Advanced Crop Quality

Lecture -3

Prof. Dr. Sundus A. Mohammed

Dept. of Field Crops

College of Agriculture

University of Basrah/ IRAQ

CHEMICAL COMPOSITION OF SEEDS

A knowledge of the chemical composition of seeds is essential for several reasons

1-Seeds are a basic source of food for both people and animals.

2- They are an important source of medicine and drugs.

3-They contain various antimetabolites that adversely affect human and animal nutrition.

4-They are an important source of raw materials useful for various industrial purposes.

5-They contain reserve food supplies and growth substances that influence seed germination and seedling vigor, seed storage, and longevity.

What do seeds store?

- Carbohydrates
- Proteins
- Lipids
- Other protective or metabolically important compounds
  - Phytate or phytic acid
  - Tannins
  - Cork, mucilage, alkaloids
  - Hormones, vitamins

FACTORS EFFECT ON CHEMICAL CONTENT OF SEEDS

The chemical composition of seeds is basically determined by genetic factors and varies among different species and seed parts(Tables1&2). However, it is influenced by environmental and practices.

Table 1. Average Chemical Composition of Seeds.

Plant	% Protein	% Fat (Lipid)
Acorn (red oak)	3.2	10.7
Barley (Pacific coast states)	8.7	1.9
Bean, Mung	23.6	0.2
Bean, Navy	22.9	1.4
Bean, Pinto	22.5	1.2
Beechnuts	15.0	30.6
Buckwheat	10.3	2.3
Chickpeas	20.3	4.3
Cottonseed kernel (without hull)	38.4	33.3
Flaxseed	24.0	35.9
Kafir grain	11.0	2.9
Mustard, Wild	23.0	38.8
Oats	12.0	4.6
Peas	23.4	1.2
Peanut (without hulls)	30.4	47.7
Rape	20.4	43.6
Rice (rough grain)	7.9	1.8
Rye	12.6	1.7
Soybean	37.9	18.0
Sunflower	16.8	25.9
Vetch	29.6	0.8
Wheat	13.2	1.9

Table 2. Chemical Composition of Different Parts of Seeds.

Chemical	Entire Seed	Endosperm	Embryo	Pericarp-Testa
Starch	74.0	87.8	9.0	7.0
Sugars	1.8	.8	10.4	.5
Oil (Lipid)	3.9	.8	31.1	1.2
Protein	8.2	7.2	18.9	3.8
Ash	1.5	.5	11.3	1.0

*Includes only selected chemical components.

From Earle et al. (1956).

