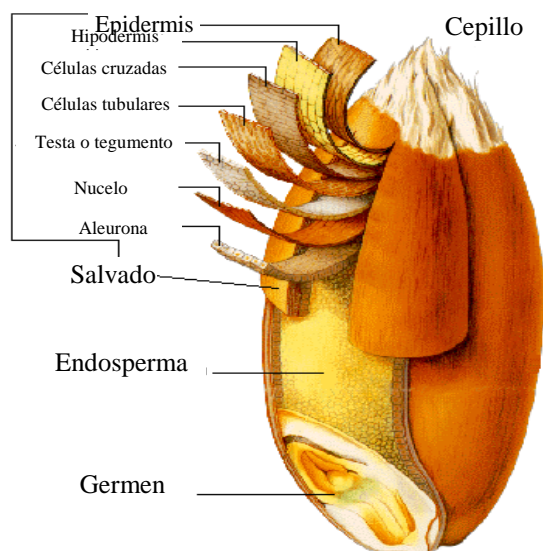


Estructura y composición de los granos de Cereales

- ◆ Estructura
- ◆ Composición general de los cereales
- ◆ Dinámica de acumulación
 - Almidón
 - Proteínas



Estructura del grano

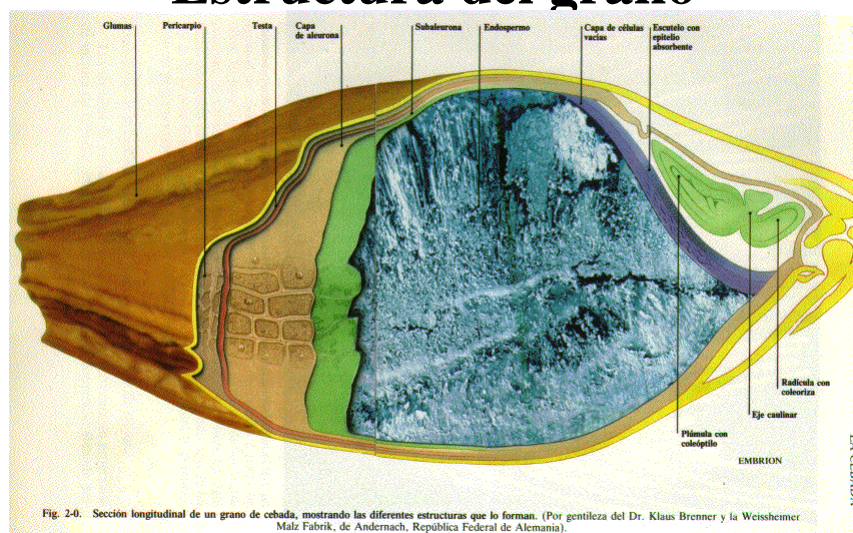


TABLE 8.2. Approximate grain size and the proportions of the principal parts comprising the mature kernel of different cereal seeds
The data are typical or average values derived from a number of sources (see Simmonds 1978)

Cereal seed	Grain weight (mg)	Embryo (%)	Scutellum (%)	Pericarp (%)	Aleurone (%)	Endosperm (%)
Barley	36-45 (41) ^A	1.8	1.5	18.3		79.0
Wheat	30-46 (40)	1.2	1.5	8.0	7.0	82
Maize	150-600(350)	1.2	7.0		5.5	82
Oats	15-23 (18)	1.6	2.1		28-42	56-68
Rice	23-27 (26)	2.5	1.5	1.5	5.0	89-94
Rye	15-40 (30)	1.8	1.7	12.0		85.0
Sorghum	8-50 (30)	8-12			7-9	80-85
Triticale	38-53 (48)	3-4		14.4		82.0

^A Values in parentheses are typical values for plump grains.

Textura del endosperma

Principalmente se refiere a propiedades de la molienda y según la resistencia del grano a transformarse en partículas de harina.

