“Biodeterioro, acción de los hongos en la destrucción de nuestro patrimonio”

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Bioquímico
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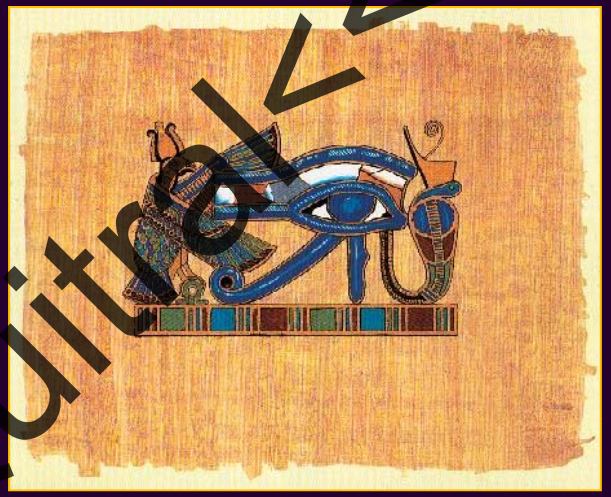
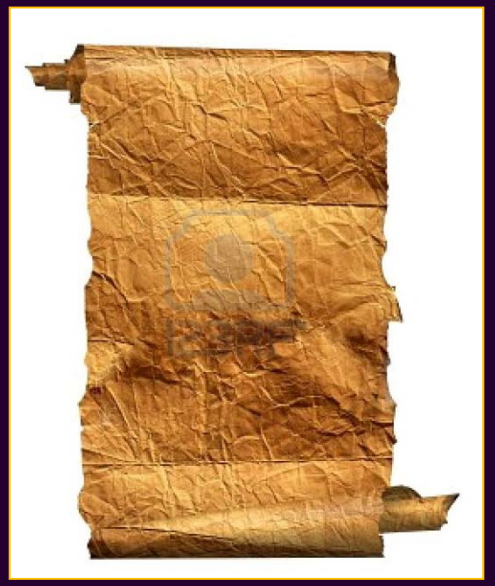
Preservar y transmitir la cultura

En Egipto….

Cyperus papyruss

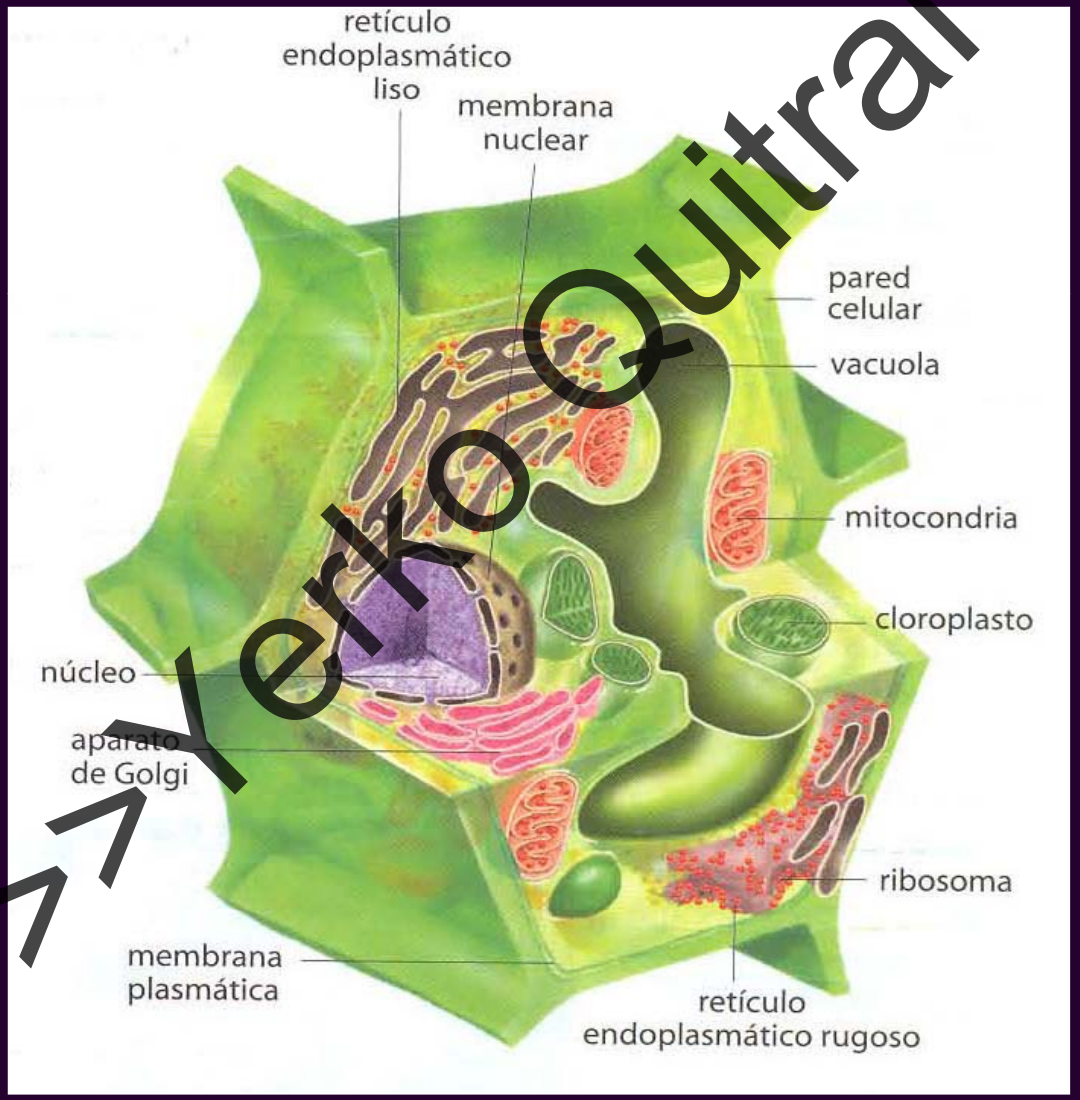




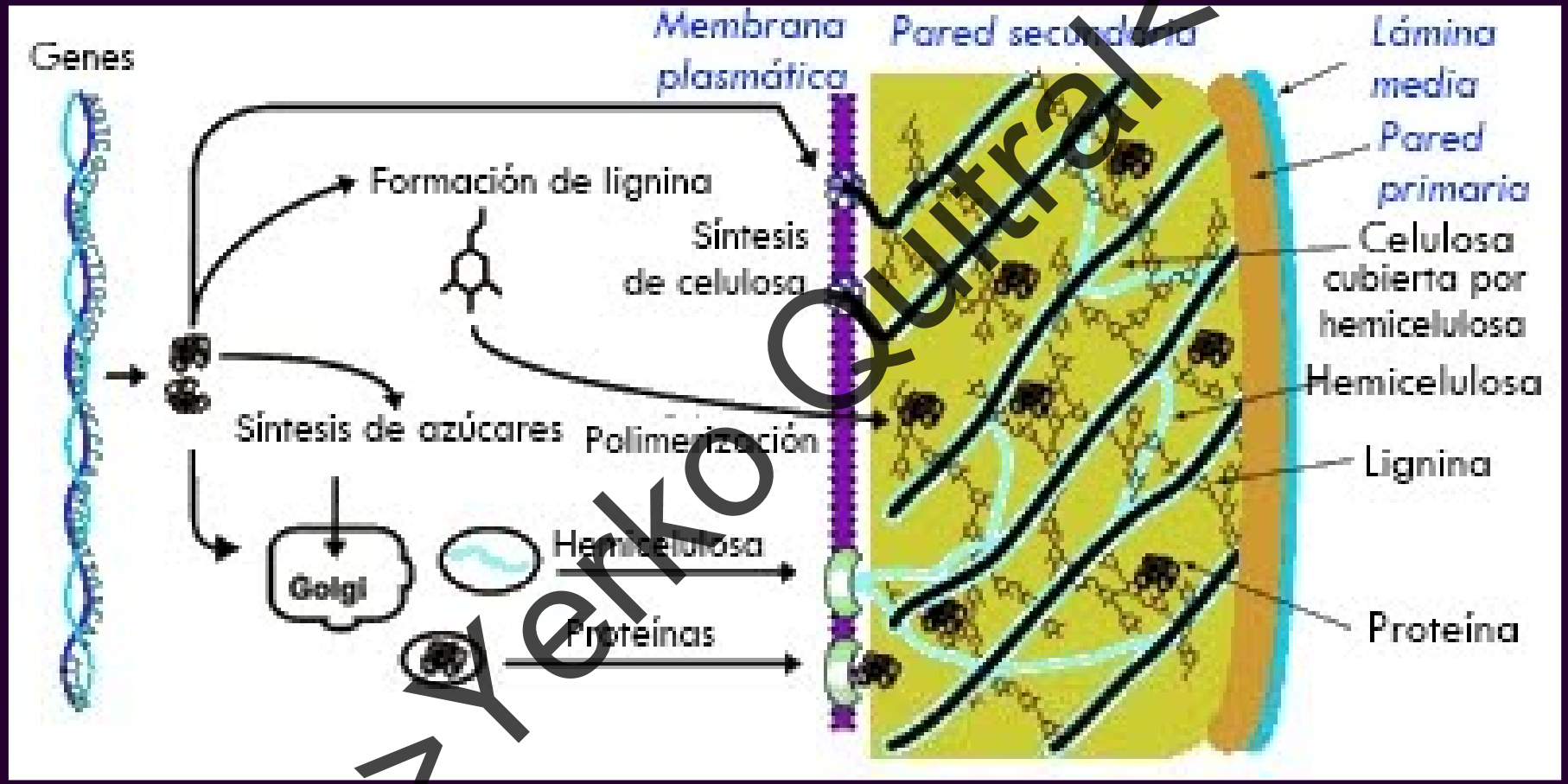
Materia prima utilizada en la elaboración de papel