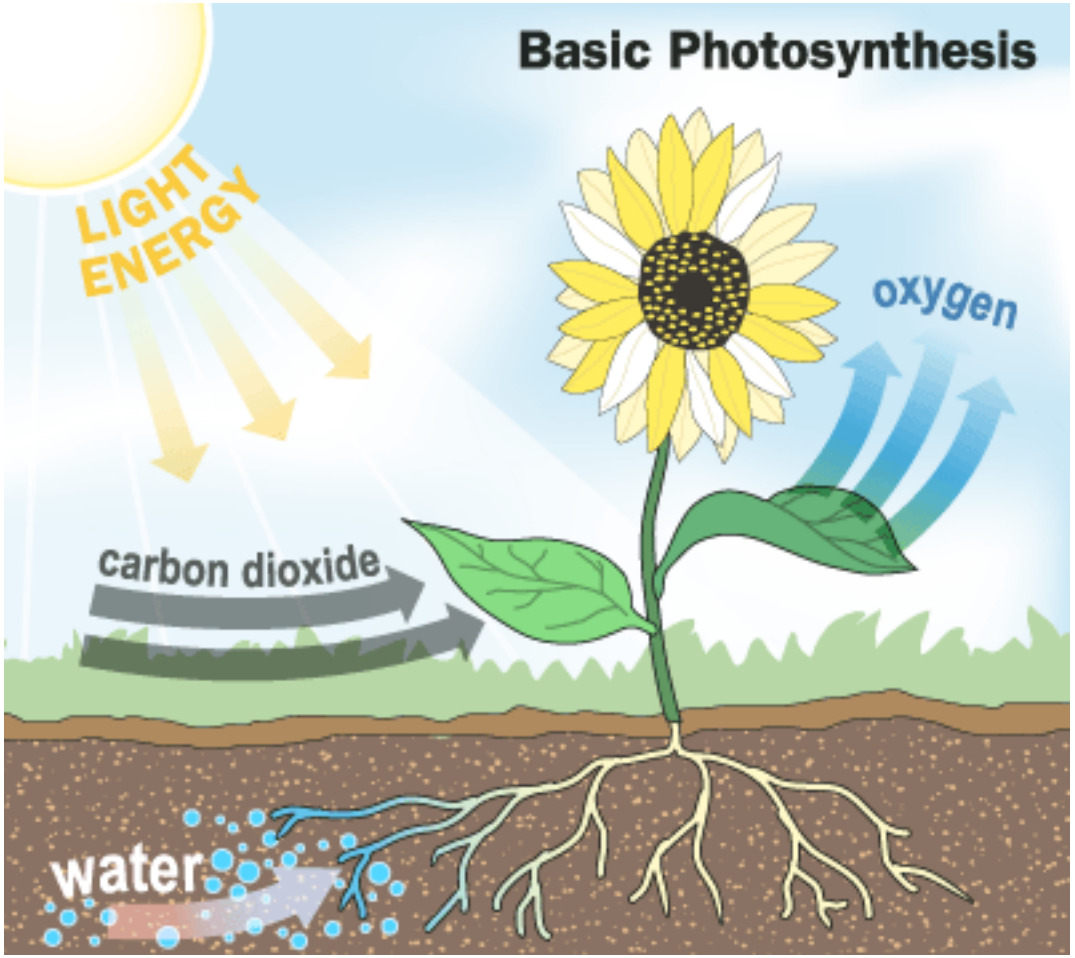
Environmental effects

- Soil fertility – seed size and weight.
- Water availability –during flowering and seed fill decrease seed size. Early plant development - seed number

http://financialpress.com/2012/08/05/congress-leaves-farmers-ranchers-high-and-dry/

- Temperature – high temperatures during seed fill tend to reduce seed size and seed germination (Gibson and Mullen, 1996; Egli *et al.*, 2005).
- Light – in general, reduced light results in smaller seeds
- Position in the plant – related to sink- source effect and competition for limiting photosynthesis

