

# FABRICS' CHEMISTRY

# INTRODUCTION...

The raw materials used for the manufacture of different garments and clothes have changed over the years. Today we can divide them into two main categories.

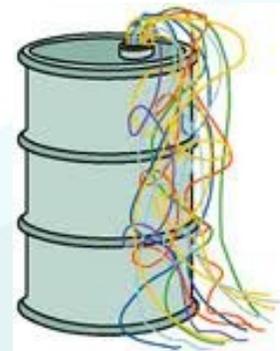
## Natural fabrics:

- Fibres of animal origin → wool, angora, cashmere, silk, etc..
- Fibres of vegetable origin → cotton, linen, hemp, etc..



## Synthetic-fibres:

- Artificial fibres → acetate, viscose, cupro, etc..
- Synthetic fibres → acrylic, polyamines, aramids, etc..



# Natural Fibres – Animal origin

The fibres of this category come from the fleece of some long fur animals...

**Merinos**



**Cashmere**



**Angora**

**Alpaca**



**Bison**



# Natural Fibres – Animal origin

...with the exception of...

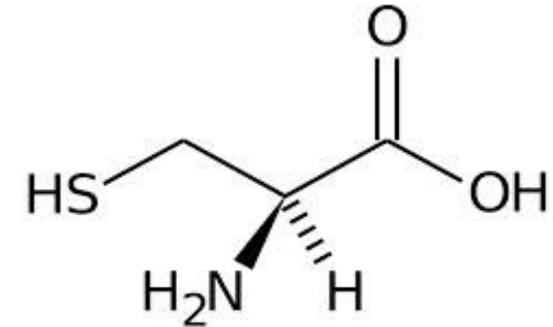


# Silk

# Natural Fibres – Animal origin – Derivatives of fleece

The fibres that come from the fleece of the animals are mainly composed of protein chains, mainly cysteine.

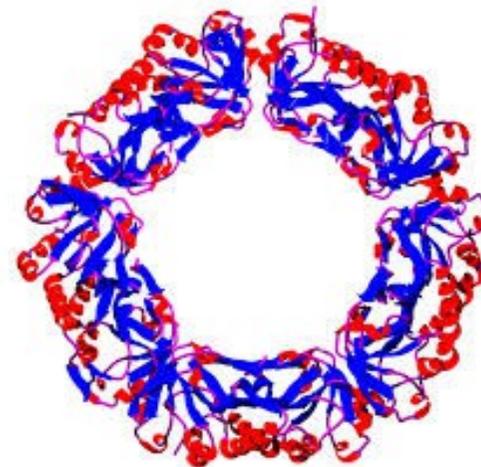
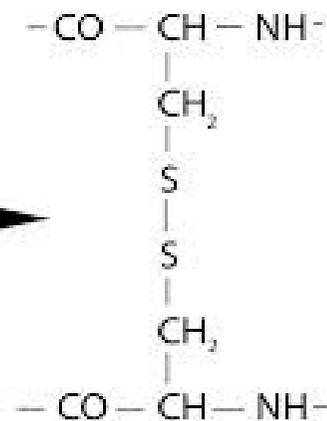
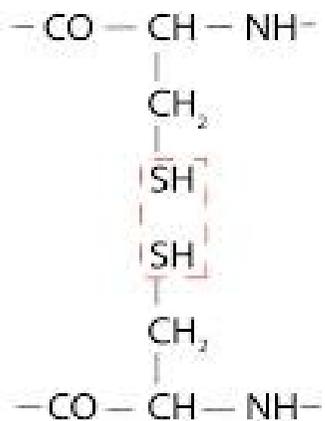
Besides proteins, we can find lipids, minerals, carbohydrates, etc..



The proteins containing cysteine are bonded by a sulphur bridge, so they wrap themselves and create the fibre.

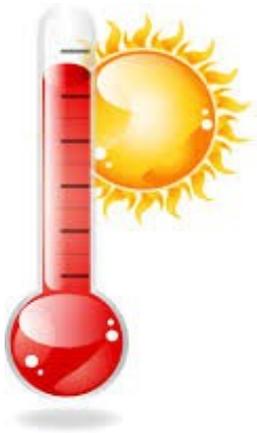
This close bond gives a strong resistance and creates a thermal barrier.