Proceso general en la obtención de papel

Célula vegetal: materia prima

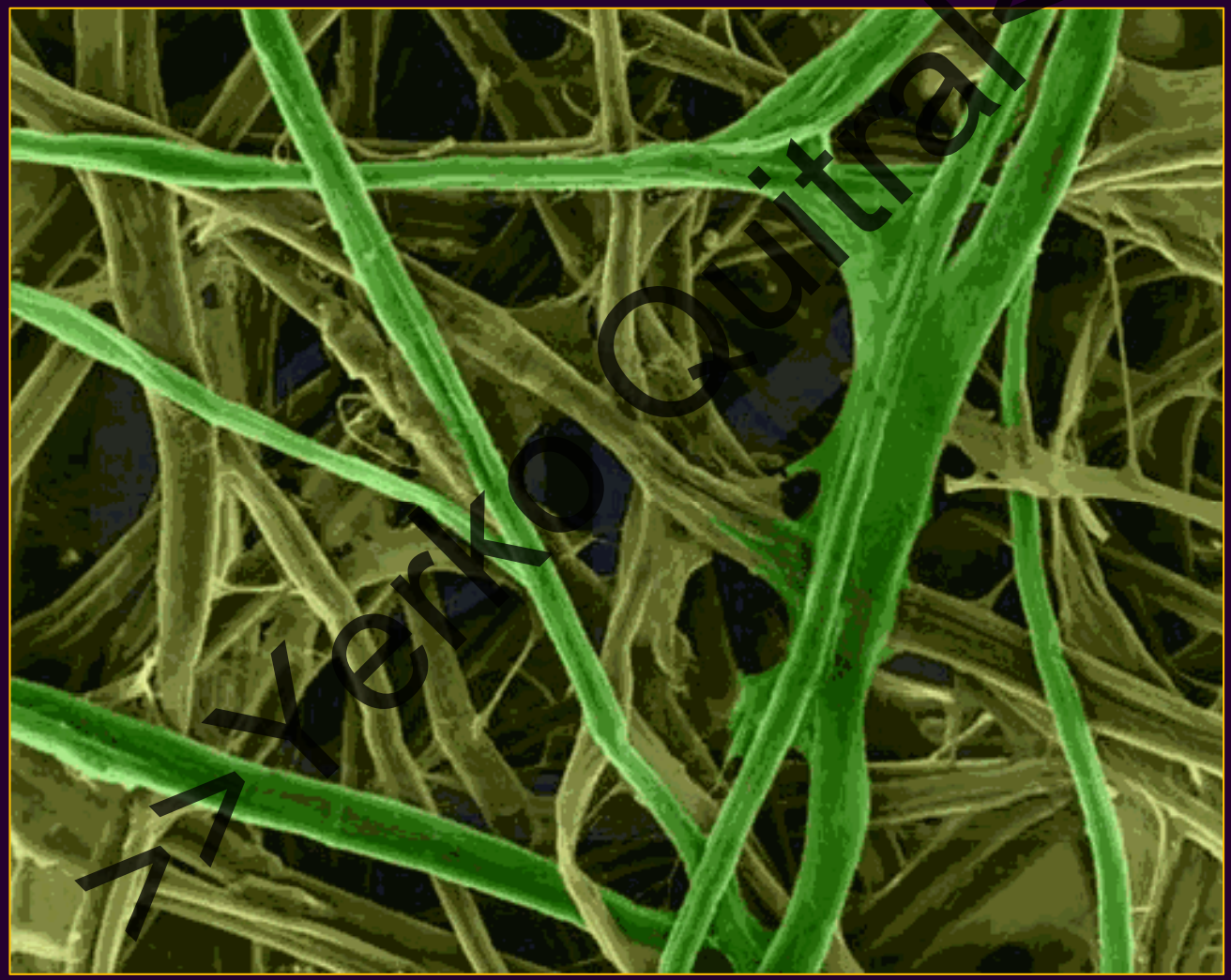


Composición de la pared celular vegetal

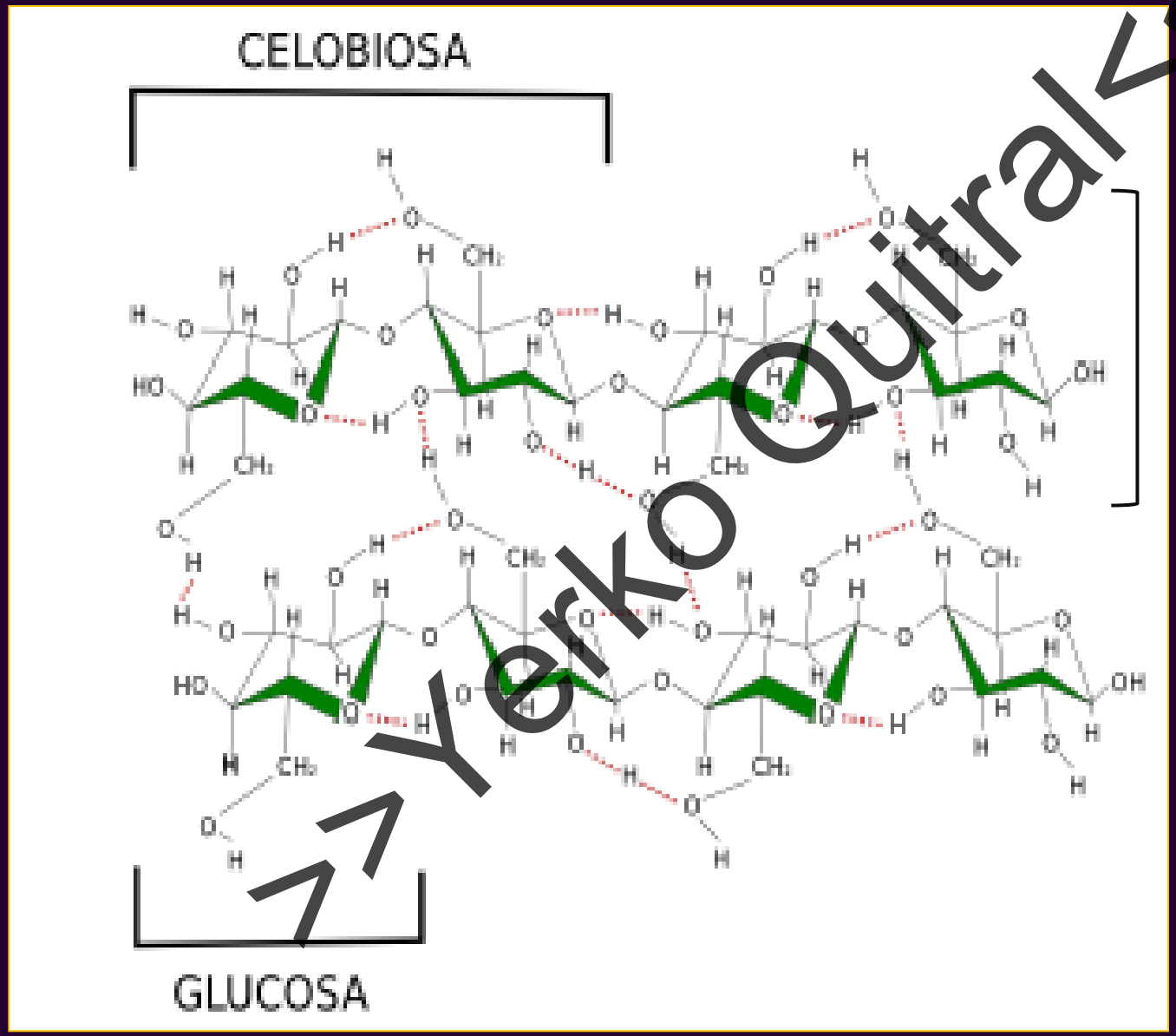


Disposición celular en vegetales, observado mediante microscopia óptica

Entramado fibrilar de una hoja de papel observado por microscopia electrónica

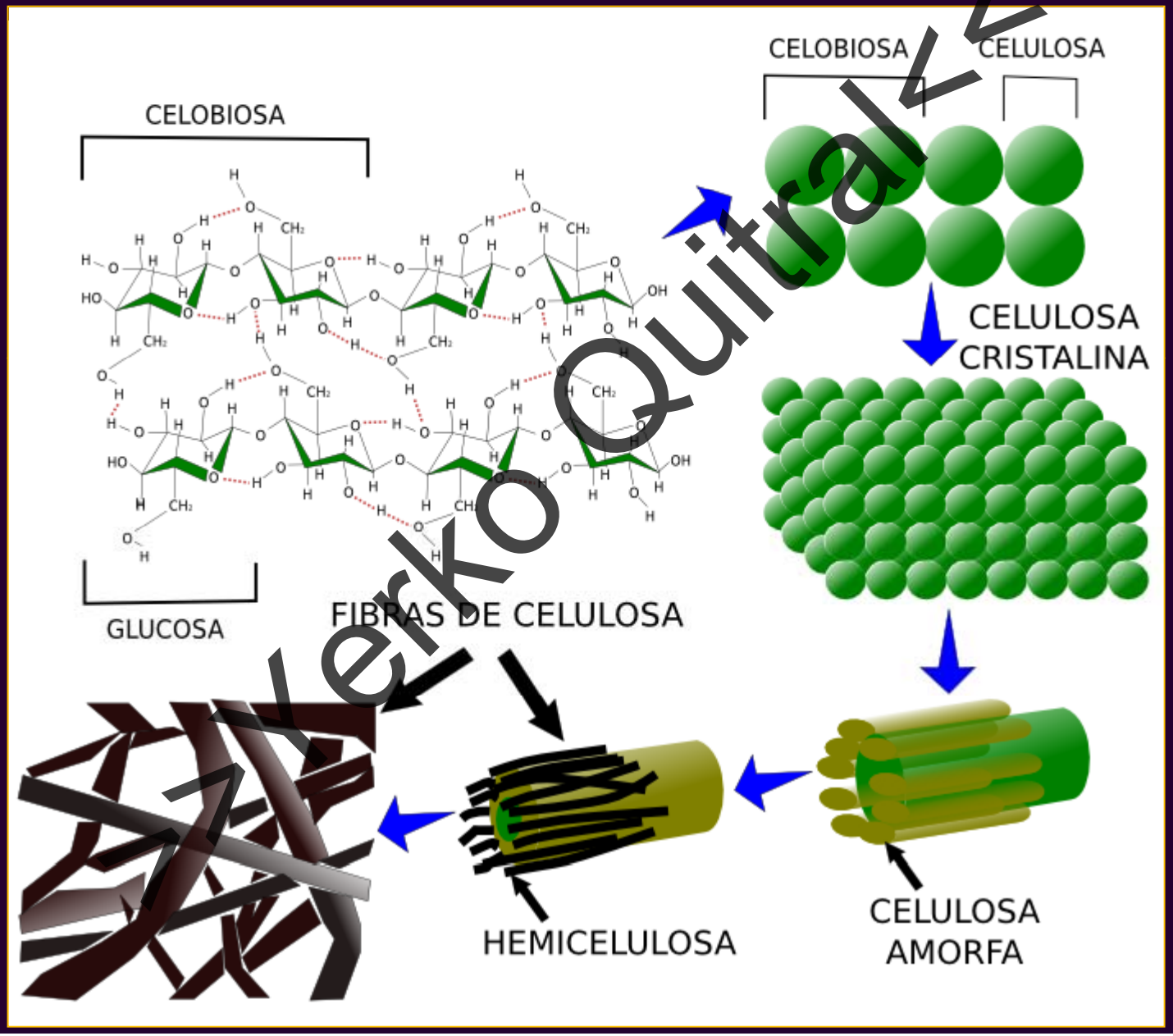


Estructura y Organización de la molécula de Celulosa

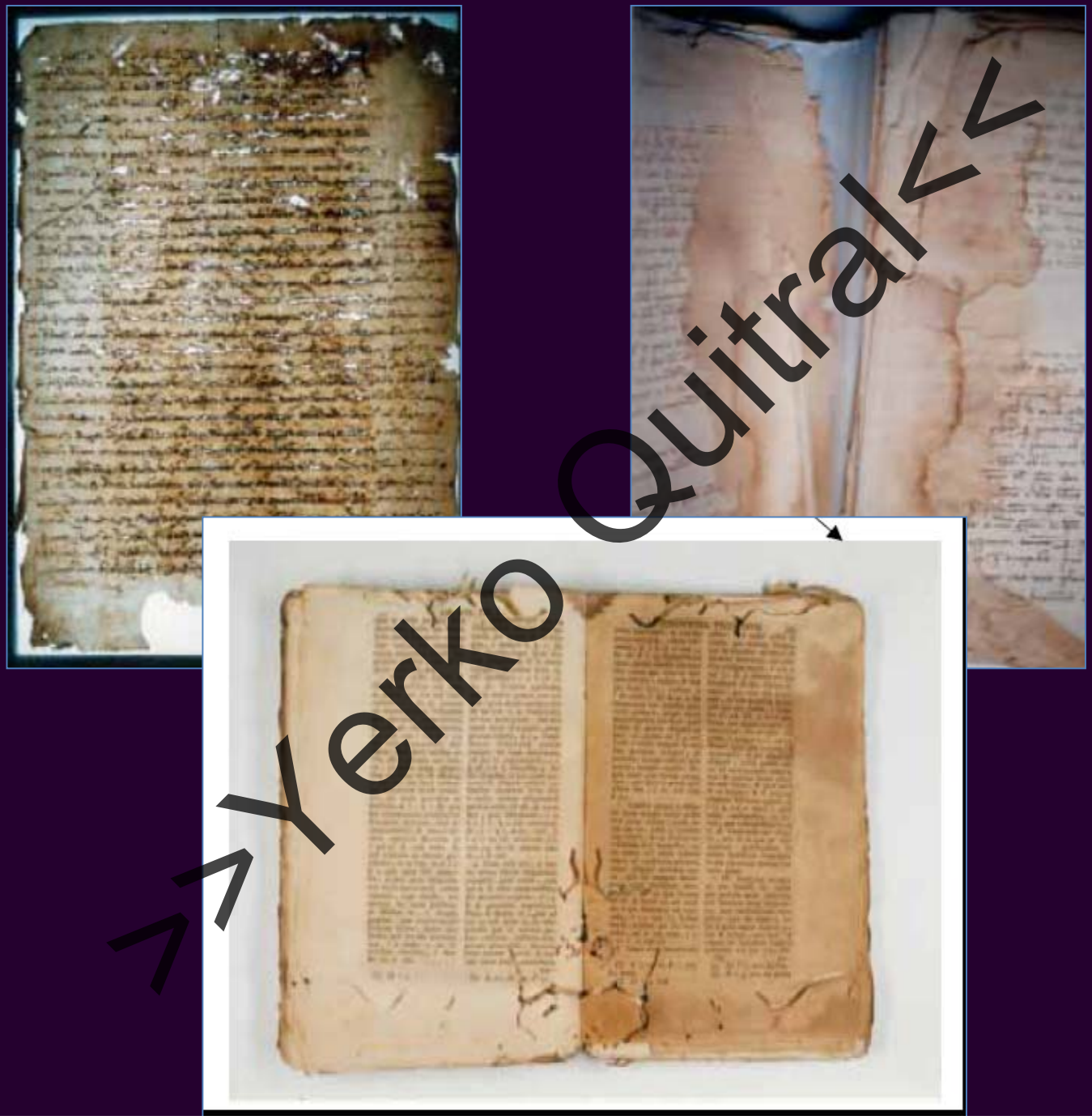


CELULOSA

Organización de fibras de celulosa



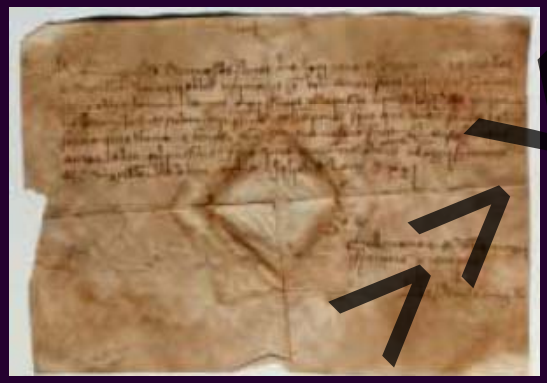
Biodeterioro


>Yerko Quitral<<

Temperatura

- La temperatura óptima de crecimiento es especifico pero oscila entre los 29°C.
- Las hifas mueren cerca de los 40°C.
- Mueren en estado de congelación.

Humedad relativa



- Es el factor más importante en la germinación de micelios
- En humedades altas 75% o más
- Las hifas necesitan Humedad para transportar sus nutrientes
- Para el desarrollo de hongos es necesario un 20% de humedad en el papel.

Luz

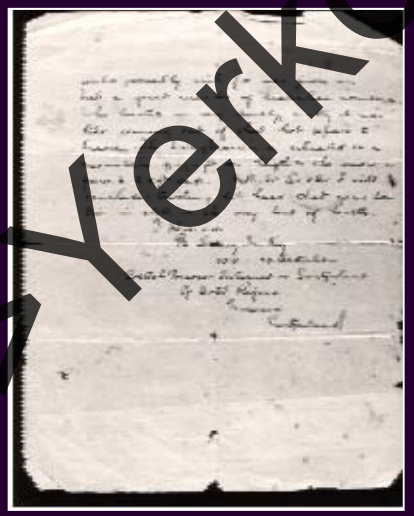
- Su accionar no se encuentra aun bien definido.
- Podría involucrarse en la activación de la esporulación en algunos hongos

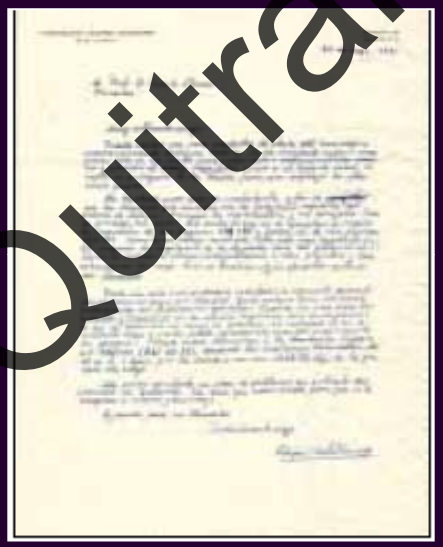
- Siendo esencial para la producción de esporas
- Muy importante en la dispersión de las esporas

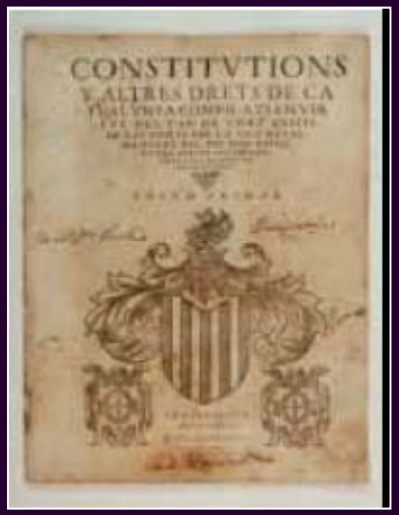
pH

- Se ha identificado un pH más acido cercano a 6.0
- El pH estaría afectando significativamente la intensidad de la mancha y el color
- El pH del sustrato cambiaria de color por metabolitos del hongo.