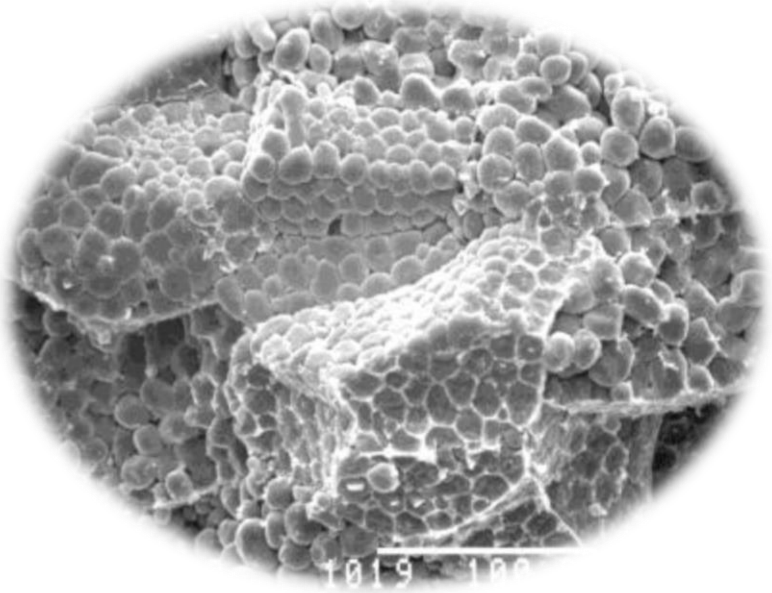
CARBOHYDRATES

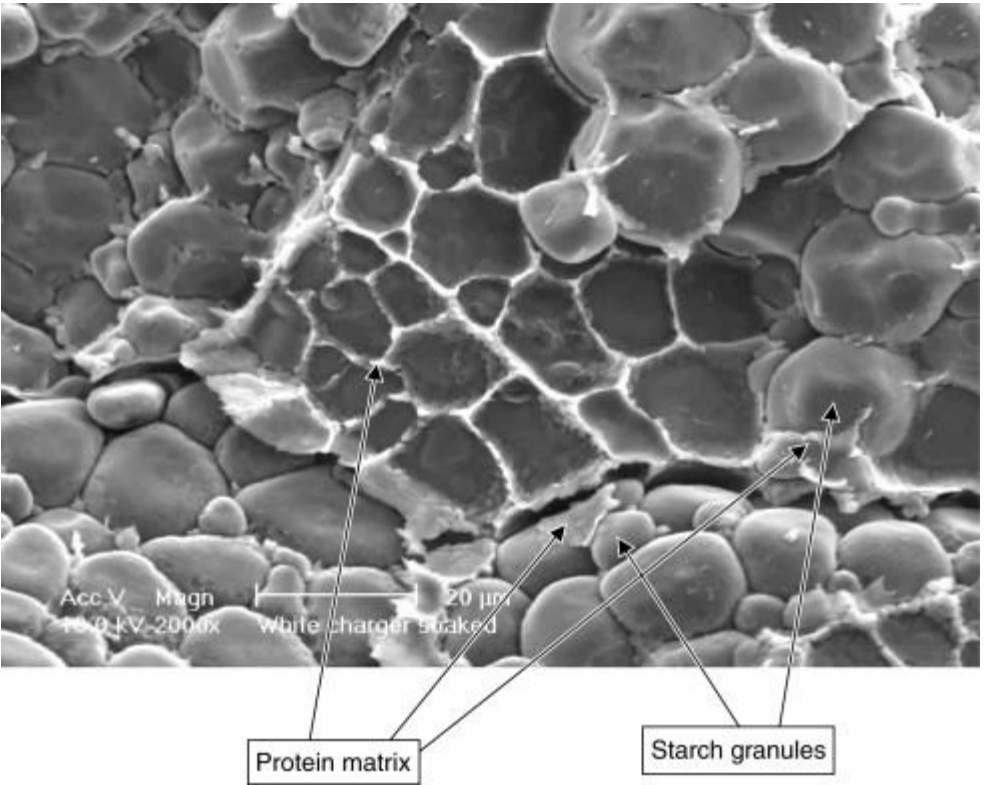


Where does the required Carbohydrates for seed filling comes from?

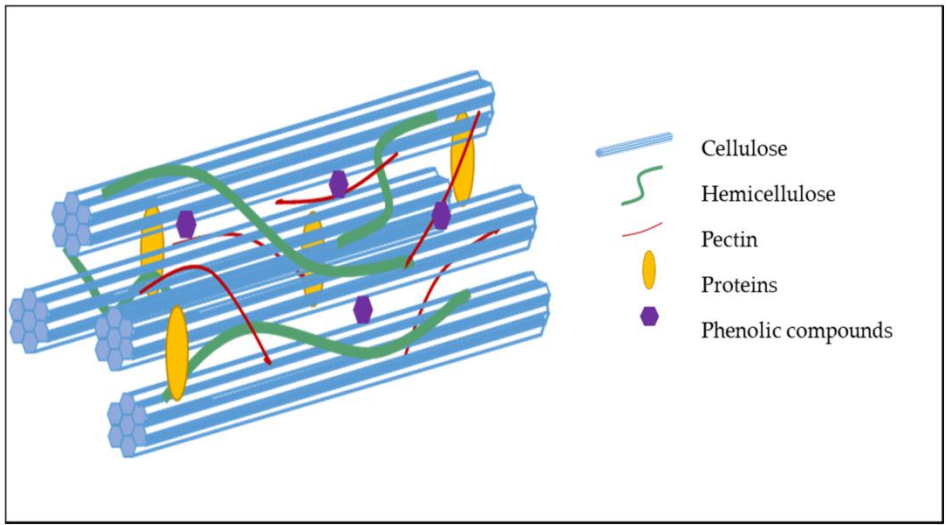
- **Cereal grain: only 15 – 20 % from carbohydrates stored in vegetative parts of the plant (pre-anthesis).**
- **85 to 90% of C originates in current photosynthesis.**
- **Starch is the main polysaccharide in the plants**
- **Starch granules consist primarily of amylose (~30%), amylopectin (~70%).**