✦ Duro

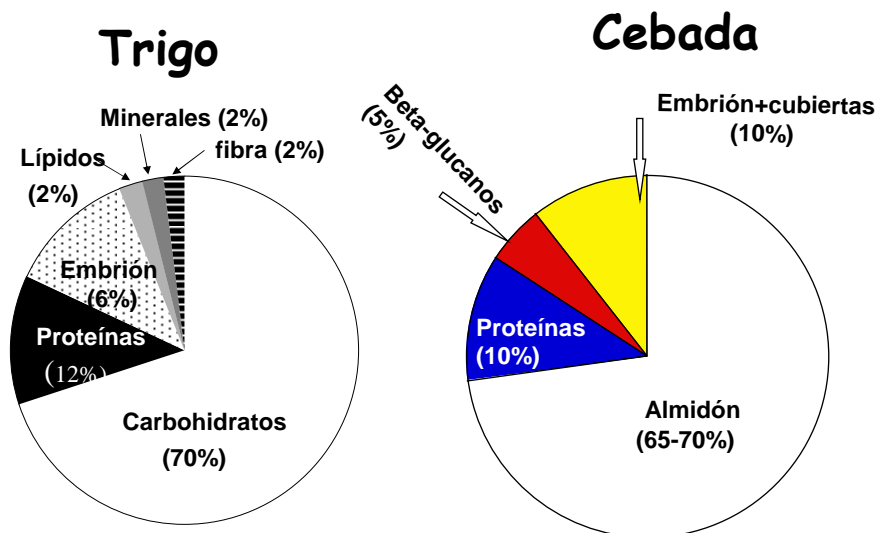
✦ Blando

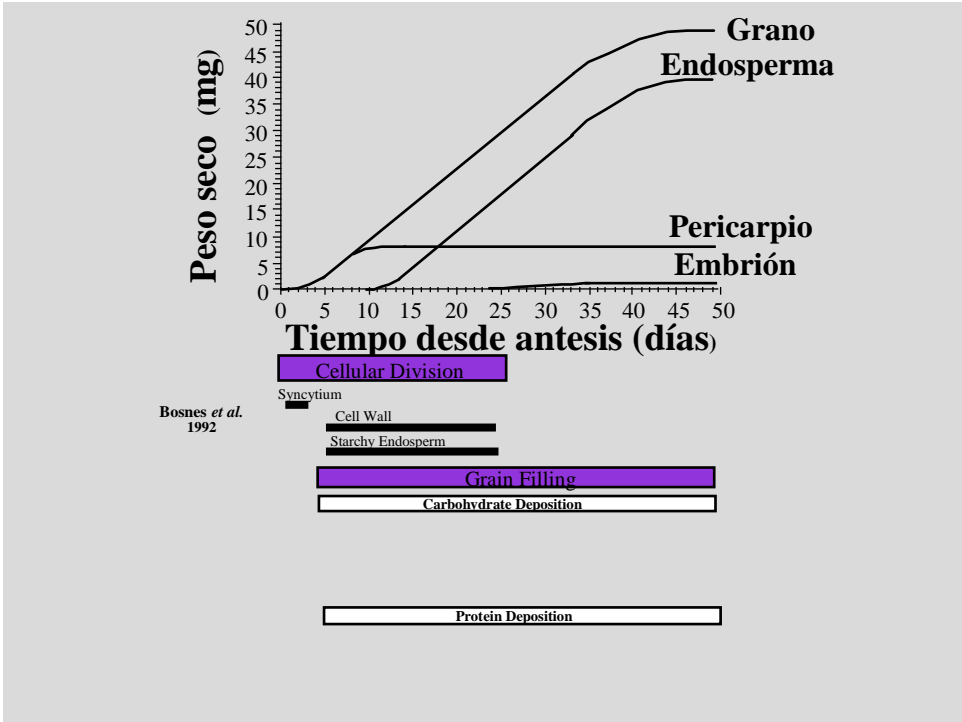
Vitreosidad

Se refiere a la apariencia del grano cuando se examina a través de un haz de luz blanca o con un fondo oscuro.