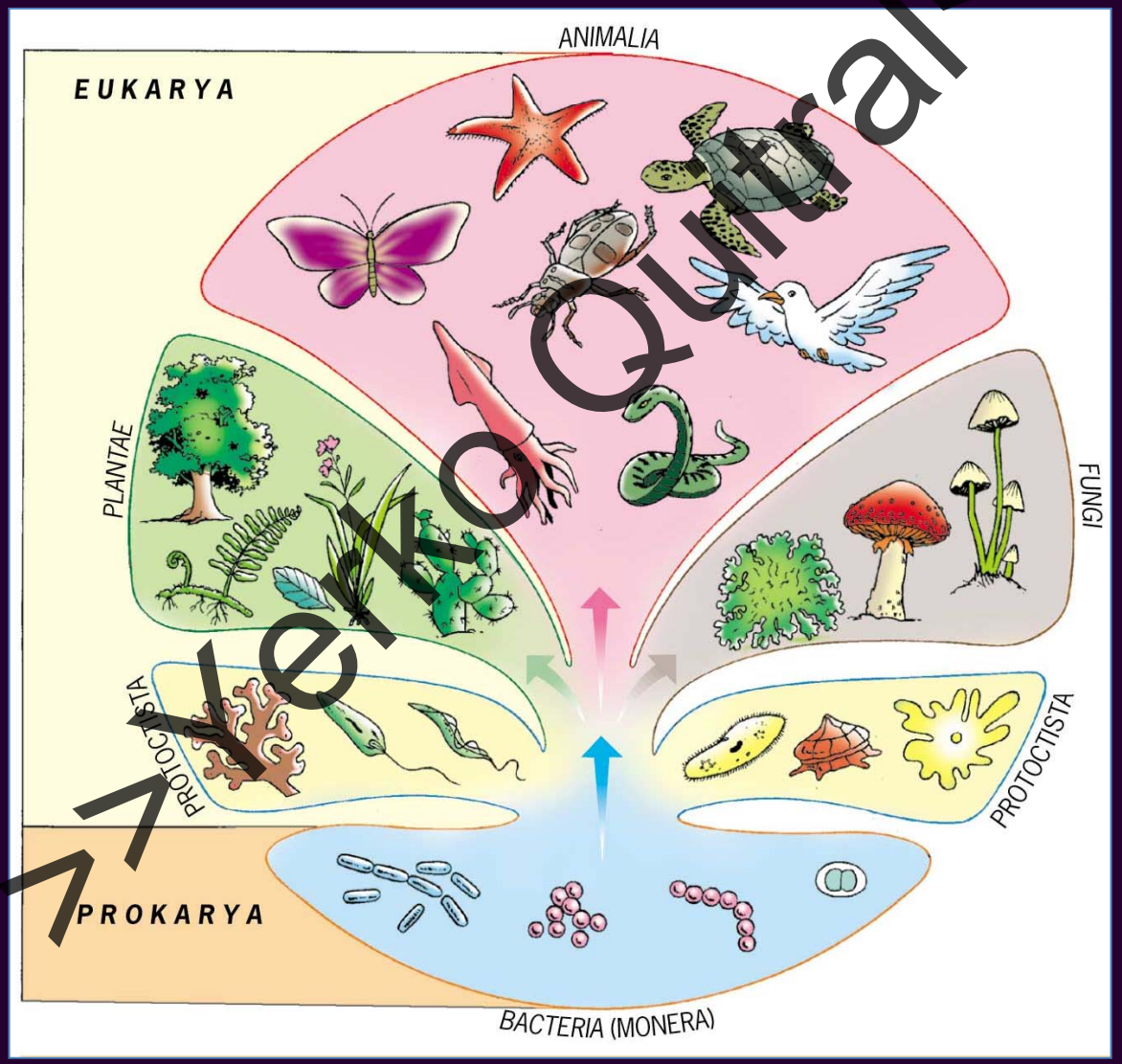
Problemas en la conservación

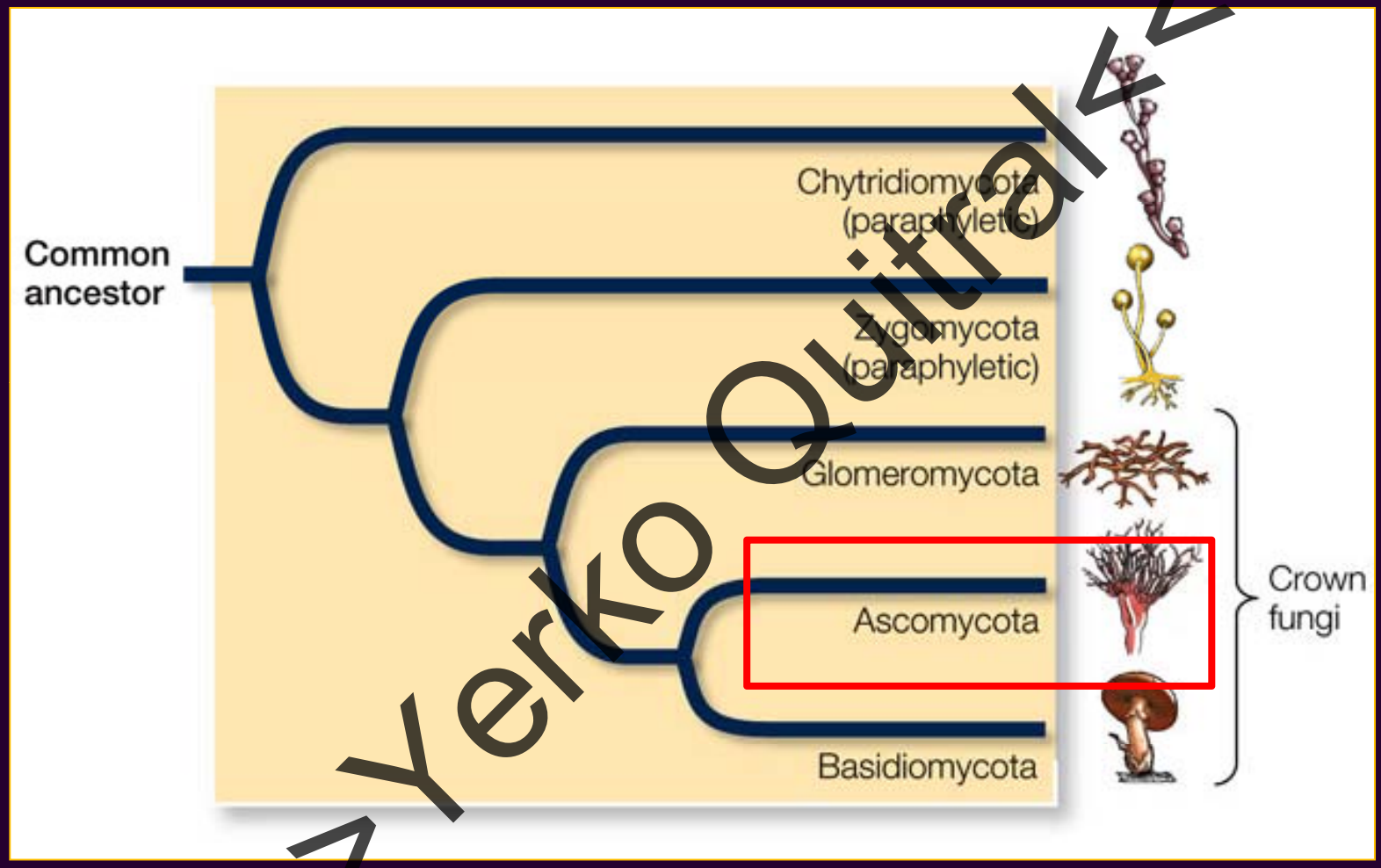






Hongos

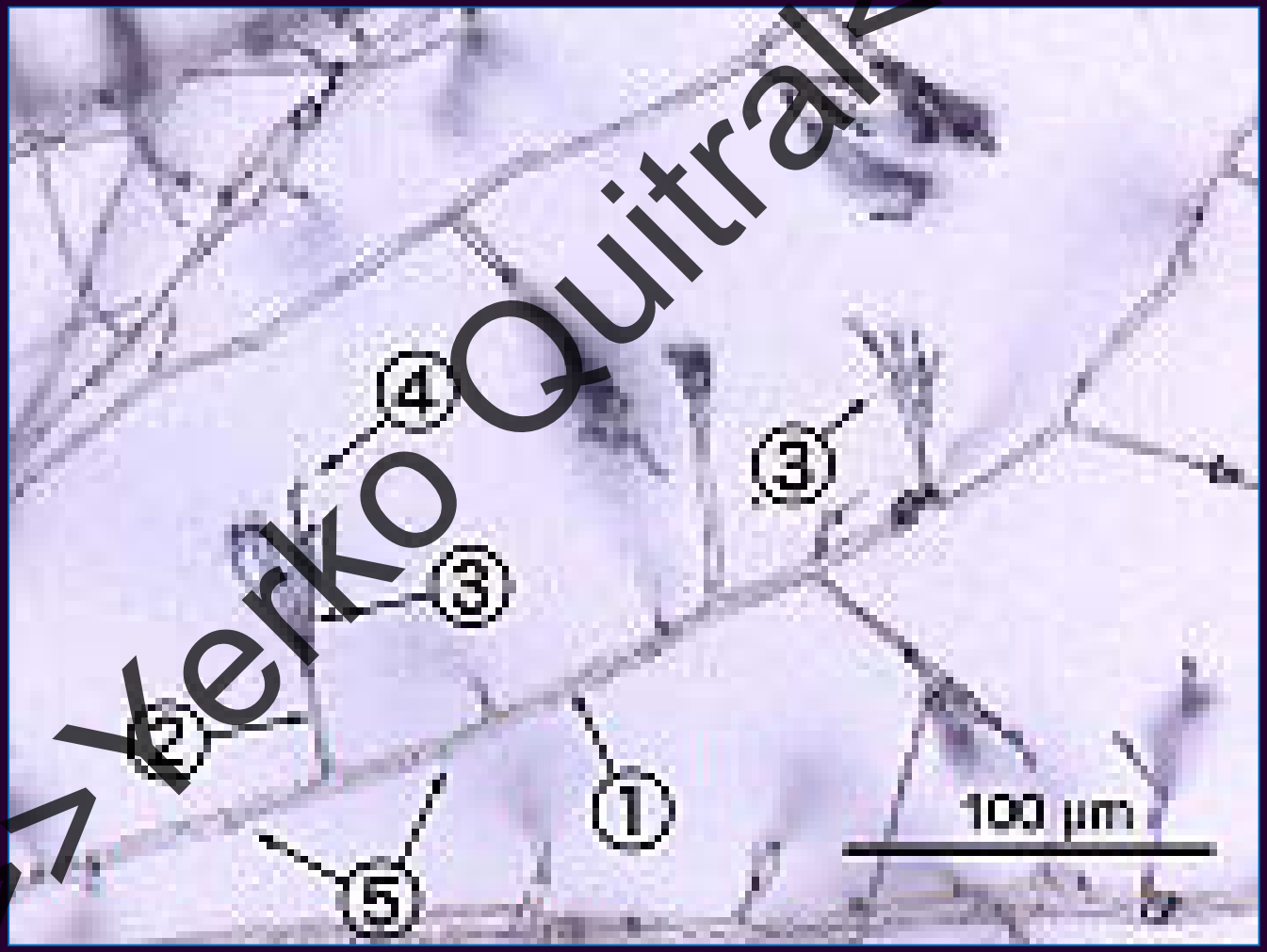




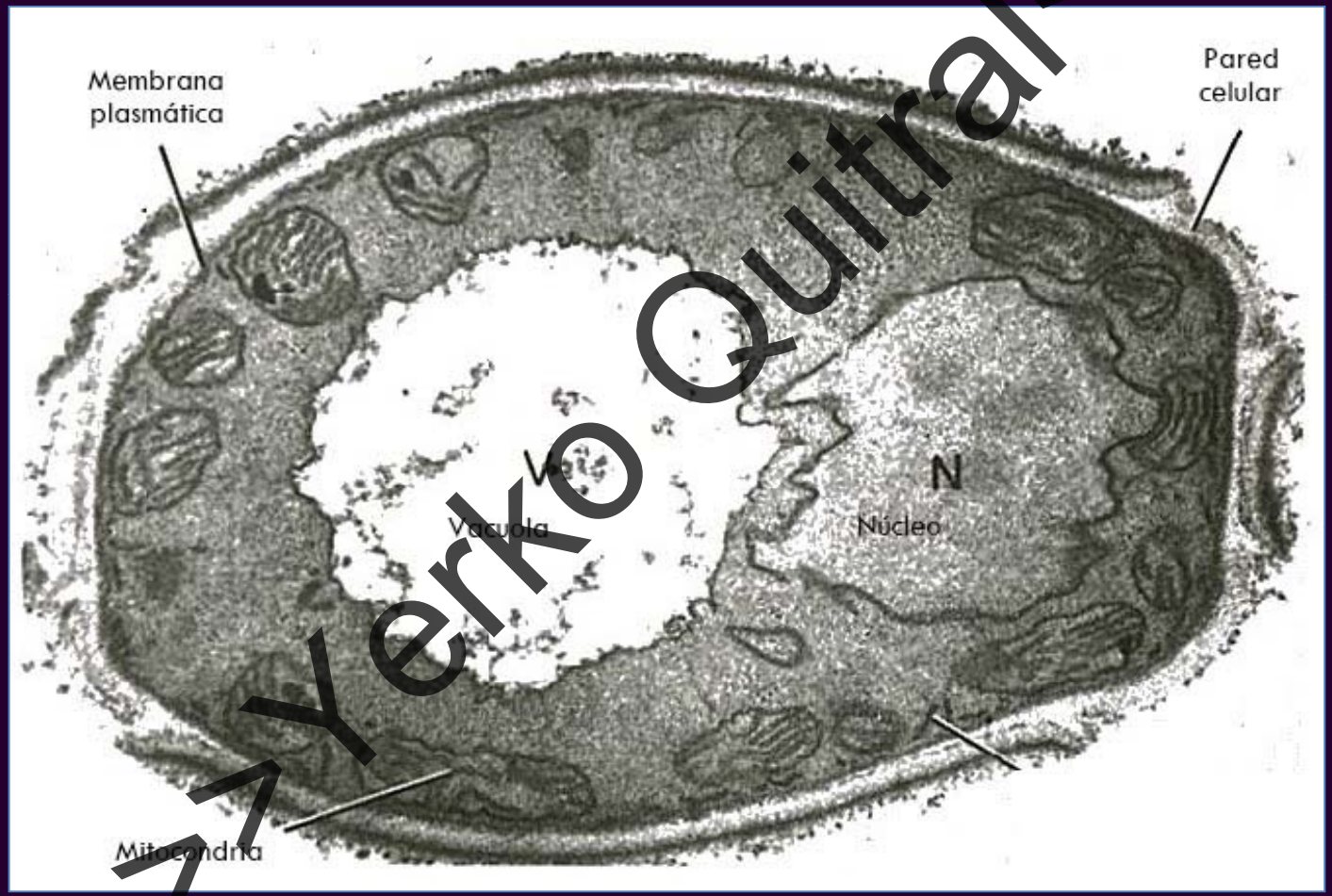
Life, The Science Of Biology,8 ed.,2007

Estructura básica de un hongo

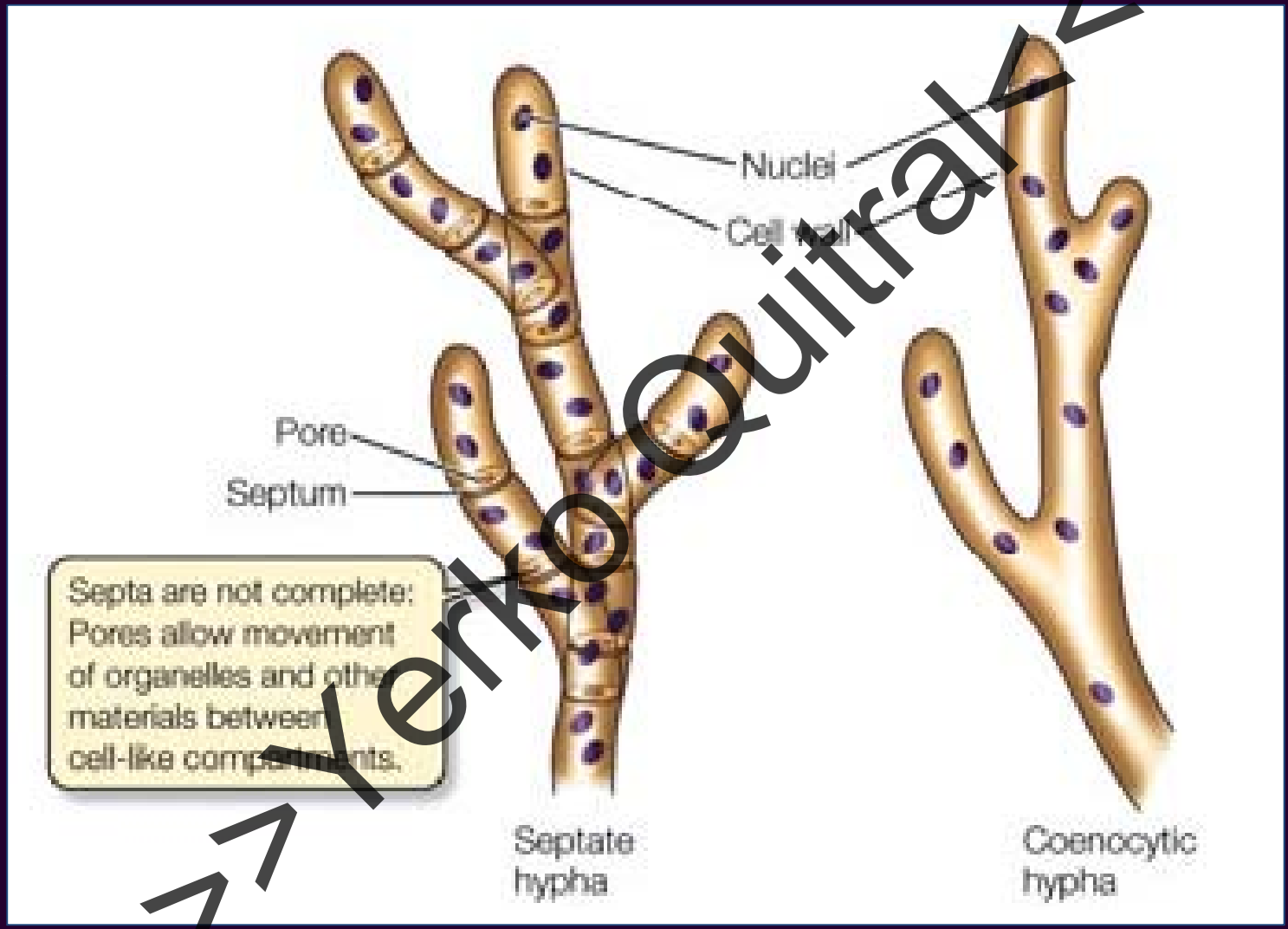
(1) Hifa
(2) Conidioforo
(3) Fiálide
(4) Conidia
(5) Septas