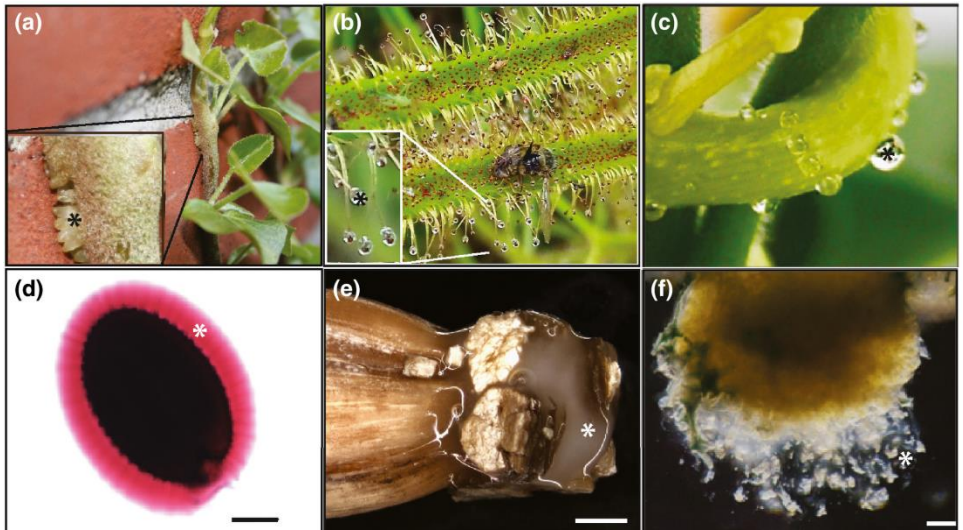
Floury endosperm in sorghum at physiological maturity showing starch granules and proteins





- Hemicellulose- (major carbohydrate in non-endospermic seeds) are deposited in the cell walls
- Mucilag occur in nearly all classes of plants in various parts of the plant, usually in relatively small percentages, and are not infrequently associated with other substances .
- Pectic- compounds cell wall.



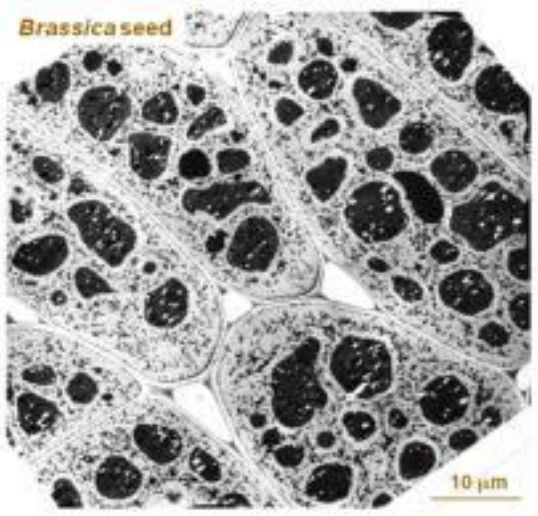


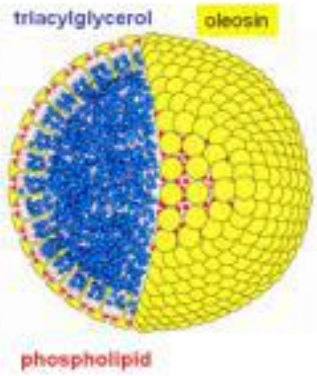
Other carbohydrates stored in seeds

- 5 to 15 % of the dry matter in pea and bean seed are stored oligosaccharides of the raffinose family
- Free sugars (rarely) –up to 11% of dry wt. of mature seed