✦ Granos vítreos o translucidos

✦ Granos no vítreos u opacos





Almidón: Amilosa + Amilopectina
(20-30%) (70-80%)

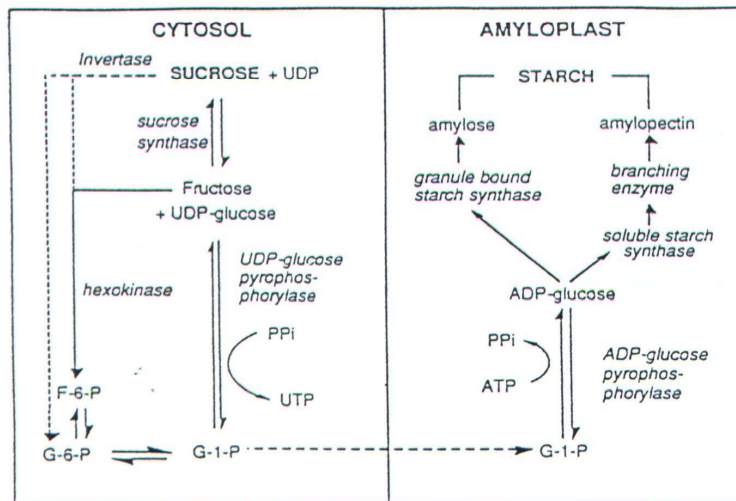
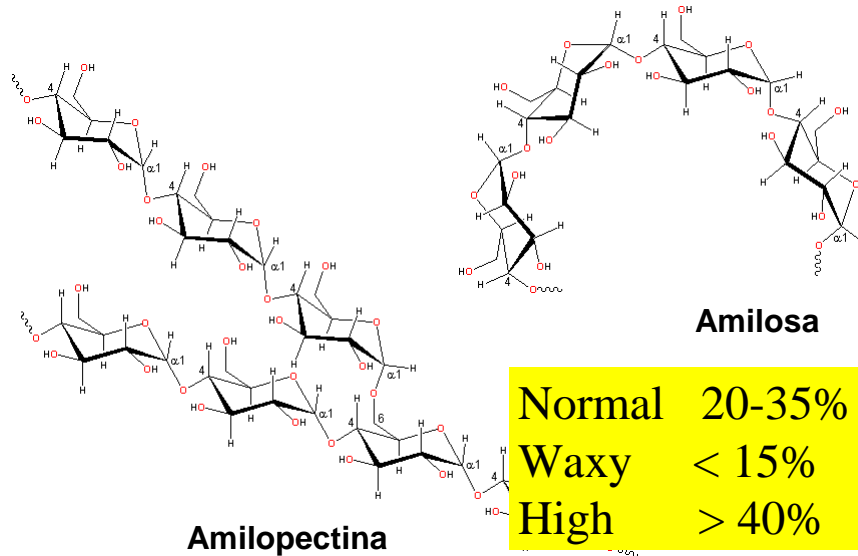
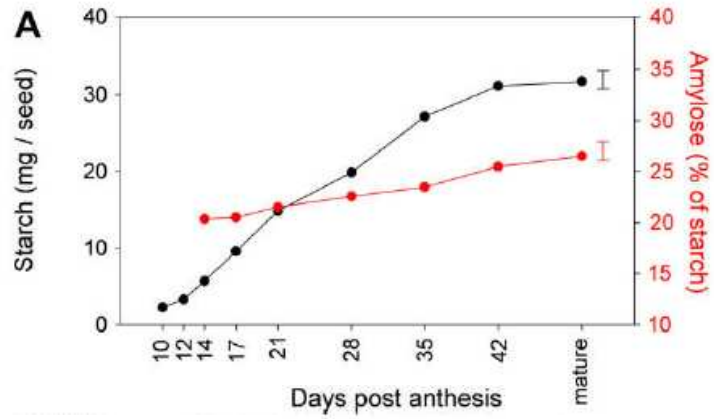


Fig. 4. Biochemical pathway from sucrose to starch in developing wheat endosperm; source Keeling *et al.* (1988).



Shewry et al 2009

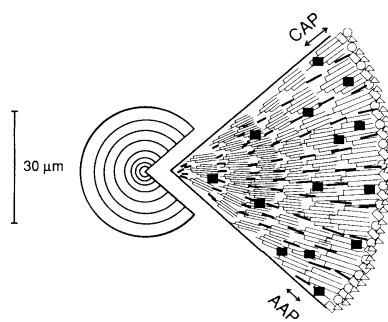


Fig. 2. Schematic representation of starch granule structure. Amylopectin molecules are represented by branched structures and amylose molecules by thick unbranched lines. Concentric regions of crystalline amylopectin (CAP) and amorphous amylopectin (AAP) are indicated. The chain lengths of the amylose and amylopectin molecules are not drawn to scale. Protein molecules associated with the granule surface are represented by open symbols, proteins located within the granule matrix are represented by filled symbols.