Célula fúngica

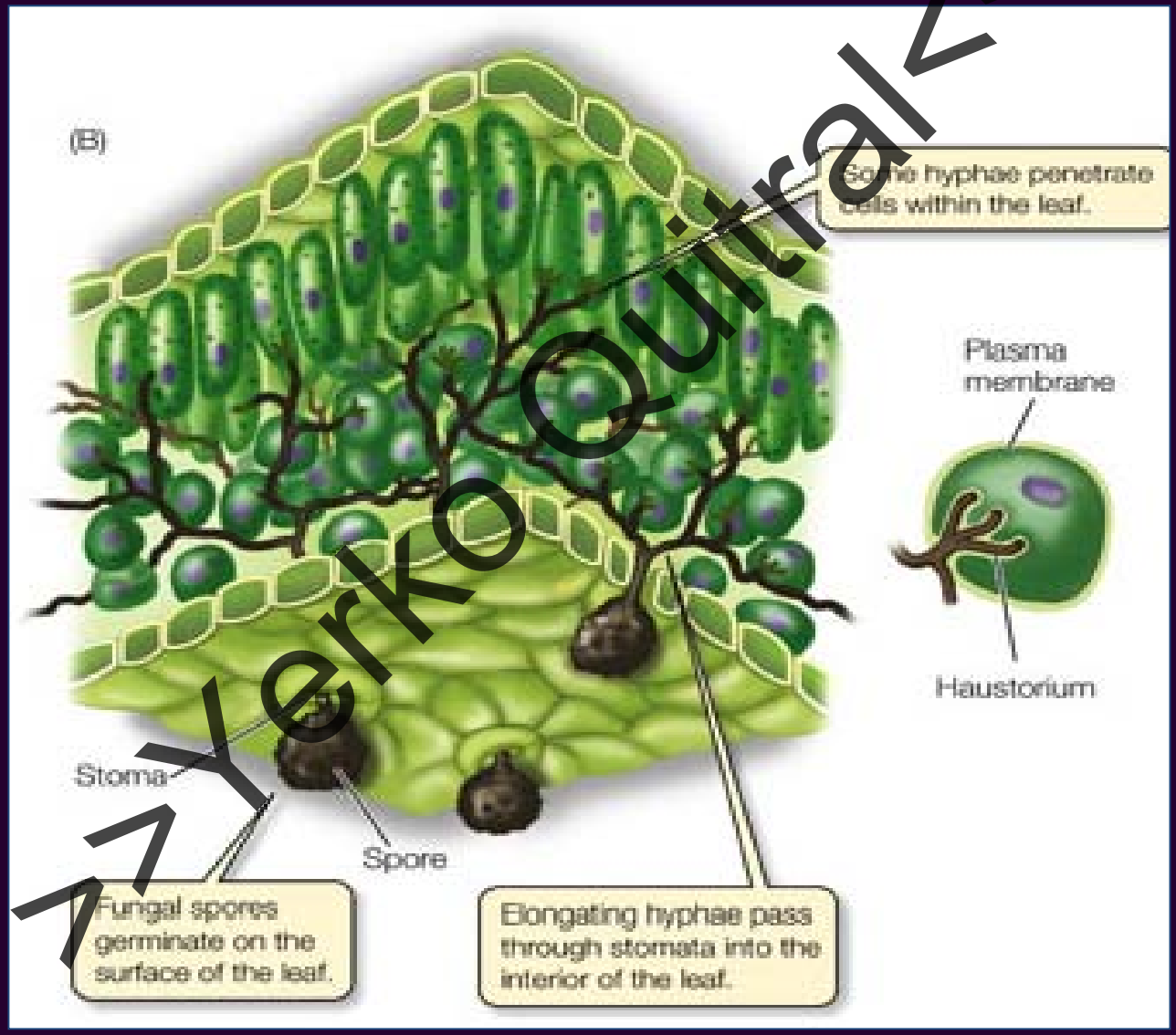


Morfología



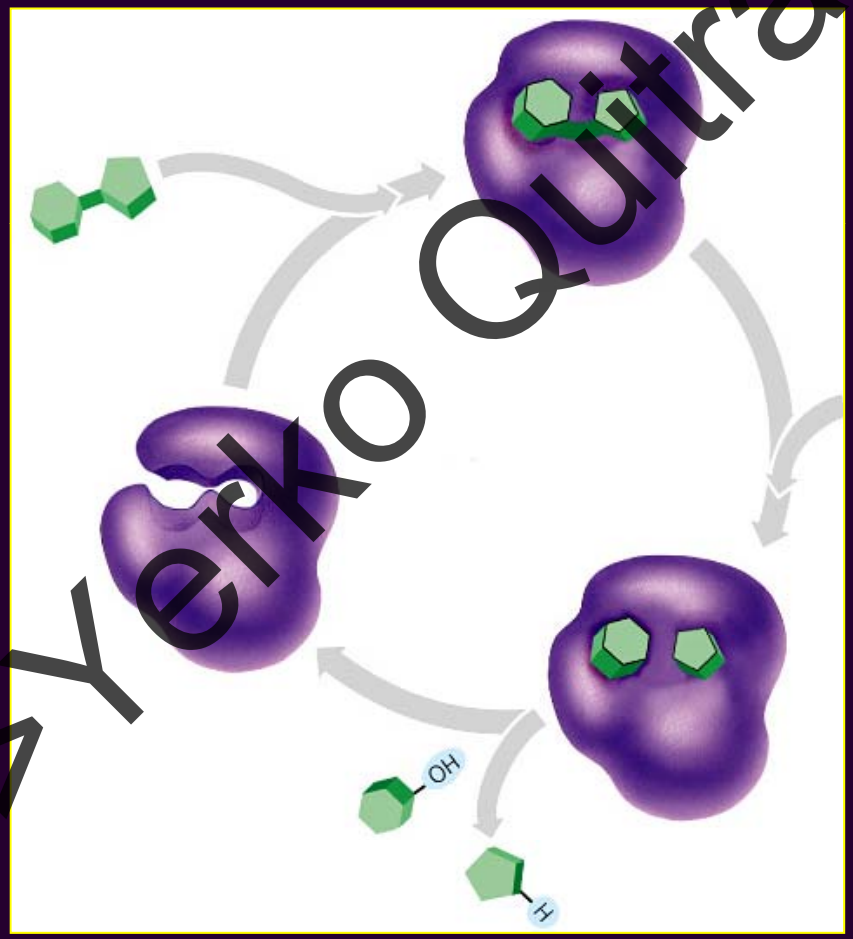
Life, The Science Of Biology,8 ed.,2007

Anclaje de los Hongos en célula vegetal



Life, The Science Of Biology,8 ed.,2007

Acción enzimática en el papel



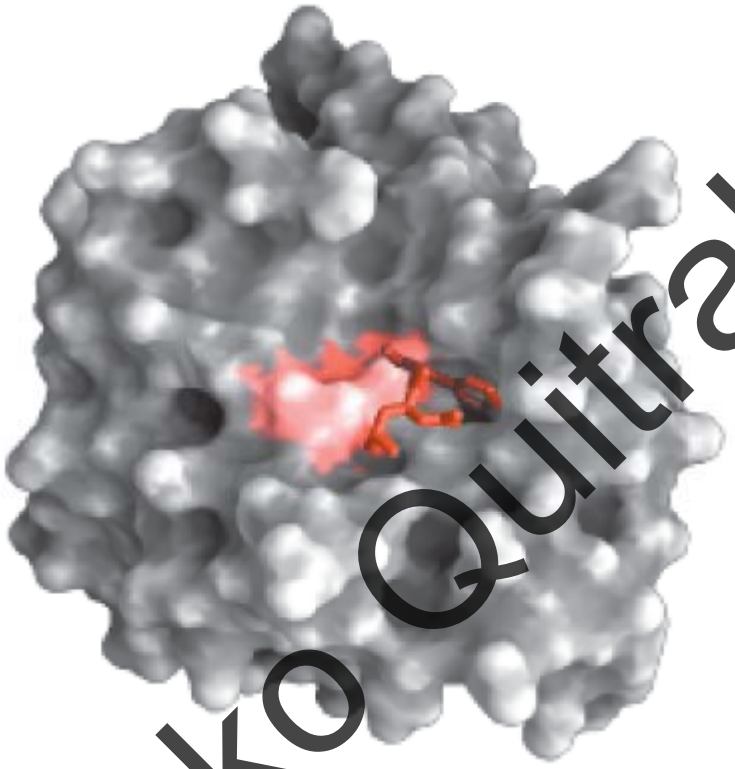


FIGURE 6–1 **Binding of a substrate to an enzyme at the active site.** The enzyme chymotrypsin, with bound substrate in red (PDB ID 7GCH). Some key active-site amino acid residues appear as a red splotch on the enzyme surface.

A simple enzymatic reaction might be written

$$E + S \rightleftharpoons ES \rightleftharpoons EP \rightleftharpoons E + P$$

Lehninger Principles of Biochemistry,Fourth Edition.2008

Respuesta a pH diferencial en la Actividad enzimática

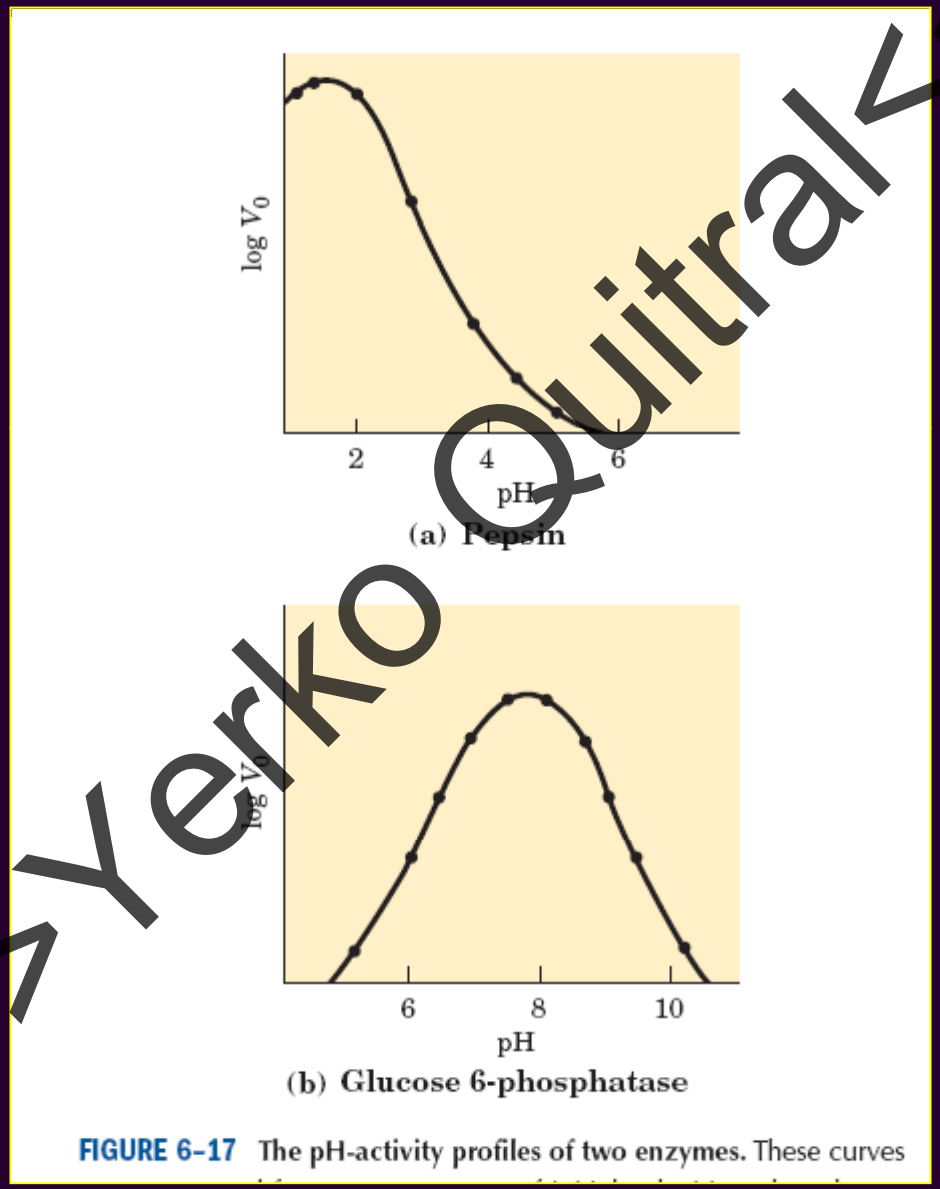
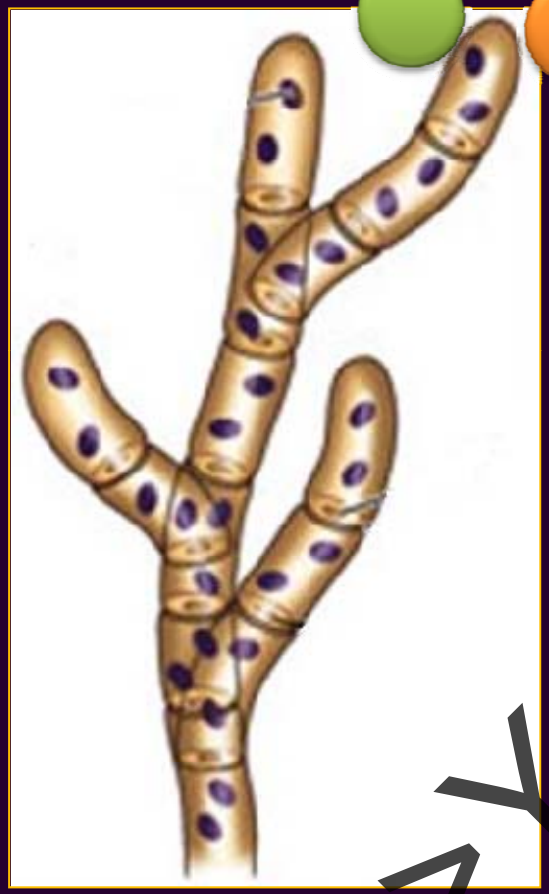