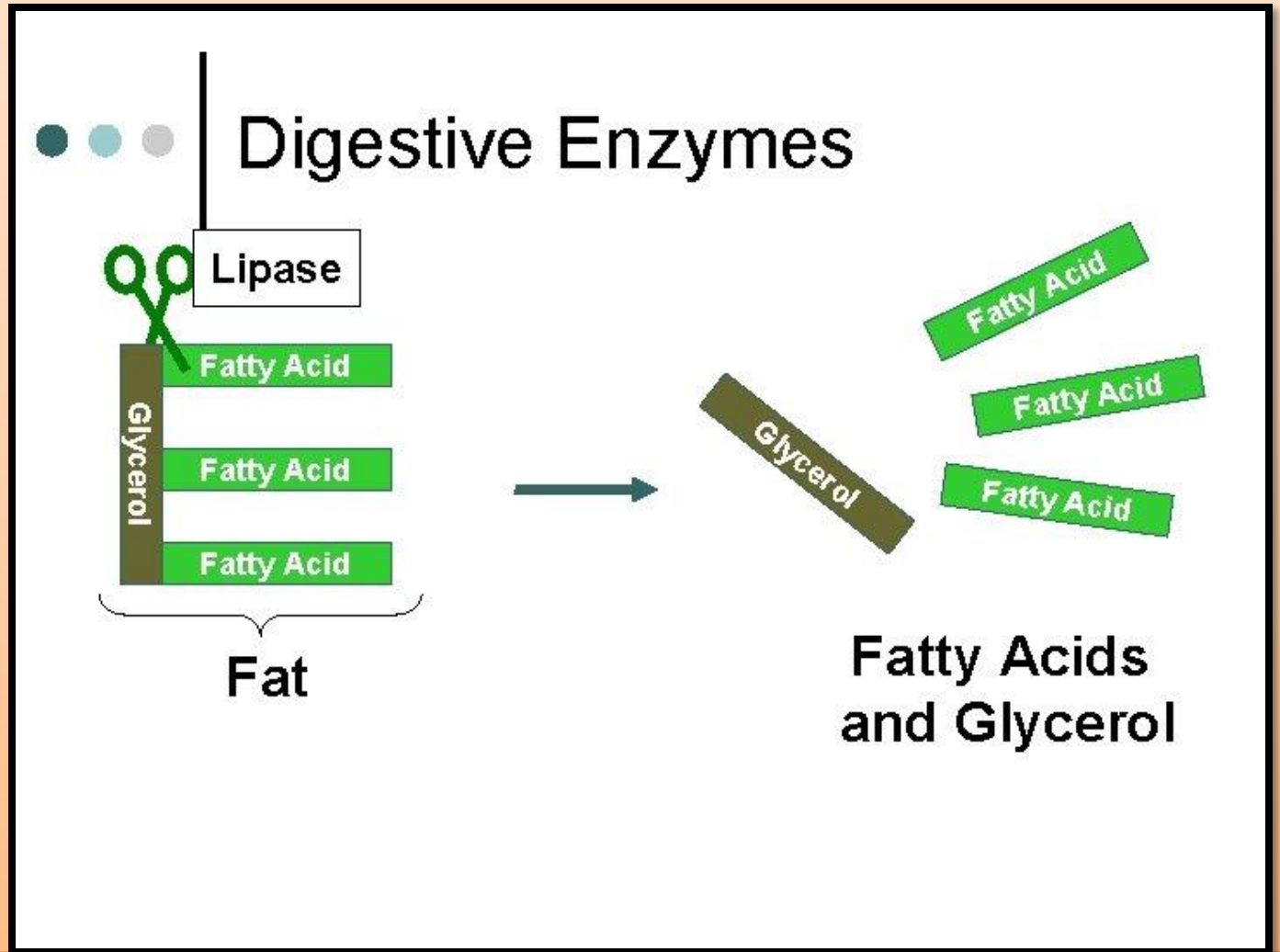
LIPIDS

- Most seeds have high LIPID content.
- The high lipids concentrations differentiates seeds from other plant organs.
- Lipids are concentrated in the endosperm or cotyledon storage tissues.
- Lipids provide the highest amount of potential energy per unit weight.