Morell et al. (1995)

Gránulos de almidón → Tamaño
 Forma
 Momento de aparición

Tipo A
 Forma lenticular
 $>10 < 50\mu$
 50-75% peso
 3% número

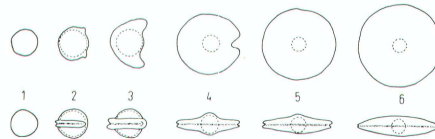


Fig. 8.11(a). Changes in the shape of A-type developing starch granules according to Evers (1971).

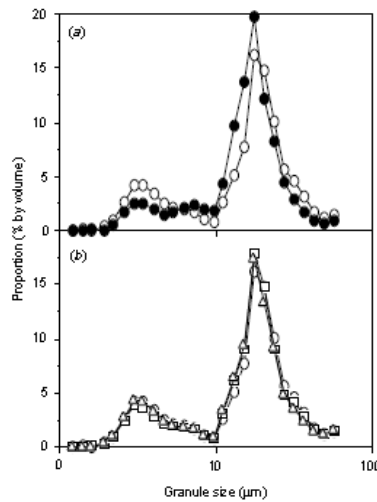
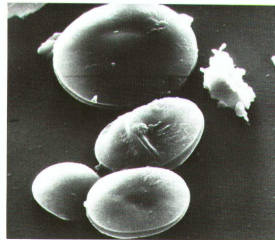
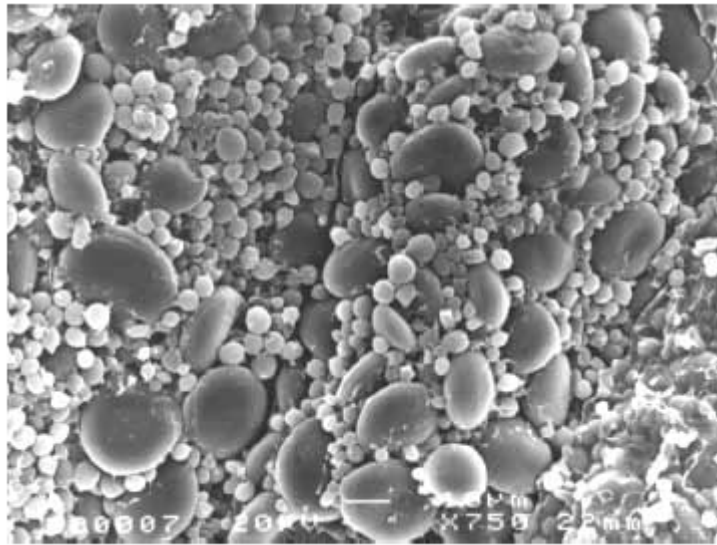


Fig. 3. Size distribution of starch granules in mature Schooner grain under (a) heat stress, and (b) moderately high temperatures. The treatments were 21/21 (○) and 40/21 (●) in (a); and 21/21 (○), 21/27 (□), and 21/30 (△) in (b). Note that the starch granule size is given on a log scale, such that the values of 10 and 100 are the antilogs of 1 and 2, respectively.

Table 4. Modal diameter (μm), modal volume granules (trillions) in Schooner barley

Treatment	Modal diameter	
	A-type	B-type
21/21	19.0	3.2
21/27	18.2	3.0
21/30	18.1	2.9
Mean	18.5	3.1
40/21	17.3	3.2
l.s.d. ($P = 0.05$)	0.9	0.3