FIGURE 6–17 The pH-activity profiles of two enzymes. These curves

Lehninger Principles of Biochemistry, Fourth Edition.2008

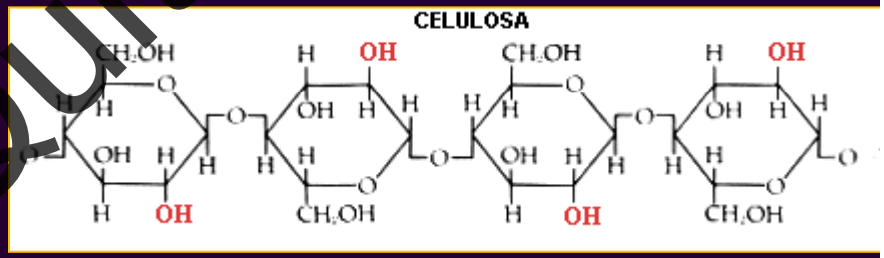
Mecanismo General de Acción degradativa

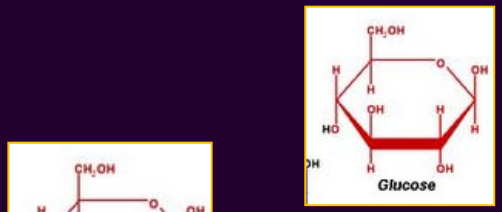
Enzimas

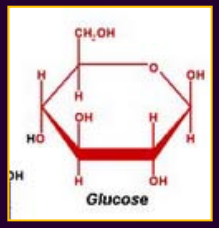


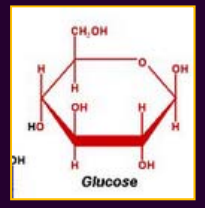
Hifas

Celulosa



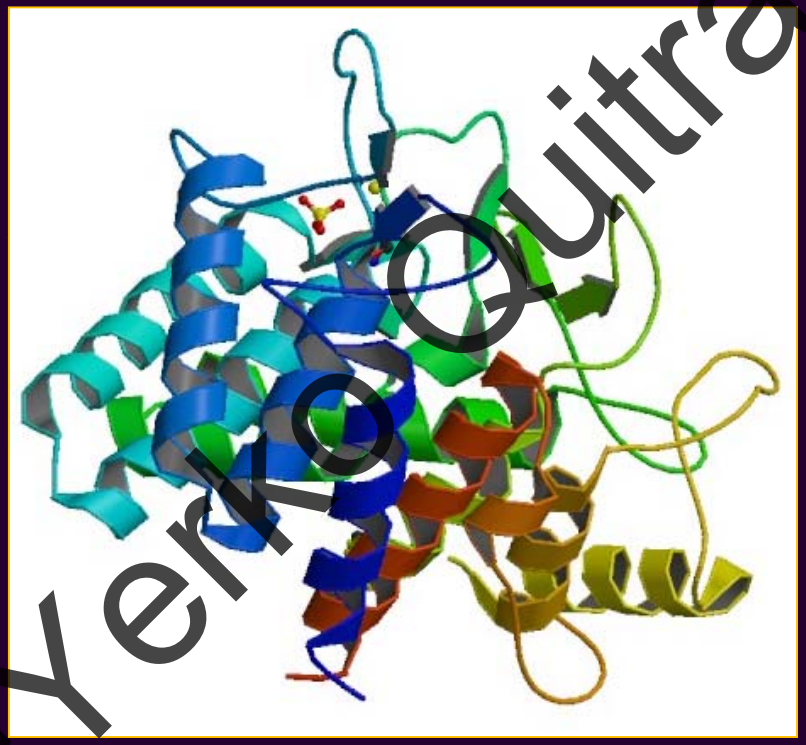






Glucosa

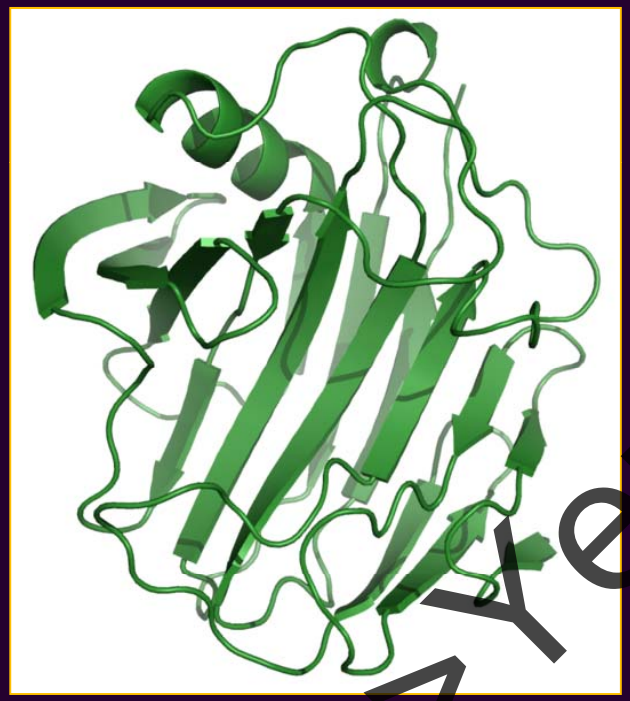
Celulasas



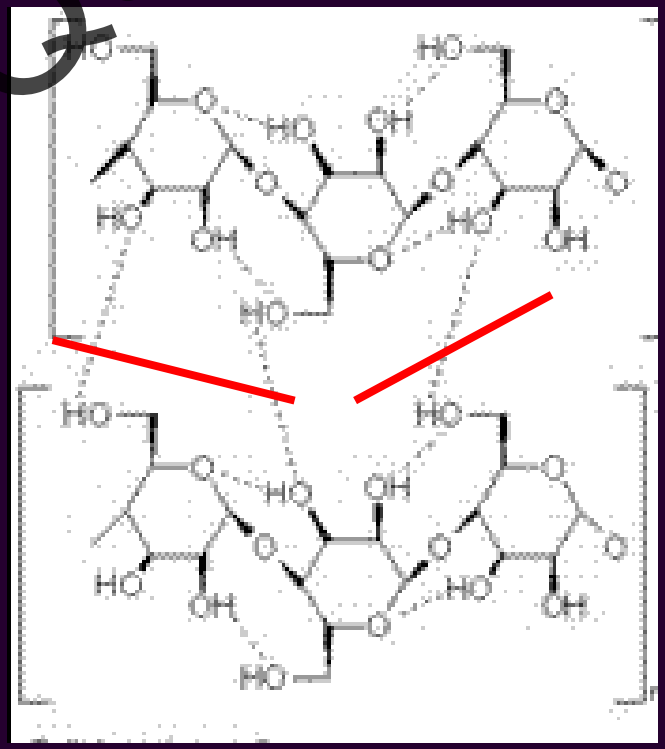
Endoglucanasa, estructura de la enzima endoglucanasa, que ataca la celulosa. (Foto: Peter Reilly)

Estos sistemas están compuestos principalmente por tres tipos de enzimas:

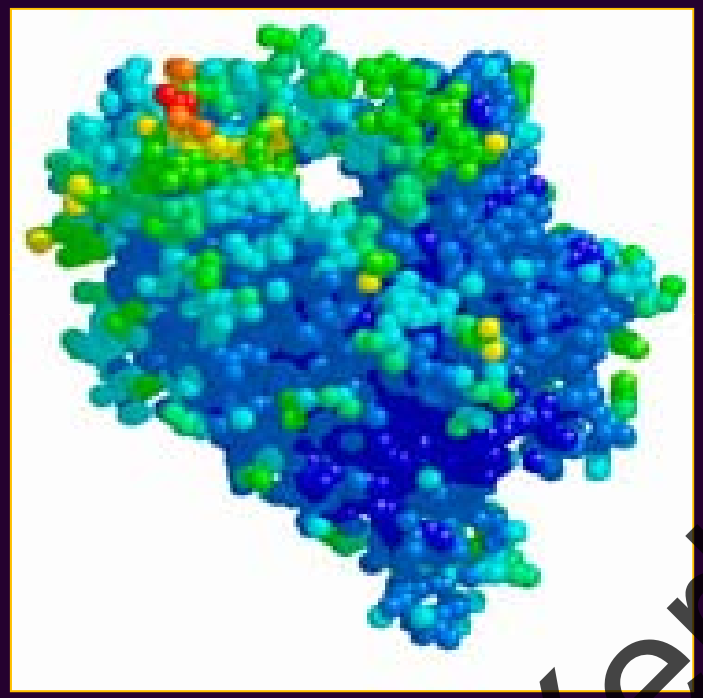
- β-1,4- Endoglucanasas



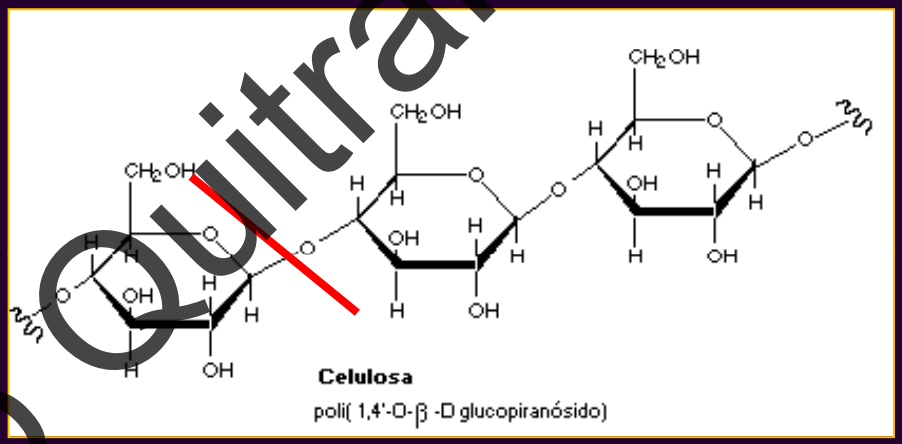
Cortan enlace 1,4-β en la cadena de celulosa

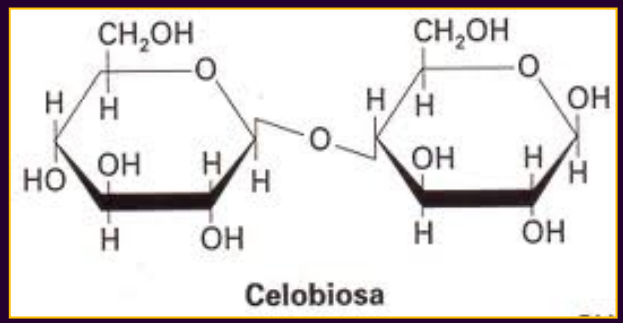


➢ β-1,4-Exoglucanasa

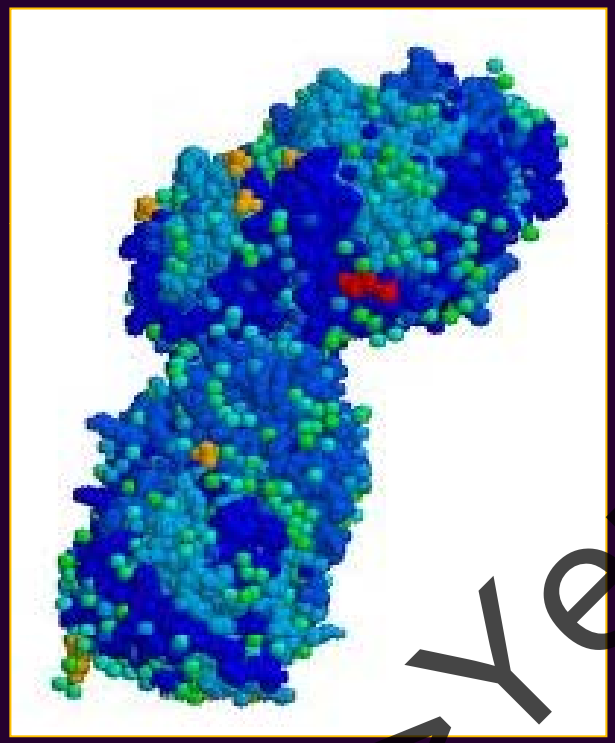


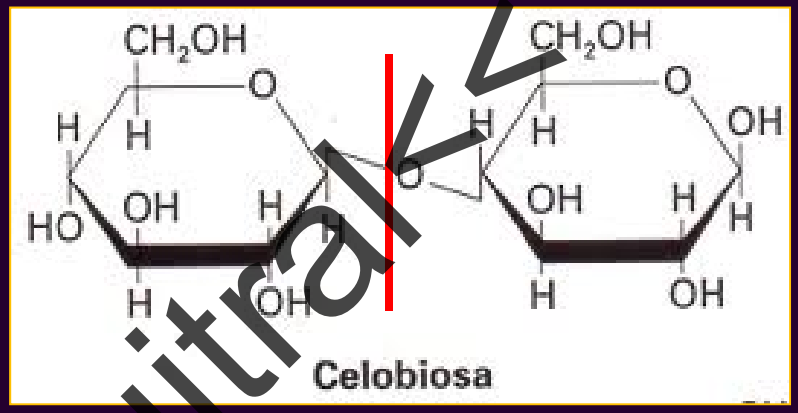
Parte de 2 o 4 unidades de glucosa produciendo tetrasacaridos o discaridos

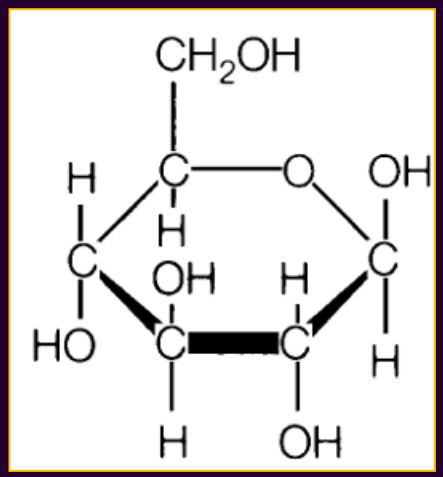




- Celobiohidrolasa (Glucosidasa)