**That's the reason way wool is so warm!!!**



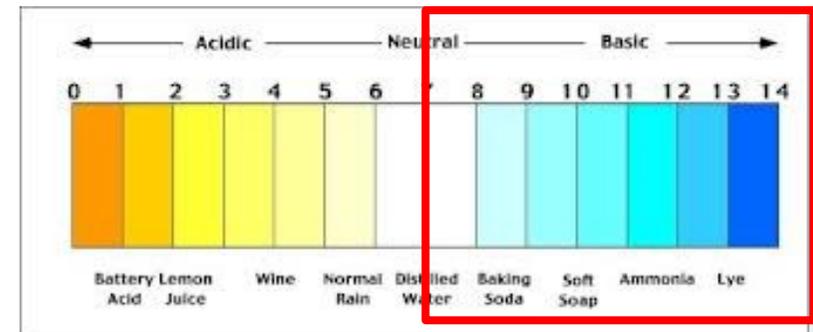
# Natural Fibres– Animal origin – WHAT TO AVOID

This intertwining of fibres, however, has two weaknesses:



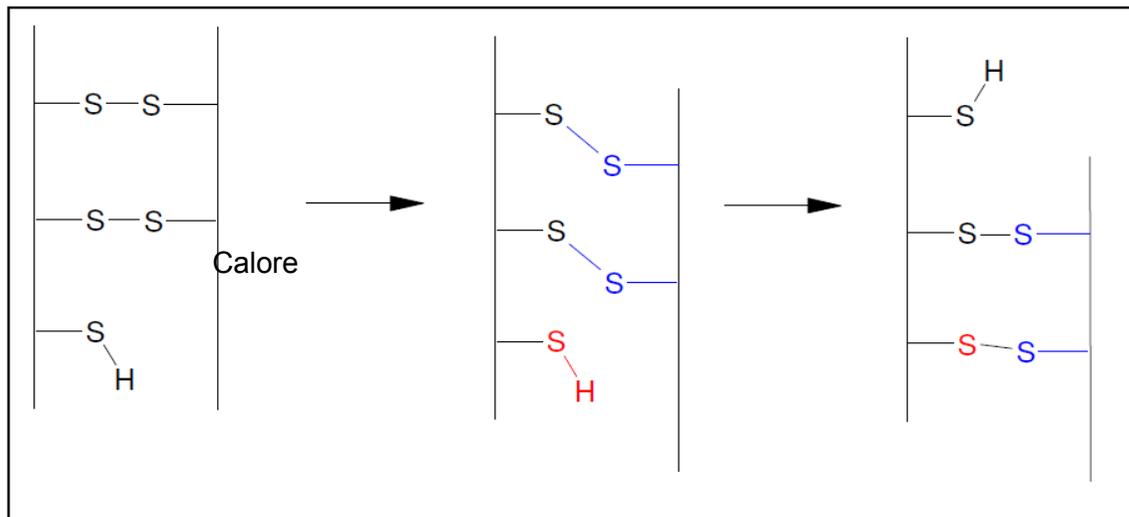
## Heat

## Basic pH



# Natural Fibres – Animal origin - Heat

The heat, on dried animal fibres, affects protein and redistributes the bonds of proteins, modifying the whole garment: the fibres reduction. We are talking about the famous **shrinkage**.



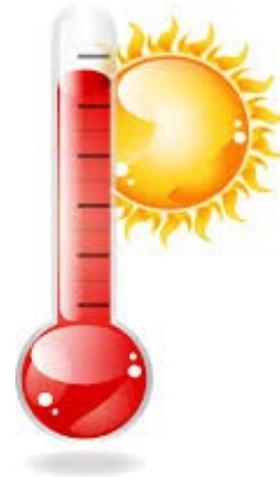
It's the principle of permanent!!!



# Natural fibres – Animal origin- Heat

So, avoid to over-dry fibres belonging to this category, or at best proceed slowly by leaving to garments a little bit of humidity in order to avoid to ruin fibres.

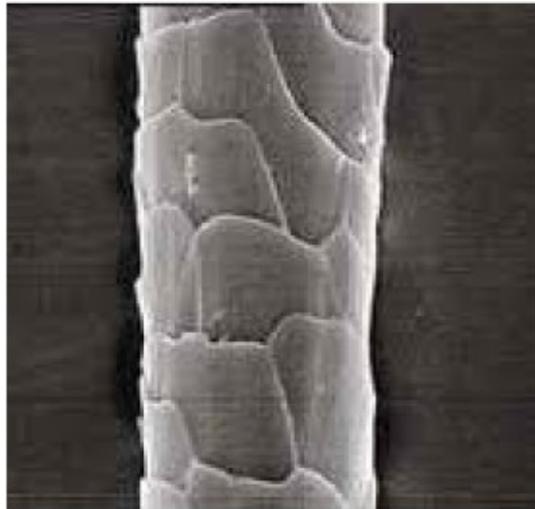
**Heat on dry fibres damage them!!!**



# Natural Fibres – Animal origin- basic pH

The isoelectric pH of fibres is usually around 5. So the fibre resists more to acids than to bases.