Savin et al. 1997



Haddad *et al.*
 JCS 34 (2001) 105-113

Endosperma de un grano de cebada

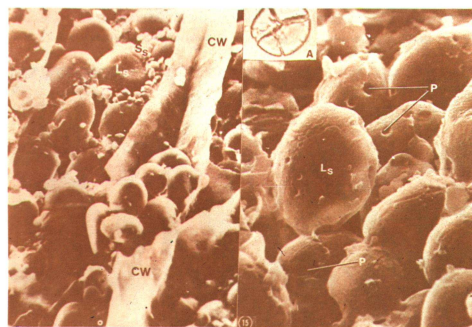


Fig. 3-5. Micrografía tomada con el microscopio electrónico de barrido en la que se ve el endosperma de un grano de cebada antes de germinar (izquierda) y después de completar varios días de germinación (derecha). En el primer caso se observan los gránulos de almidón grandes (L_s) y pequeños (S_s) incluidos entre las paredes celulares aún sin degradar (CW). En la parte derecha se observan dichos gránulos completamente liberados de las paredes celulares y con algunos agujeros producidos por la acción de las amilasas (sección en recuadro A). (Por gentileza del Dr. Jorgen Larsen y del Carlsberg Research Laboratory de Copenhague, Dinamarca).

Síntesis de proteínas

Clasificación de las proteínas } solubilidad
 } tamaño
 } secuencia de AA

Clasificación de Osborne (1907)

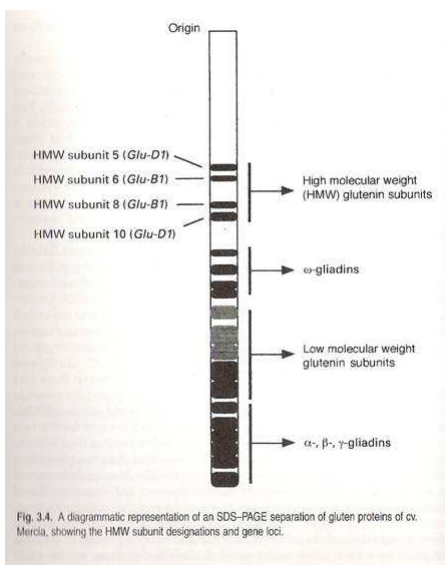
- agua: **ALBUMINAS**
- sc. salina: **GLOBULINAS**
- alcohol-agua: **PROLAMINAS (o GLIADINAS)**
- ac. o alcali: **GLUTELINAS (o GLUTENINAS)**

En general, las prolaminas y glutelinas son las proteínas de reserva en cereales y las globulinas son las proteínas de reserva en las dicotiledóneas

- **ALBUMINAS 22%**
- **GLOBULINAS 15%**
- **GLIADINAS 40%**
- **GLUTELINAS 23%**

Stone & Savin (1999)

Clasificación basada en características biológica Función y localización (Shewry *et al.*, 1986)



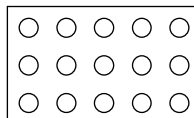
Godding & Davis (1997)

TABLE 9.3. Classification and characterization of wheat storage proteins according to Shewry *et al.* (1986)

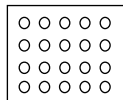
Prolamin group:	Sulfur-poor		Sulfur-rich		HMW
Classical nomenclature:	ω -gliadins	α -gliadins	γ -gliadins	Aggregated gliadin LMW subunits of glutenin	HMW subunits of glutenin
Partial amino acid composition (mol %)					
Glutamine	41-53	36-42	39-40	38	34-39
Proline	20-30	15-16	18-19	15	13-16
Glycine	0.9-1.4	1.9-2.7	2.7	3.3	14-20
Phenylalanine	8.1-9.0	3.7-3.9	1.4-1.7	4.7	0.3-1.1
Cystine/2	0	1.8-1.9	1.9-2.0	2.7	0.4-1.5
Methionine	0-0.1	0.9-1.2	0.9-1.7	0.6	trace-0.4
Molecular weights by:					
SDS-PAGE	44-74000	32000	38-42000	36-44000	95-136000
Sequencing	—	31000	—	33000	64-70000
Structural gene located on chromosome: ^A	1AS, 1BS DS	6AS, 6BS 6DS	1AS, 1BS 1DS	1AS, 1BS 1DS	1AL, 1BL 1DL

^ASee below for further discussion regarding the chromosomes controlling the synthesis of different wheat storage proteins.