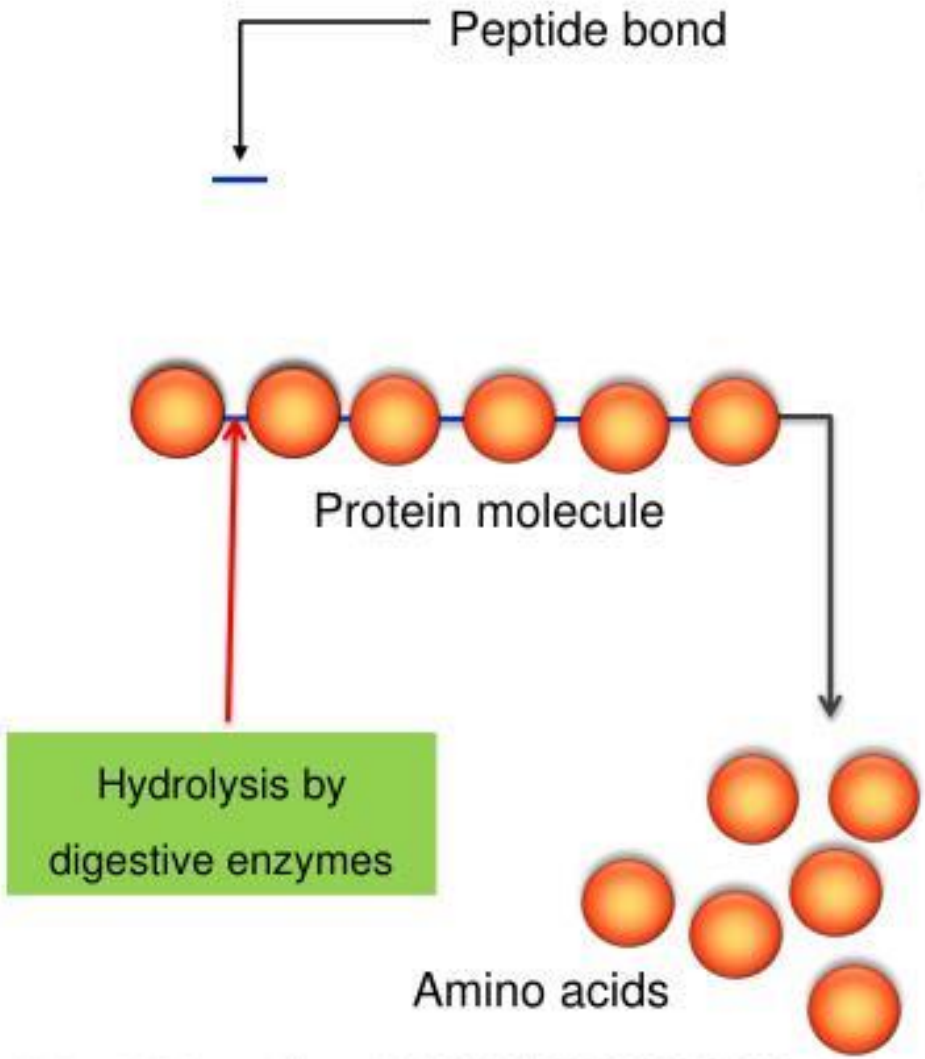


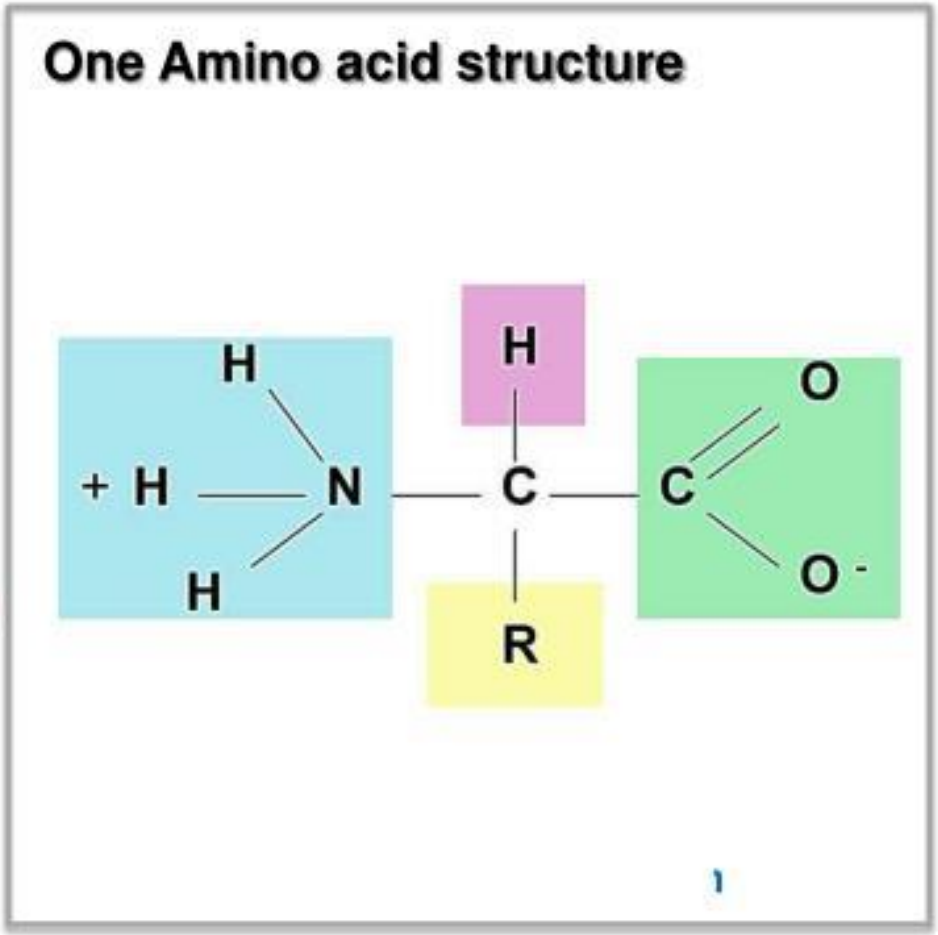
- **The seed lipid reserve is generally hydrolyzed to glycerol and fatty acid by lipases.**



- The fatty acids are utilized for phospholipids and glycolipids.
- These are required as constituents of organelles.
- However, most are converted to sugars and transported to the seedling for growth.
- They dissolve in organic solvents e.g. benzene, acetone, alcohol, ether but do not dissolve in H_2O.
- The value of seed-borne lipids for food and industrial uses is enormous.
- In contrast to animal fats their highly unsaturated chemical nature has caused increased interest in them for health purposes.
- High lipid content is usually associated with decreased protein content e.g. soybean, rapeseed.

Proteins: Amino Acids





http://www.hardbodysuccessblog.com/.a/6a00e00995147488330115704e4379970c-pi
http://www.whitetigernaturalmedicine.com/wp-content/uploads/2012/02/amino-acid-structure.jpg