Glucosa

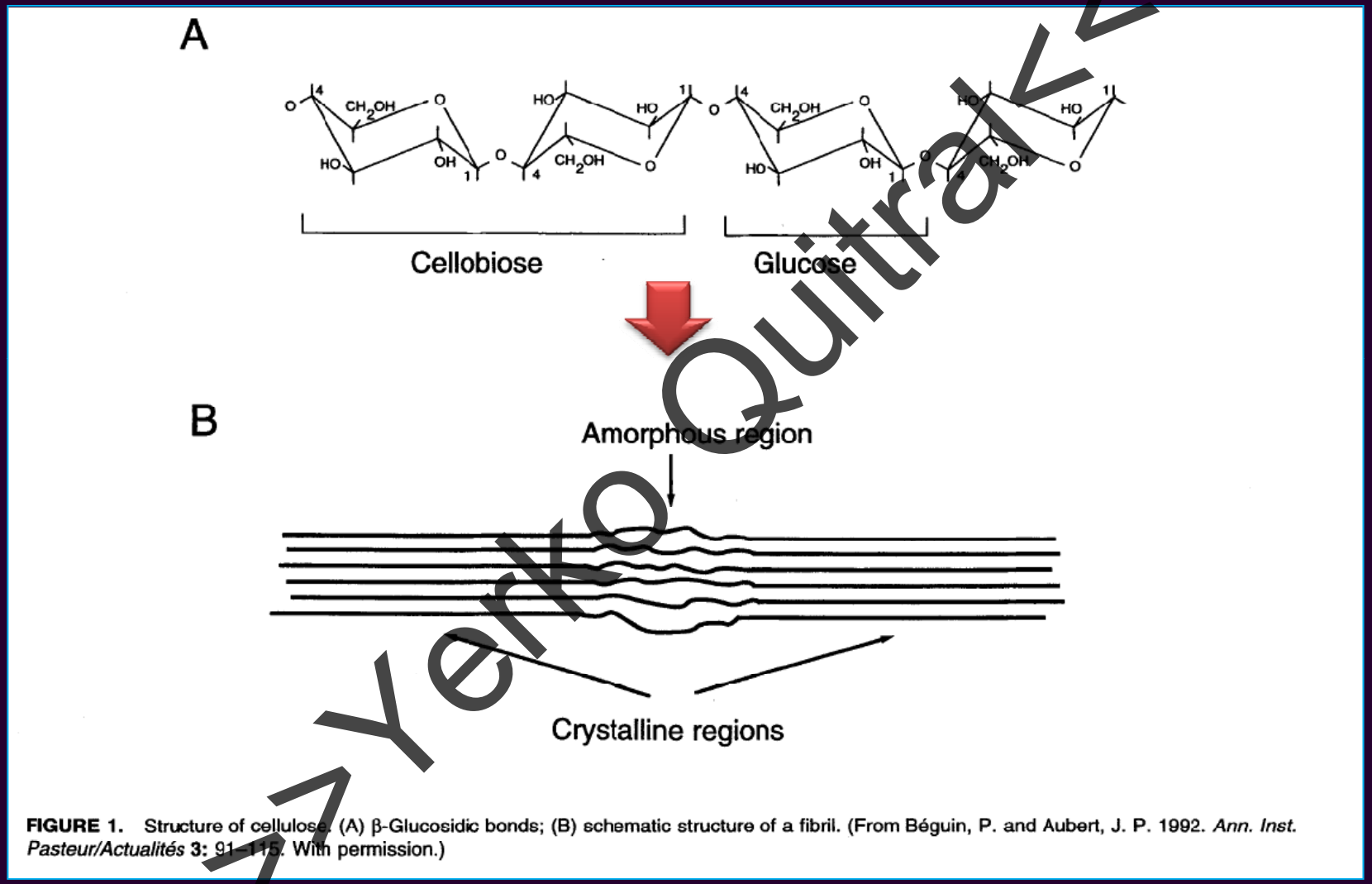
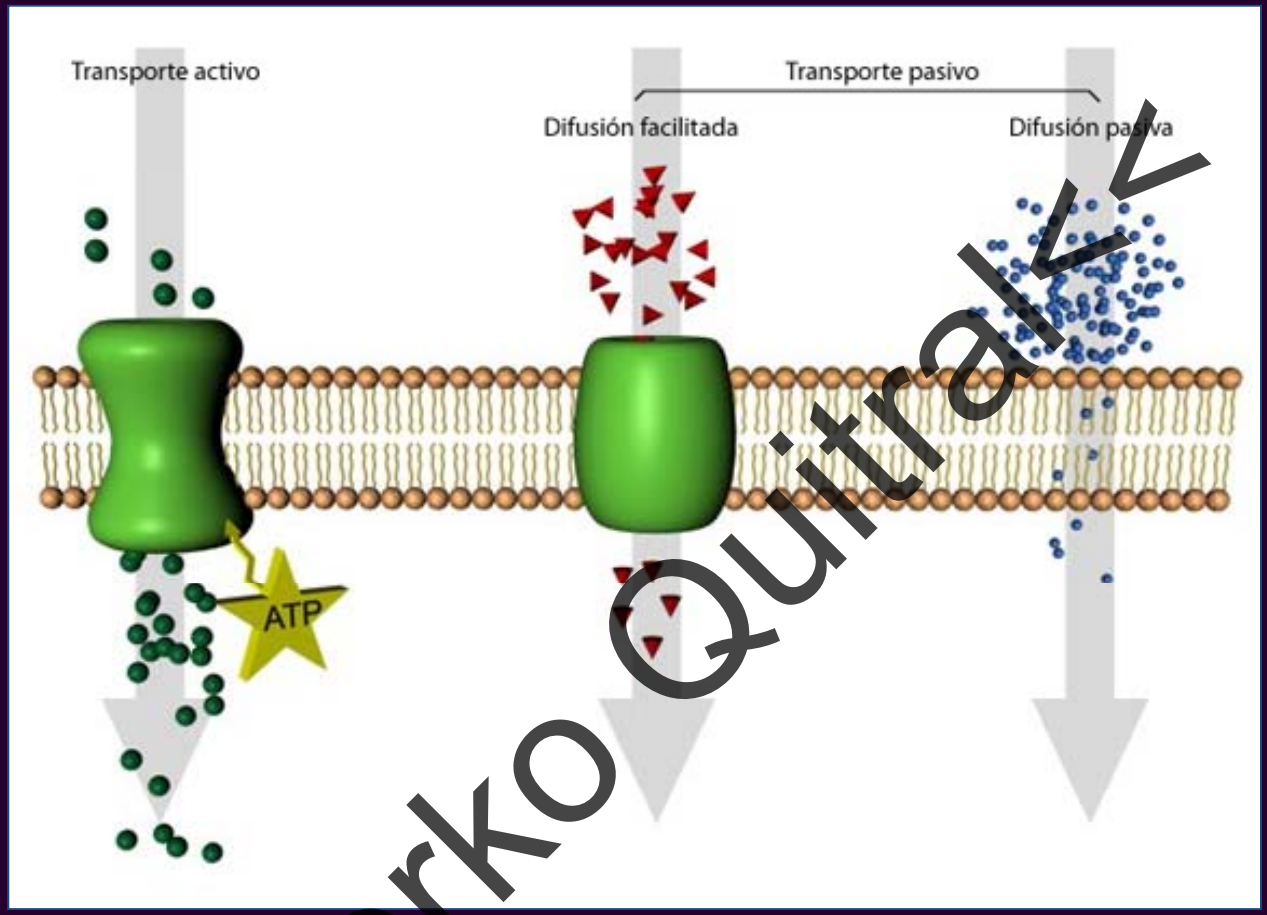
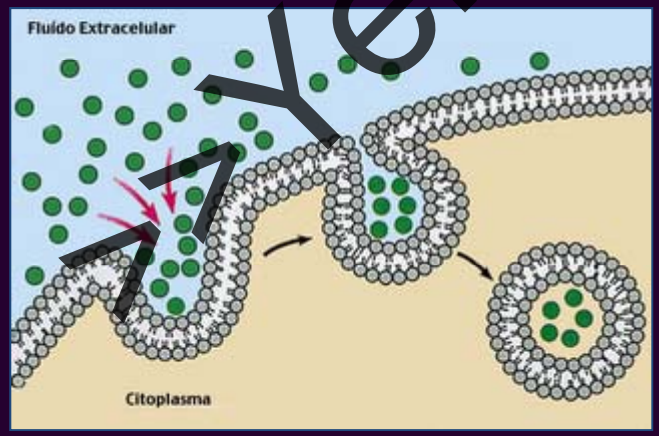
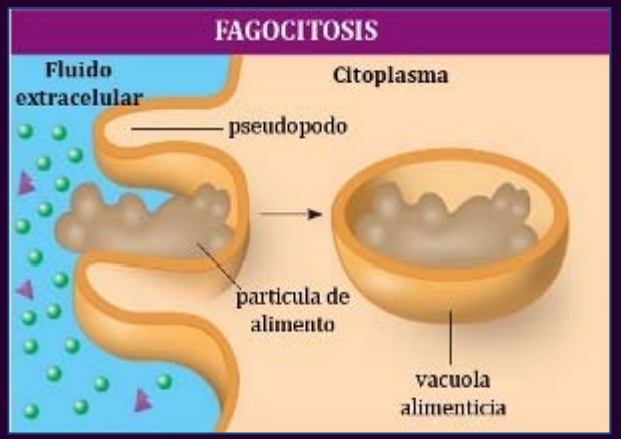


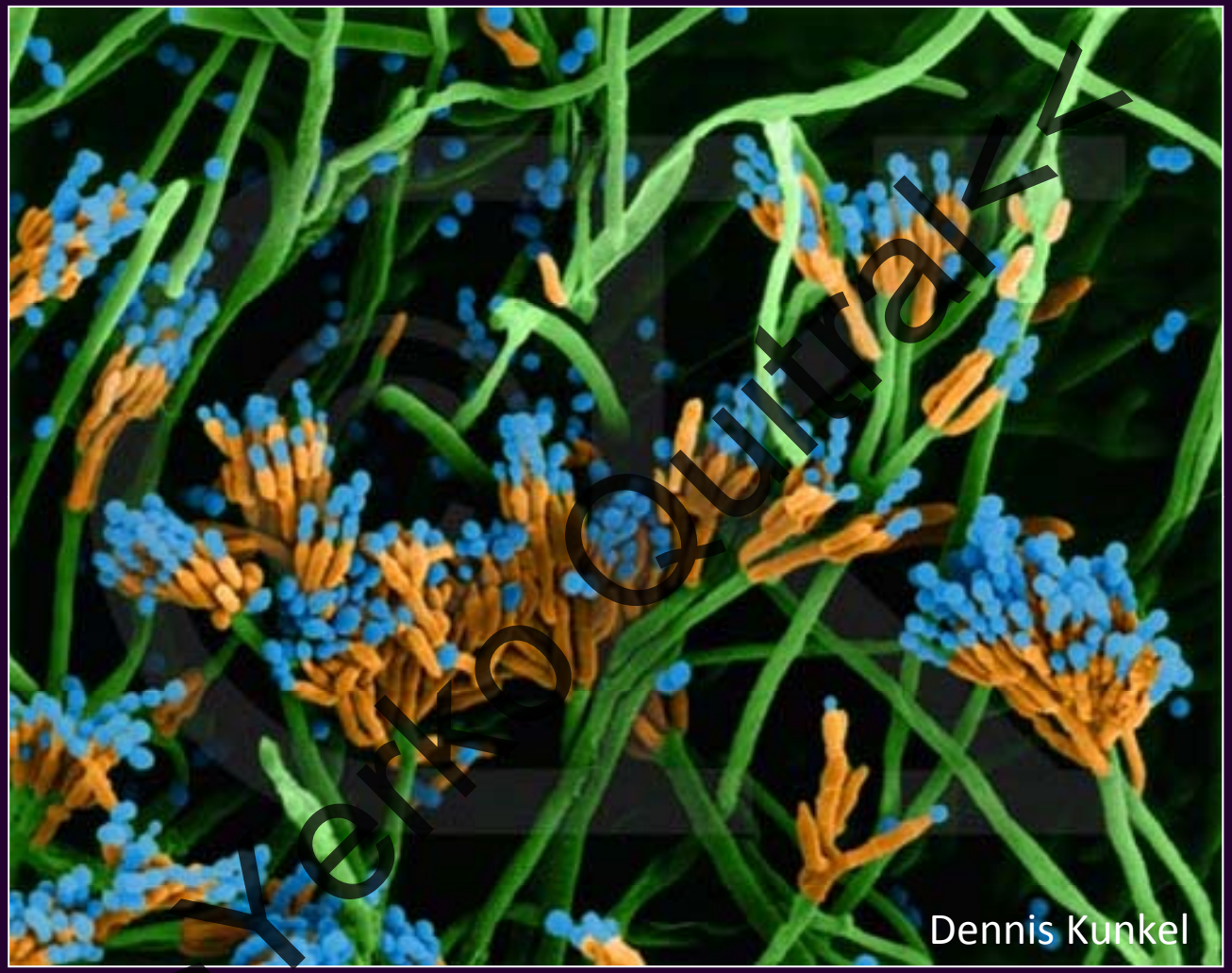
FIGURE 1. Structure of cellulose: (A) β-Glucosidic bonds; (B) schematic structure of a fibril. (From Béguin, P. and Aubert, J. P. 1992. *Ann. Inst. Pasteur/Actualités* **3:** 91–115. With permission.)

Béguin Pierre and Lemaire Marc,1996.Critical Reviews in Biochemestry and Molecular Biology.



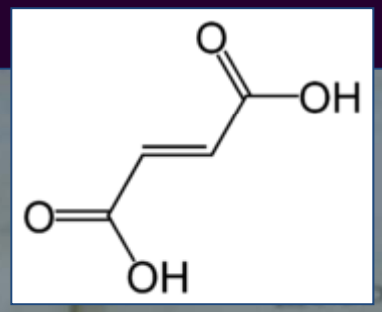




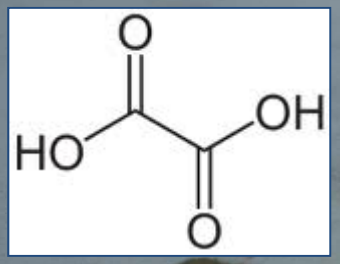


Microscopía Electrónica de Barrido. Se observan los micelos del hongo *Penicillium sp* con sus hifas (verde) , esporangio (naranjo) y sus esporas (azul)

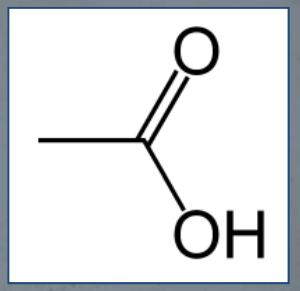
Nieves Valentin.El biodeterioro de materiales orgánicos.
Instituto del Patrimonio Histórico Español.