If you maintain a pH around 5-7, keratin (the fibre) is not damaged



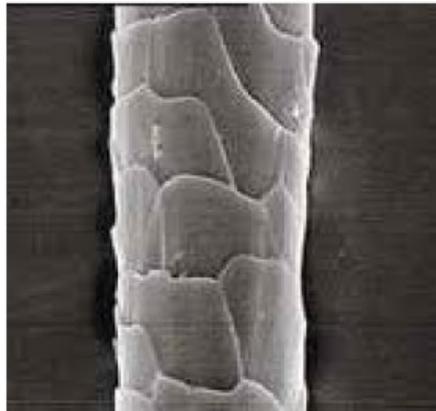
Using the right products, fibre's structure is preserved.



← acid pH

# Natural Fibres – Animal origin- WOOL

The particular “scale” structure of the wool fibre is the cause of felting.



The more is the use of the wool garment, more the fibres will slide among them creating the peeling phenomenon. To limit this problem and give again the initial appearance of the fibre we have to use a product that can feed it and creates a protective veil on it.

Tintolav, for this purpose, has developed SFELTRIX! Thanks to the hydrolized proteins it feeds and restores fibres, creating a protein veil that can give again elasticity and softness to the garment.

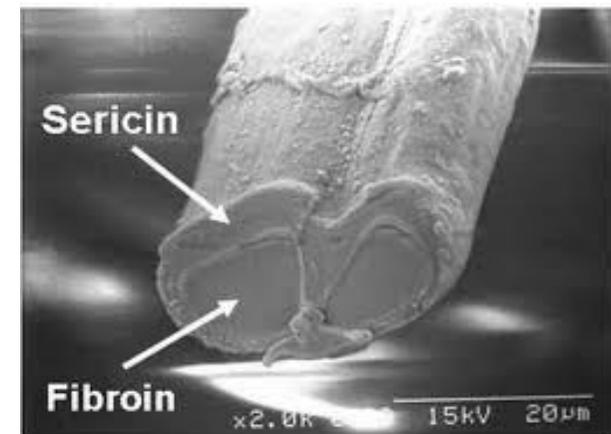
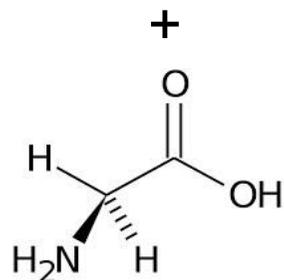
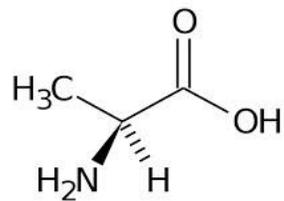


# Natural Fibres – Animal origin- SILK

Silk derives from silkworm created by *Bombix mori* who, during the metamorphosis from worm to moth, lets this spun come out.



Silk is composed for the 70-80% of fibroin (composed by alanine and glycine and in the external part by sericine).



Silk fibroin

# Natural Fibres – Animal origin- SILK

Hydrogen links that are generated among fibres give a good tenacity. This characteristic is lost if wet. So for this reason the dry-cleaning is better. Laundry has to be done with particular precautions and foresees mild cycles and non aggressive surfactants.

Differently from the other animal fibres that derive from the fur, silk doesn't present the problem of shrinking after wash.

Differently from wool, silk stands better alkaline surroundings, but it is better to wash with slightly acid detergents.



# Natural Fibres – Animal origin- MOTHS

Moths are lepidoptera who feed on fibres keratin. They need fibres which contain proteins to survive. In particular they feed on wool and silk..



This is the reason why they leave the holes onto garments.



Moths are attracted by damp places and dirty garments.

# Natural Fibres – Animal origin- MOTHS

In order to eliminate these insects it is better to wash the garments and keep them dry. To prevent or eliminate the infestations we have two possibilities:

- Use synthetic Biocides
- Use natural preparations with a repellent action

Tintolav, to solve this problem, suggests the LENTARMIN line in gel or spray!!!



