conclusion is that inhibition of both the biosynthesis and action of ethylene eliminates the rise in respiration without preventing eventual senescence

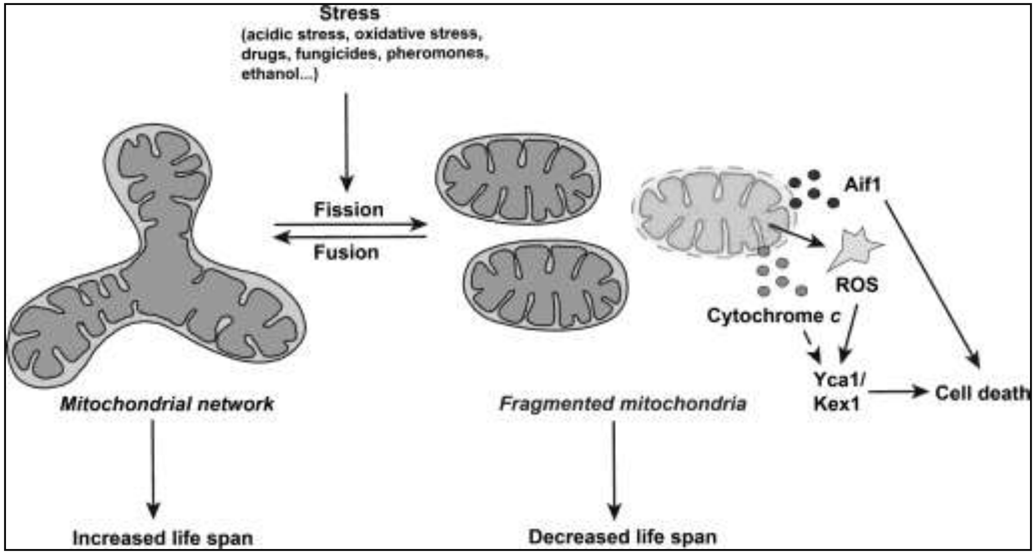
➢Respiration rate decreases as senescence pronounced



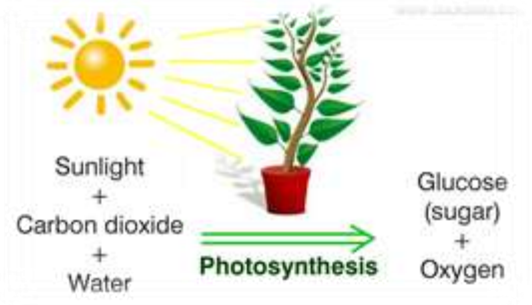
Respiratory pathways of senescence plants include glycolysis, pentose pathway, TCA cycle and the Electron transport pathway, where some changes have been described but also an **alternative oxidase pathway** which is enhanced during senescence. It has been suggested that the alternative pathway is activated when the cytochrome pathway is saturated or limited, allowing the TCA cycle to function using up excess carbohydrates.

➢Mitochondria play crucial roles in programmed cell death and aging. Different stimuli activate distinct mitochondrion-dependent cell death pathways, and aging is associated with a progressive increase in mitochondrial damage, culminating in oxidative stress and cellular disfunction.

➢Mitochondria that remain intact until late after senescence onset, are in turn degraded when the energy demand decreases .