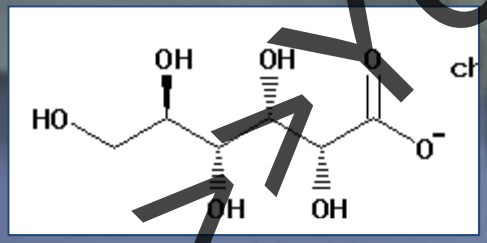
Ac. fumarico



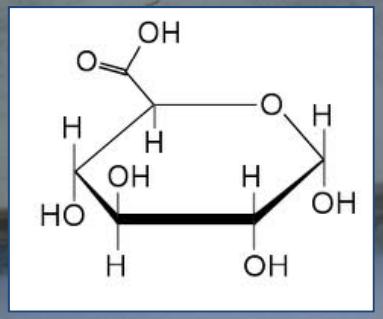
Ac. oxálico



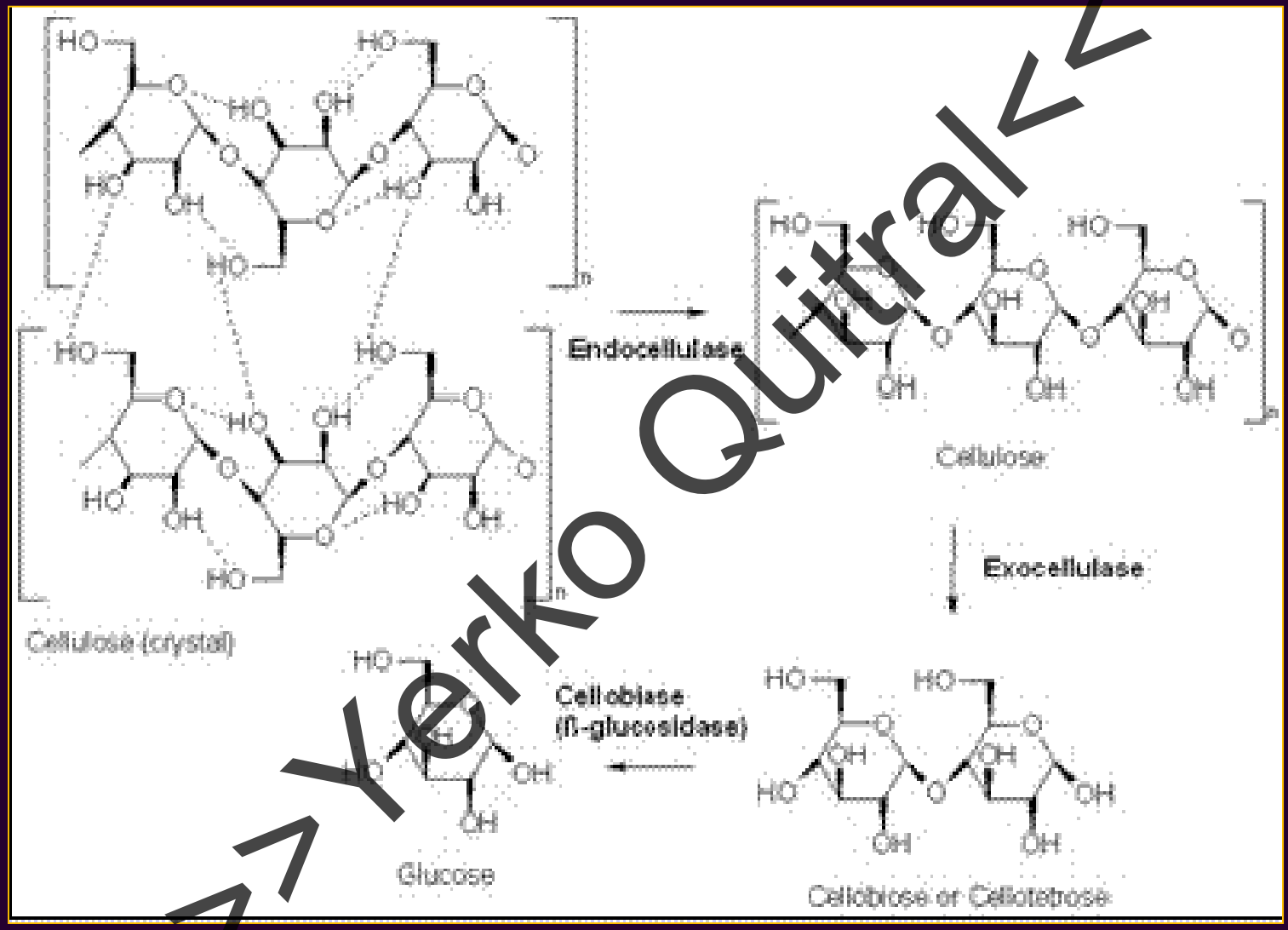
Ac. acético

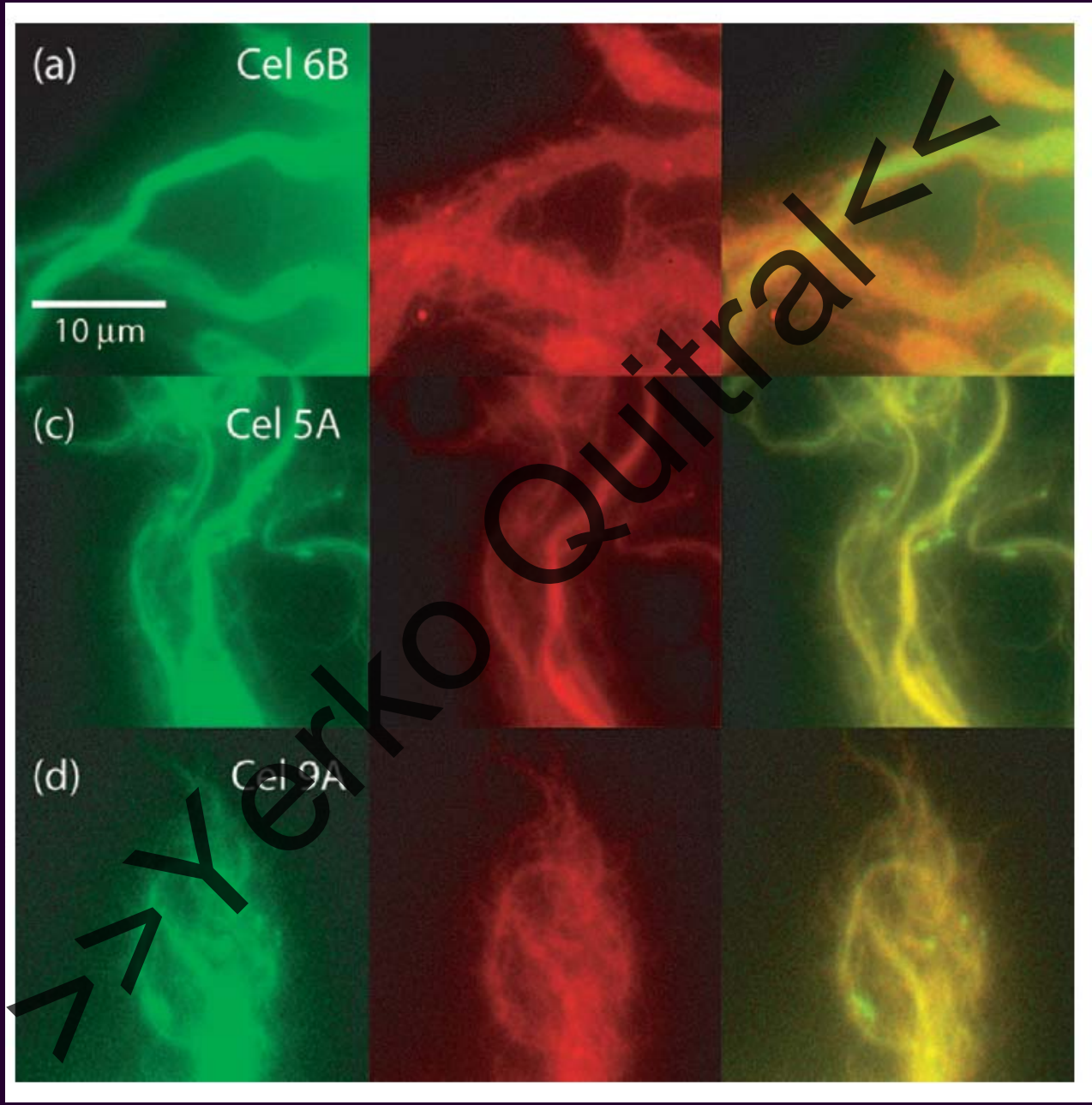


Ac. glucónico



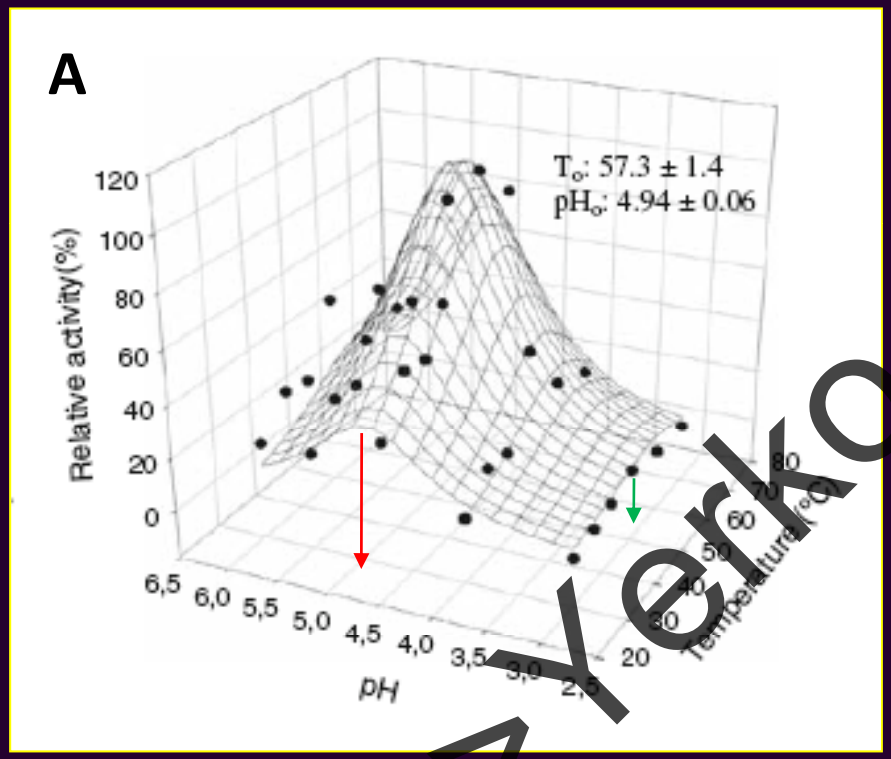
Ac. glucurónico

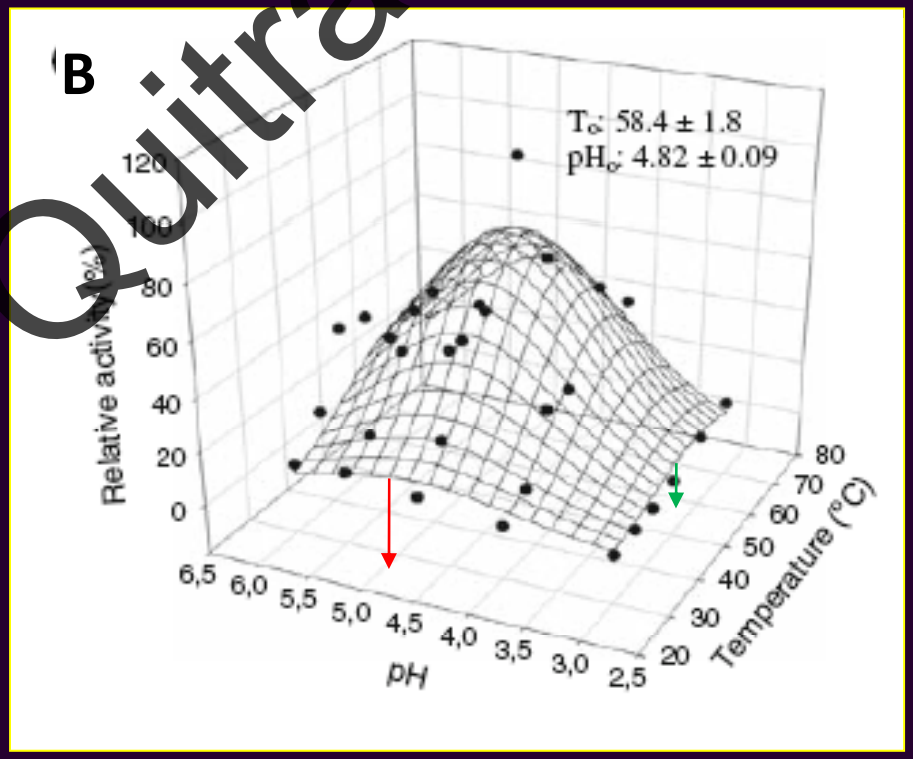




Jose M. Moran-Mirabal *et al*, 2008. Biotechnology and Bioengineering.

Influencia del pH y la Temperatura sobre la actividad enzimática
a) Glucosidasa b) endoglucanasa





Machado de Castro *et al*.,2010. J Ind Microbiol Biotechnol.

Crecimiento de hongos específicos en libros y ambiente

Tabla 1. Distribución del número de unidades formadoras de colonias (UFC) obtenidas en el muestreo del ambiente y en los libros

Sección	Tipo de agar	Ambiente	Libros	Total	UFC por secciones	UFC (%)
Sala de	Celulosa	26	9	35	74	18.09
Hemeroteca	ADP	33	6	39		
Depósito de	Celulosa	16	3	19	40	9.78
Hemeroteca	ADP	18	3	21		
Colección	Celulosa	94	3	97	143	34.97
Libros	ADP	30	16	46		
Antiguos						
Depósito	Celulosa	111	1	112	152	37.16
General	ADP	39	1	40		
Total	Celulosa	247	16	263	409	100
	ADP	120	26	146		

Marinés Giraldo-Castillón et al.,2009.

Factores como temperatura y humedad relativa en el crecimiento de hongos.

Tabla 2. Promedio e intervalo de temperatura y humedad relativa registrada en cada sitio de muestreo

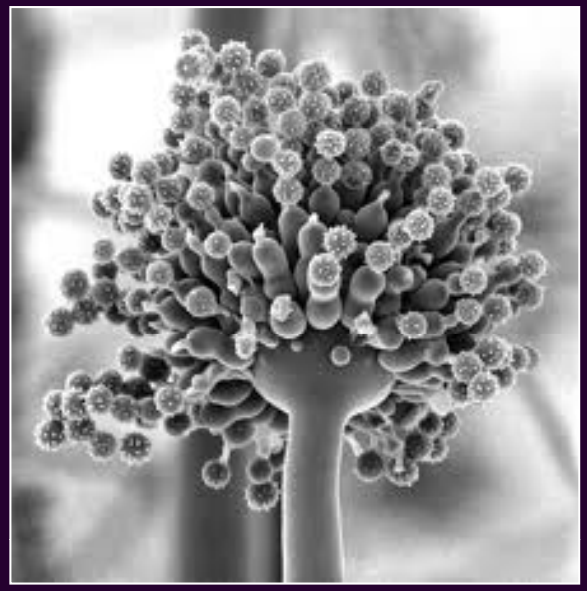
Sitio de muestreo	Temperatura (°C)	Humedad relativa (%)
Sala de la Hemeroteca	23.4 (18.3 – 28.5)	41.7 (39.9 – 45.1)
Depósito de Hemeroteca	22.0 (16.1 – 27.9)	48.1 (45.6 – 51.7)
Colección Libros Antiguos	23.3 (17.6 – 29.0)	65.1 (62.5 – 67.8)
Depósito General	23.6 (18.3 – 28.8)	60.7 (59.3 – 62.2)

Marinés Giraldo-Castillón et al.,2009.