PROTEINS

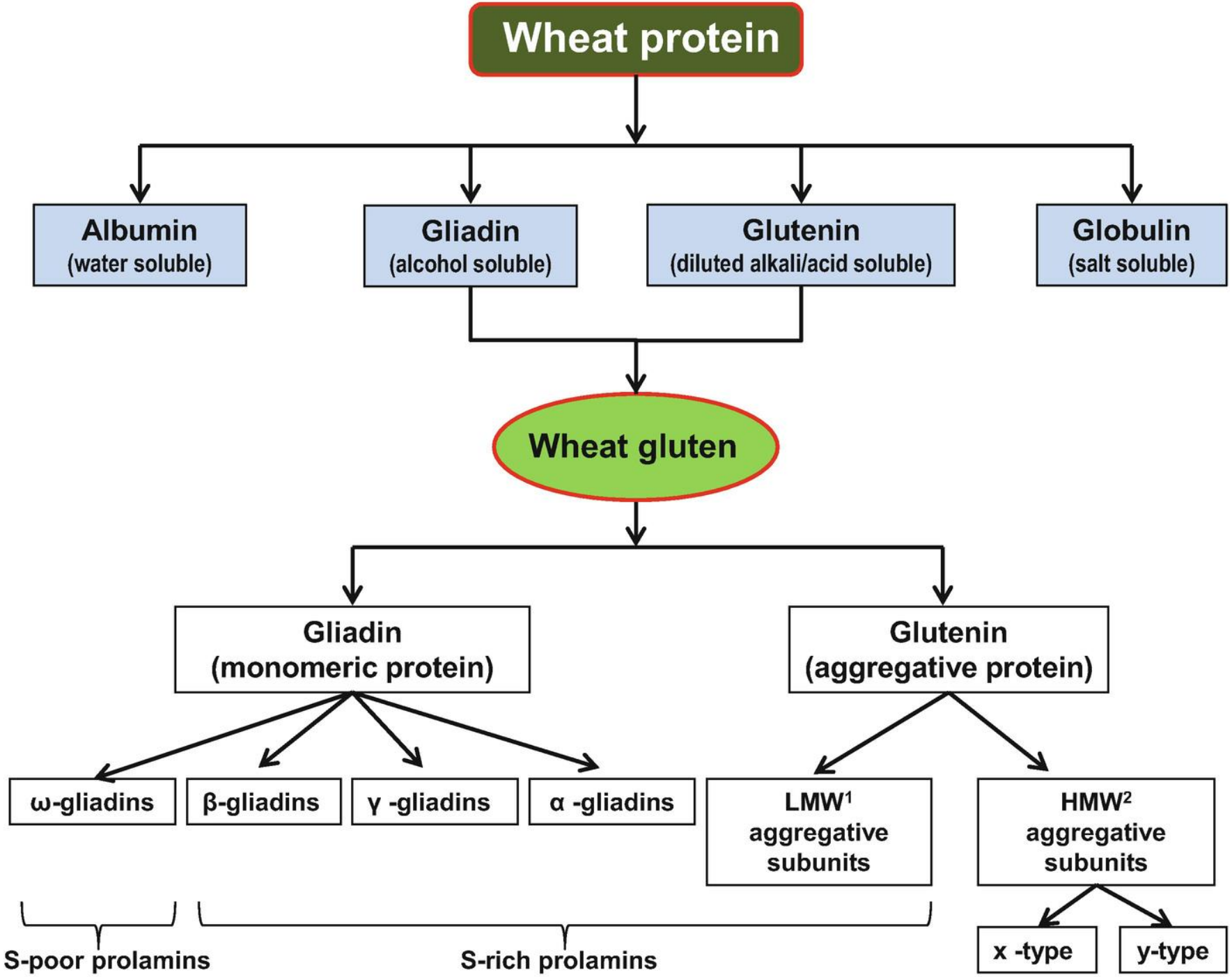
- **All seed contain PROTEIN as the protoplasmic component.**
- **Protein are huge N_2 containing molecules with huge structures, greater part of which yield amino acid upon hydrolysis of peptide bond.**
- **70 % of human demand for protein is met by direct or indirect (animal) consumption of seed.**
- **Cereals: 10 – 15% of DW**
- **• Legumes: up to 40 – 50% of DW**

- **The biological role of storage proteins is to provide carbon, nitrogen and Sulphur for seedling growth.**
- **T.B. Osborne (1924) Classification of proteins according to solubility**
  - **Albumins, soluble in H_2O.**
  - **Globulins, soluble in diluted salt solutions.**
  - **Glutelins, soluble in diluted alkali and acids solutions.**
  - **Prolamins, soluble in aqueous ethanol.**

❖ Shewry *et al.*, (1986) **Classification of proteins according to the physical, chemical and functional properties of proteins.**

-Metabolism Proteins: Globulines & Albumines

-Reserve Proteins: Gliadines& Glutenines


Wheat protein
Albumin
(water soluble)
Gliadin
(alcohol soluble)
Glutenin
(diluted alkali/acid soluble)
Globulin
(salt soluble)
Wheat gluten
Gliadin
(monomeric protein)
Glutenin
(aggregative protein)
ω-gliadins
β-gliadins
γ -gliadins
α -gliadins
LMW1
aggregative
subunits
HMW2
aggregative
subunits
x -type
y-type
S-poor prolamins
S-rich prolamins


THANK YOU