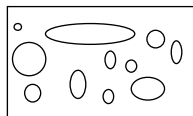
Harina + agua  Masa = Gluten



Gliadinas=gluteninas

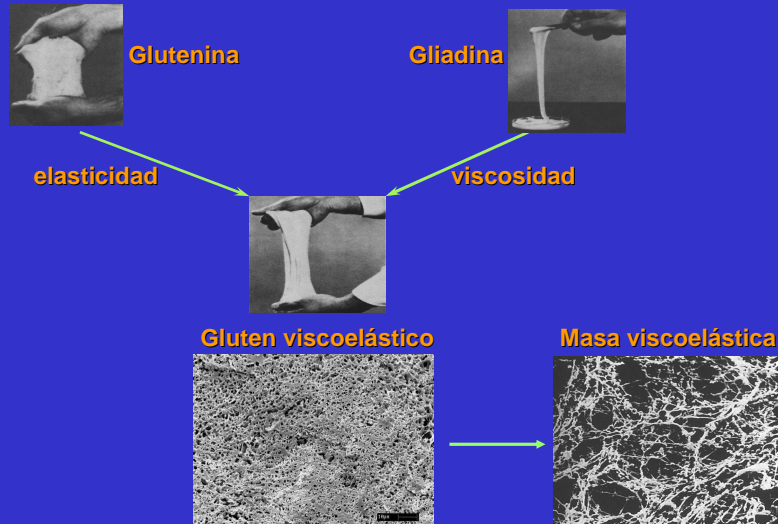


↓ Gliadinas/gluteninas



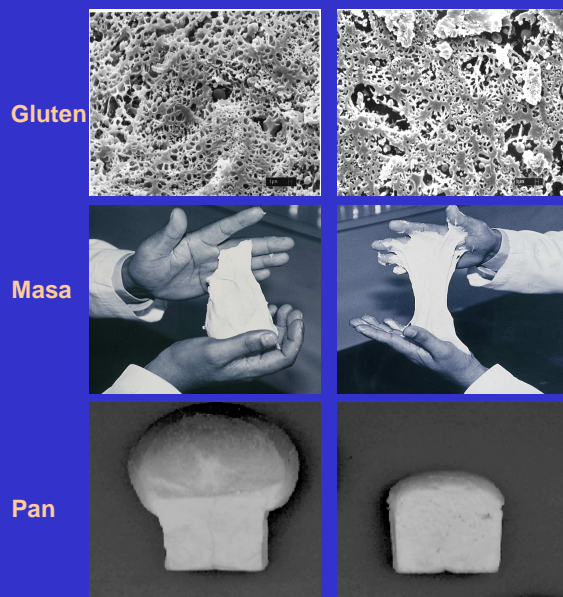
↑ Gliadinas/gluteninas

Proteínas del gluten del trigo



Javier Peña
CIMMYT

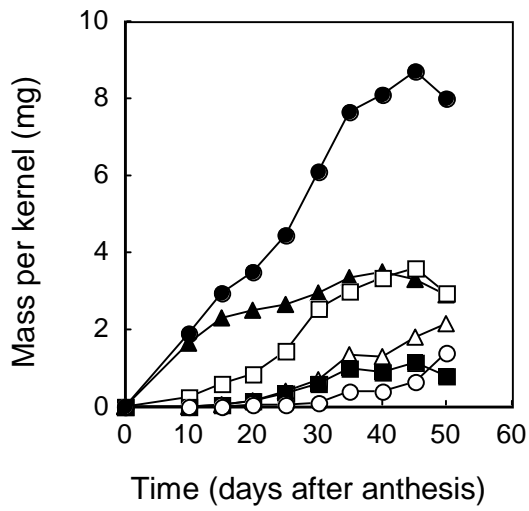
Calidad de Trigo



Las propiedades de calidad de panificación dependen principalmente de las propiedades viscoelásticas (fuerza y extensibilidad) del gluten

A la vez, las propiedades viscoelásticas del gluten dependen de la composición de las gluteninas y de las gliadinas

Javier Peña
CIMMYT



- Proteína total
- ▲ Albumina/globulina
- Gliadinas
- △ Gluteninas
- Glu SDS insoluble
- Glu SDS soluble