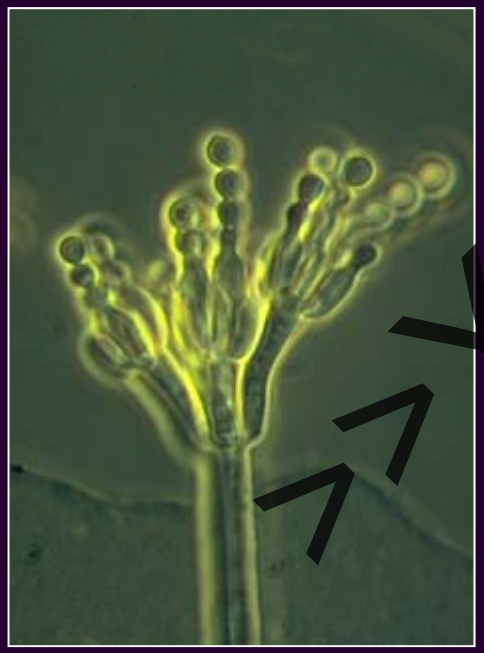
Hongos más comunes

Rhizopus stolonifer (SEM)

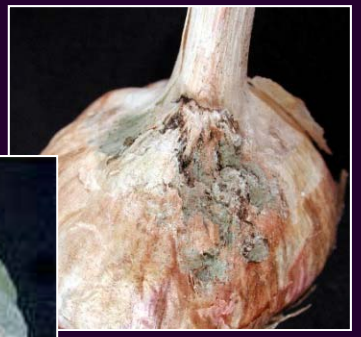
Rhizopus (SEM)

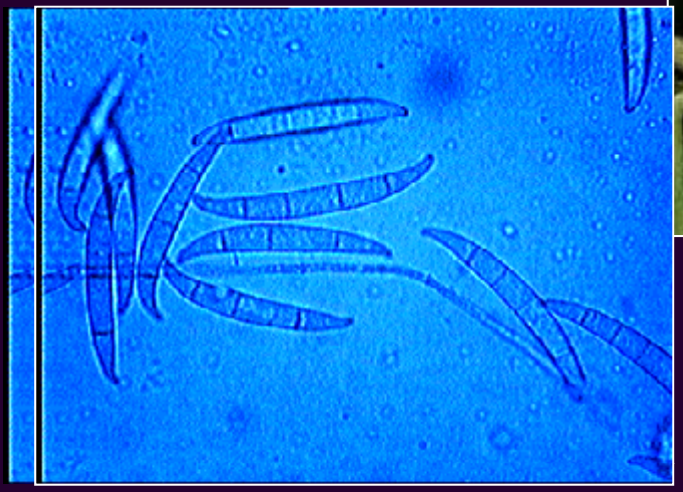


Aspergillus

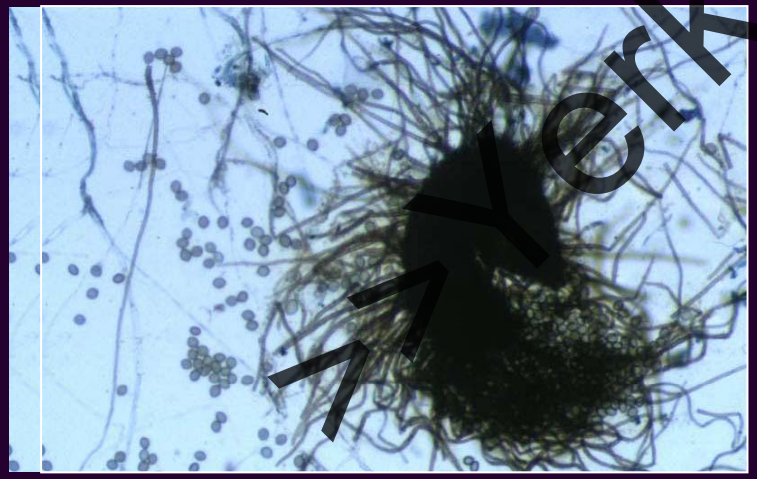


Penicillium





Fusarum

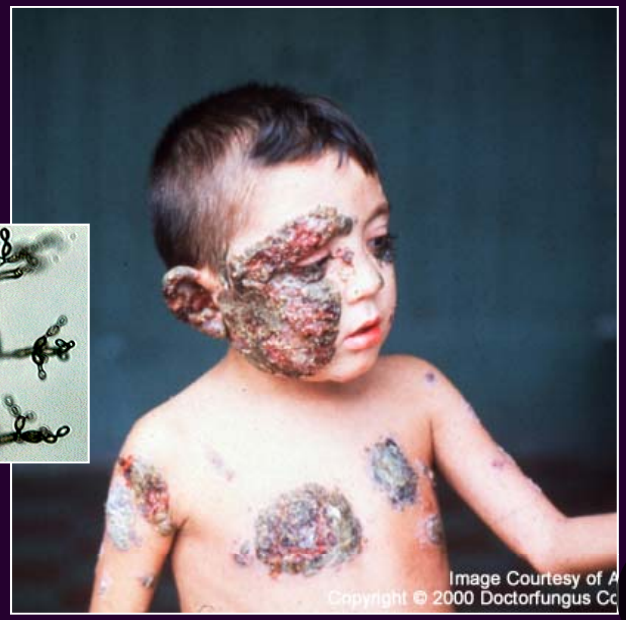


Chaetomium

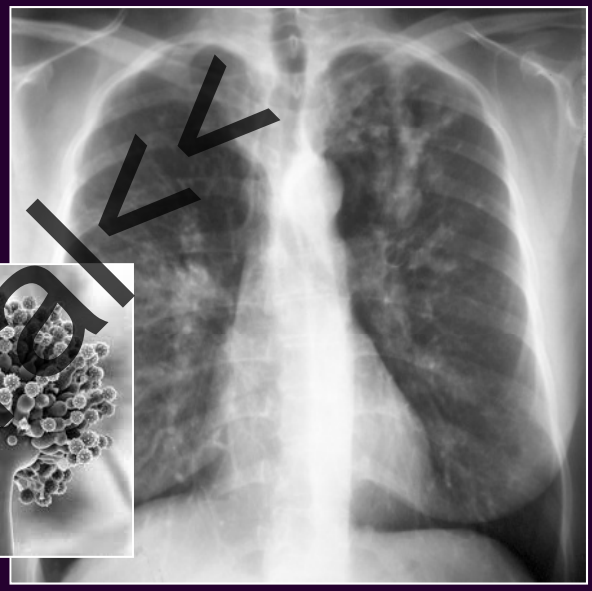
Alternaria

Cladosporium

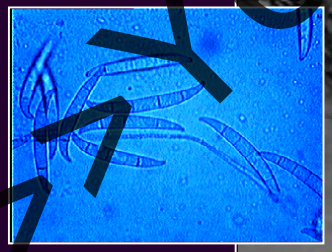
Consideraciones de trabajo

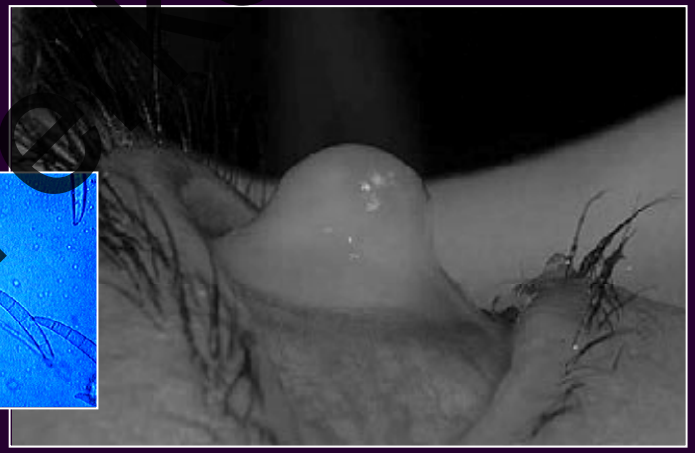


Cladosporium



Aspergillus





Fusarum sp.

Paul L. Curt *et al.*, 1977. Biochem. J.

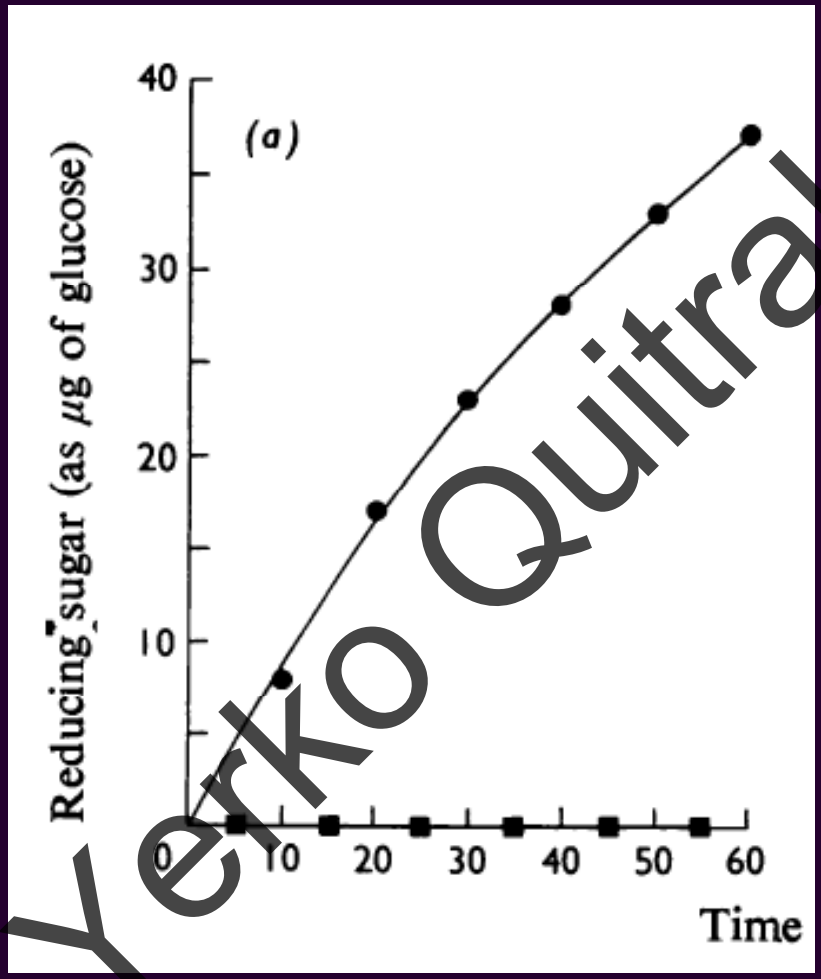


Fig. 1. *Hydrolysis of CM-cellulose*

(*a*) Production of reducing sugars during the hydrolysis of CM-cellulose. Each assay contained 0.1 ml of enzyme solution (0.25 μg) and 0.5 ml of CM-cellulose (10 mg/ml) in 0.1 M-sodium acetate buffer, pH 4.0 at 40°C. Tubes were removed from the incubation bath at the times indicated, kept on ice and reducing sugars (●) and glucose (■) determined as described under 'Methods'. (*b*) Effect of cellulase on the viscosity of CM-cellulose solution. Solutions of CM-cellulose (20 mg/ml, in 0.1 M-sodium acetate buffer, pH 4.0, 30 ml) and cellulase (25 μg/ml, in the same buffer, 5 ml) were mixed and 5 ml samples were removed at the times indicated for the determinations with an Ostwald viscometer. The specific viscosity at zero time was determined by substituting buffer for the enzyme solution. The experiment was carried out in a constant-temperature room at 40°C.

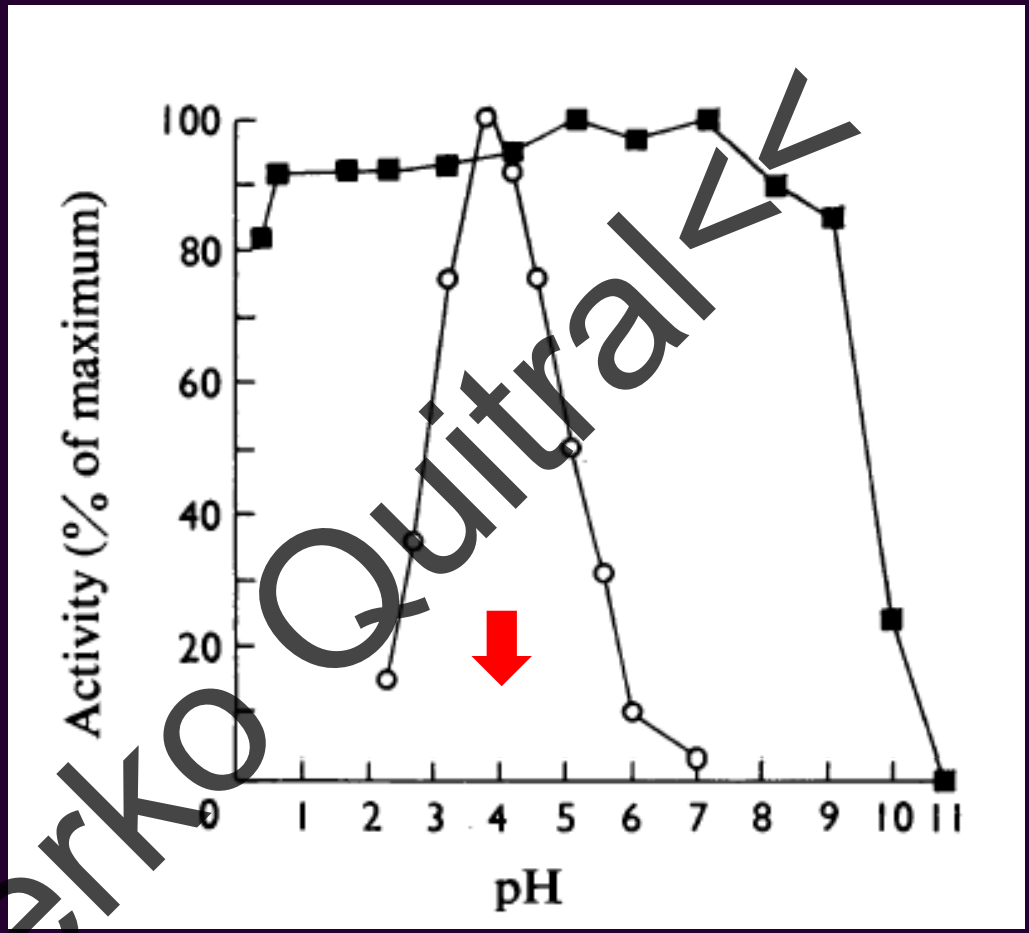


Fig. 2. *Effect of the pH on the activity and stability of cellulase*

The effect of pH on the enzymic hydrolysis of CM-cellulose (○) was measured in the assay system consisting of 0.25 ml of CM-cellulose (20 mg/ml) in water, 0.25 ml of an appropriate buffer and 0.1 ml of cellulase (0.25 μg). Buffers used were: 0.2 M-glycine/HCl (pH 1.5, 2.0, 2.5); 0.2 M-citric acid/NaOH (pH 3.0, 3.5); 0.2 M-acetic acid/NaOH (pH 4.0, 4.5, 5.0, 5.5); 0.2 M-succinic acid/NaOH (pH 5.0, 5.5, 6.0); 0.2 M-imidazole/HCl (pH 4.0). Points were the average of three determinations. In determining the stability of the enzyme (■), cellulase was incubated at 25°C for 24 h in a mixture containing 0.5 ml of buffer, 0.4 ml of water and 0.1 ml of enzyme solution (250 μg/ml). After incubation, 0.1 ml samples were transferred to 1.0 ml of 0.25 M-sodium acetate buffer, pH 4.0. Duplicate assays were carried out on 0.1 ml portions. Buffers used were: 0.2 M-glycine/HCl (pH 1.5, 2.0); 0.2 M-citric acid/NaOH (pH 3.0, 4.0, 5.0, 6.0); 0.2 M-imidazole/HCl (pH 7.0); 0.2 M-Tris/HCl (pH 8.0, 9.0); 0.2 M-glycine/NaOH (pH 10); 0.2 M-$NaHCO_3$/NaOH (pH 11.0). For pH values below 1 dilute HCl solutions (approx. 0.5 M) were used. The pH of each incubation was measured after mixing the component solutions.

Paul L. Curt *et al.*,1977. Biochem. J.

Tratamientos actuales