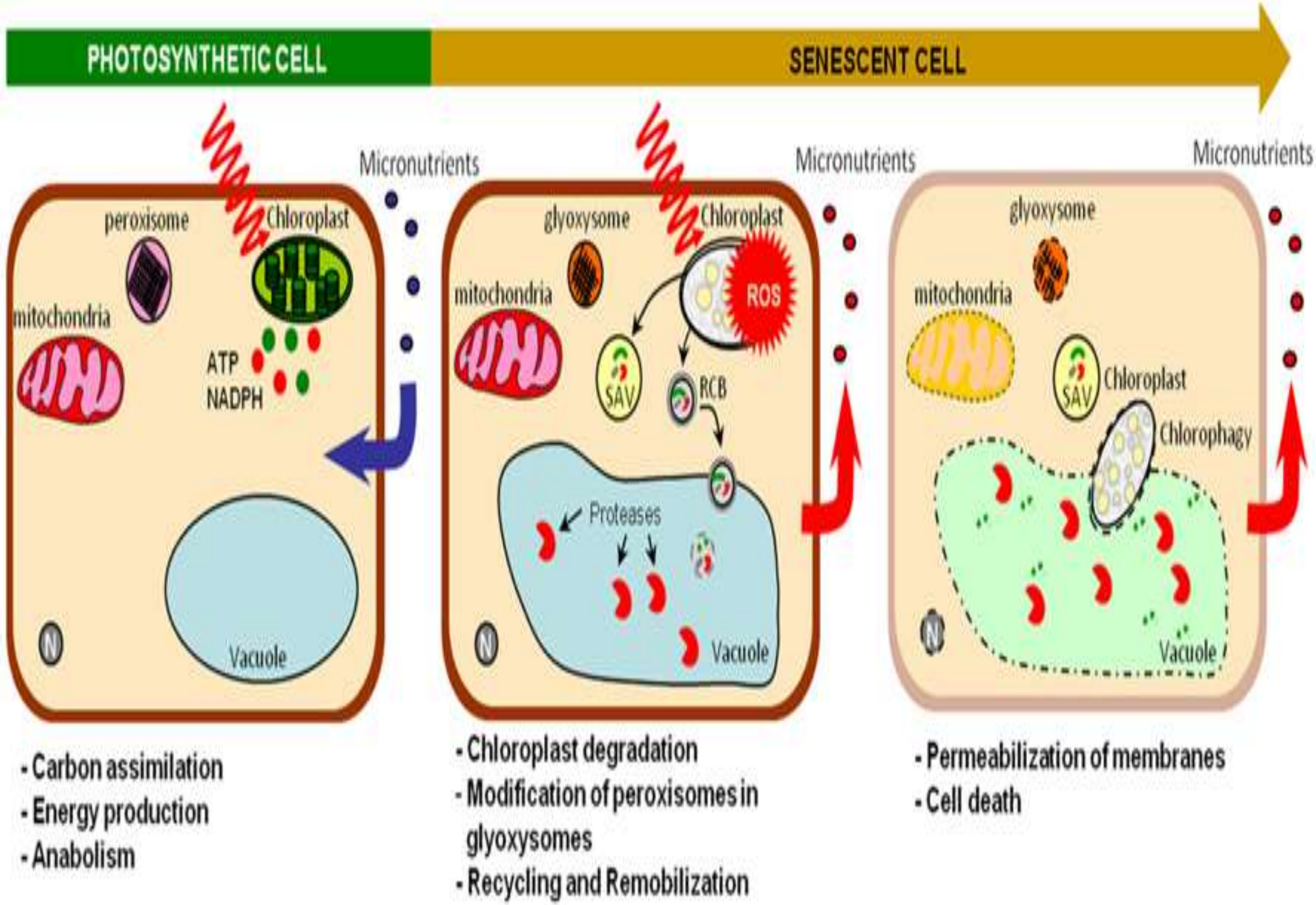
Photosynthetic changes :



✓Decrease in the rate of photosynthesis with the age of a leaf to decline in dry weight of leaves and their eventual death are the symptoms of leaf senescence.

✓The rate of photosynthesis starts declining as soon as the leaf reaches its full size or becomes mature.

✓There is a gradual loss of chlorophyll and carotenoids, which results in yellowing of leaves and or cotyledons particularly during the later stages of senescence.


PHOTOSYNTHETIC CELL
SENESCENT CELL
Micronutrients
peroxisome
Chloroplast
mitochondria
ATP
NADPH
Vacuole
N
Micronutrients
glyoxysome
Chloroplast
mitochondria
ROS
SAV
RCB
Proteases
Vacuole
N
Micronutrients
glyoxysome
mitochondria
SAV
Chloroplast
Chlorophagy
Vacuole
N
- Carbon assimilation
- Energy production
- Anabolism
- Chloroplast degradation
- Modification of peroxisomes in glyoxysomes
- Recycling and Remobilization
- Permeabilization of membranes
- Cell death

Leaf conductance and CO_2 assimilation

Senescence produces closure of stomata leading to a decline in transpiration. It has been suggested that stomata aperture may control the rate of leaf senescence. The main entrance for CO_2 are stomata and insufficient CO_2 supply could be the cause of the decreased photosynthetic assimilation observed during senescence.

Experimental measurement of CO_2 concentration in the substomatal cavity, suggests that CO_2 does not limit photosynthetic assimilation. Hence stomatal closure may be more a consequence than a cause of lowered photosynthetic activity, according to the optimal variation hypothesis, which proposes that stomatal conductance adapts to the photosynthetic capacity of a leaf.

Hormonal levels

Hormone level changes may be a primary cause or a secondary effect of senescence in leaves. In most plants cytokinins are anti senescence compounds that can postpone plant death, gibberellins also have similar effect, but in fewer plant species.

Auxins influence senescence and abscission in very complex manners, apparently depending on the auxin source or depending on the age and receptivity of the tissue. When applied to the leaf auxin often retards senescence, but paradoxically when auxin enters the leaf from stem, it sometimes promotes senescence.