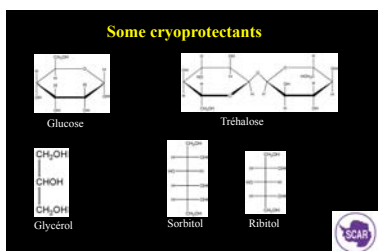
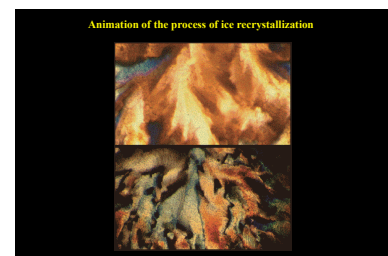
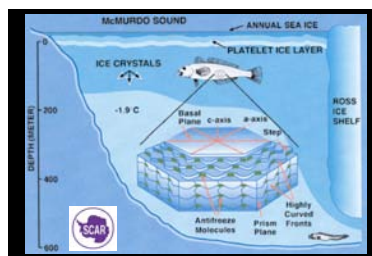
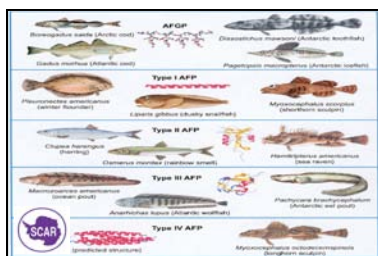
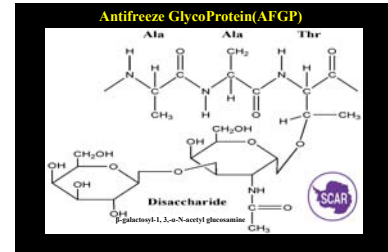


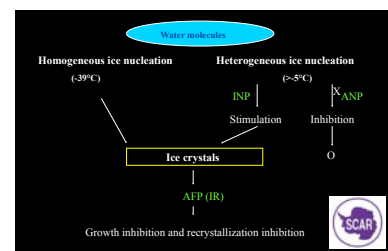
General properties of enzymes from psychrophiles

- High specific activity at low and moderate temperatures
- High thermostability - Flexible structure




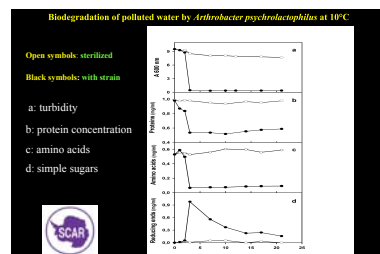
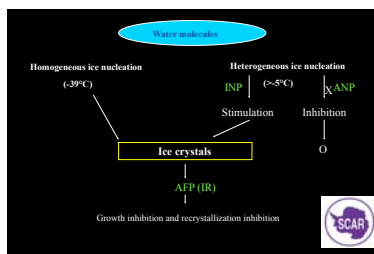
Effects of cryoprotectants

- 1- They depress the freezing point of water
- 2- They prevent cell dehydration when extracellular ice is present
- 3- They protect proteins against cold denaturation


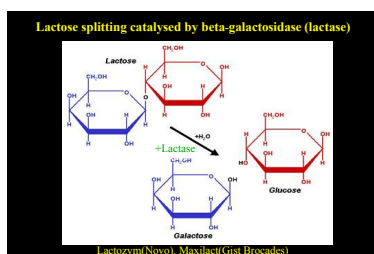


Effects of ice-nucleating proteins

- 1-Ice is confined in the extracellular space
- 2-The formation of ice is controlled by the organism (time)
- 3-At the same time production of cryoprotectants
- 4-Some water is lost contributing to decrease the freezing point in the intracellular space


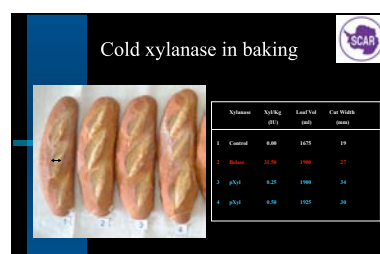
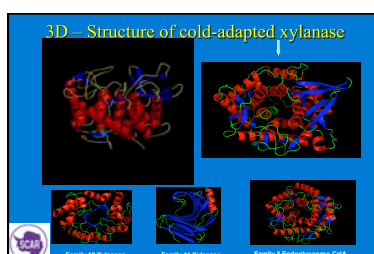
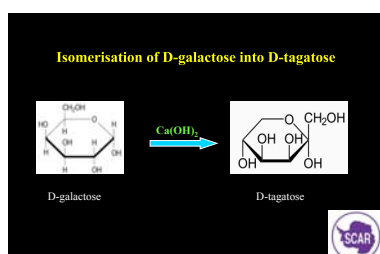
Psychrophiles and cold-active enzymes in Biotechnology		
Applications	Advantage	Involved enzymes
Detergents	Washing at low temperature	Protease, lipase, amylase, cellulase, oxygenase
Food industry	Improved taste and aroma of fermentation products (cheese, wine)	Fermentation and ripening enzymes
	Lactose hydrolysis	β -galactosidase
	Juice clarification and yield of extraction	Pectinase, cellulase
	Wine fermentation	Protease
Organic synthesis	Stable and heat-sensitive compounds, organic phase synthesis	Protease, lipase, glyceryl-hydrolyase, etc.
Molecular biology	Mild inactivation, ligation, PCR	Various enzymes
Textiles	Low temperature	Ligation, carry-over in PCR
	Improved quality due to mild treatment for dyeing, bio-polishing and stone washing of fabrics	Amylase, laccase, cellulase
Environment	In situ bioremediation of organic pollutants and hydrocarbons	Various hydrolases, mono- and dioxygenases, dehydrogenases
	Biogas production	Psychrophilic anaerobic digestion

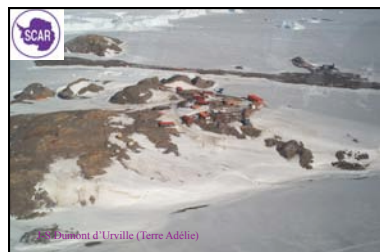



Tests in milk at 5°C

Lactose + $\text{H}_2\text{O} \xrightarrow{\beta\text{-galactosidase}} \text{D-glucose} + \text{D-galactose}$
 $\text{D-galactose} + \text{NAD}^+ \xrightarrow{\text{Gal-DH}} \text{D-lactonolactone} + \text{NADH} + \text{H}^+$

β -galactosidase	[Lactose] (mg/l)	Fresh [D-galactose] (mg/l)	[Lactose] hydrolysed (mg/l)
<i>P. halophilus</i>	0.778	0.135	0.256
Maxilact	0.770	0.049	0.093



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