# Natural Fibres – Animal origin

## An advice :

As we have seen these garments derive from proteins, so it is better to use detergents with enzymes, because if used for a long time they can damage fibres, damaging the links of these fibres.

It is necessary to use specific detergents to preserve fibres.



# Natural fibres – Vegetable Origin

Vegetable origin fibres derive from seeds, trunks, fruits or leaves of different kinds of plants..



Cotton



Linen



Hemp



Coconut fibre



Jute

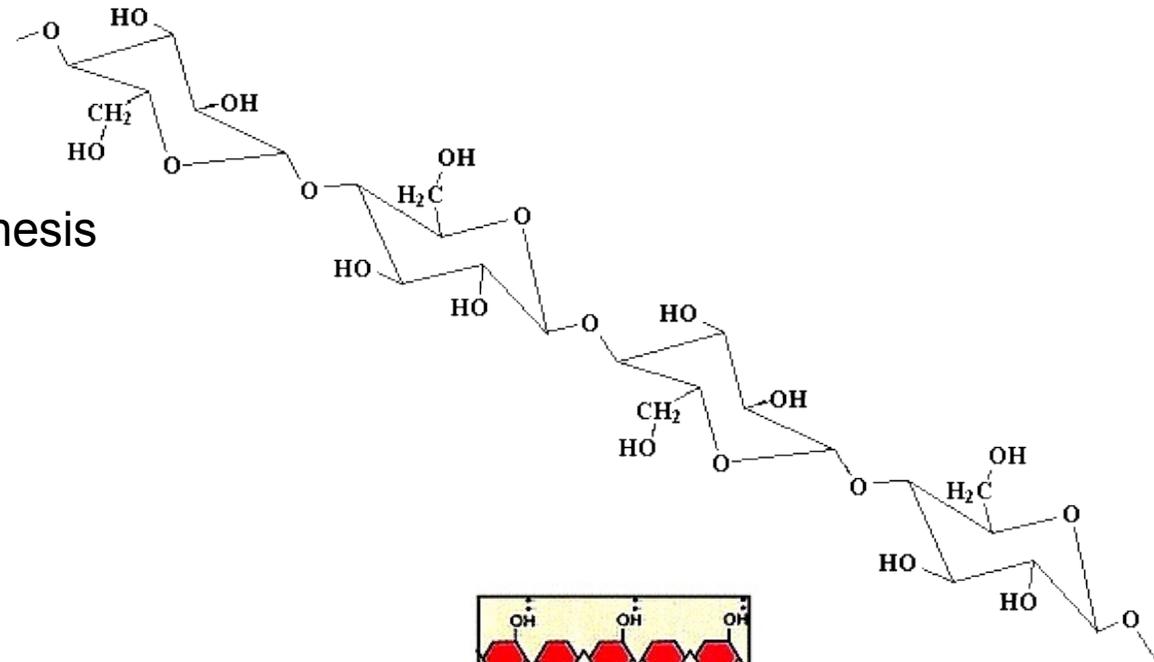
# Natural fibres – Vegetable Origin

These fibres are mainly composed by cellulose.

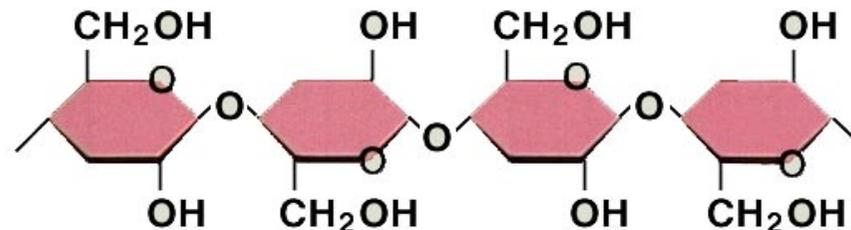
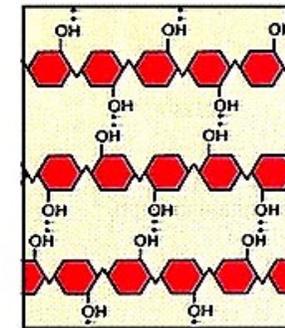
They derive from the vegetable photosynthesis that creates cellulose fibres polymers.

Cellulose is no more than a glucose chain!!!

Glucose chains are linked among them with strength boundaries, and they give to fibre a high mechanic resistance.



Cellulosa



# Natural fibres – Vegetable Origin

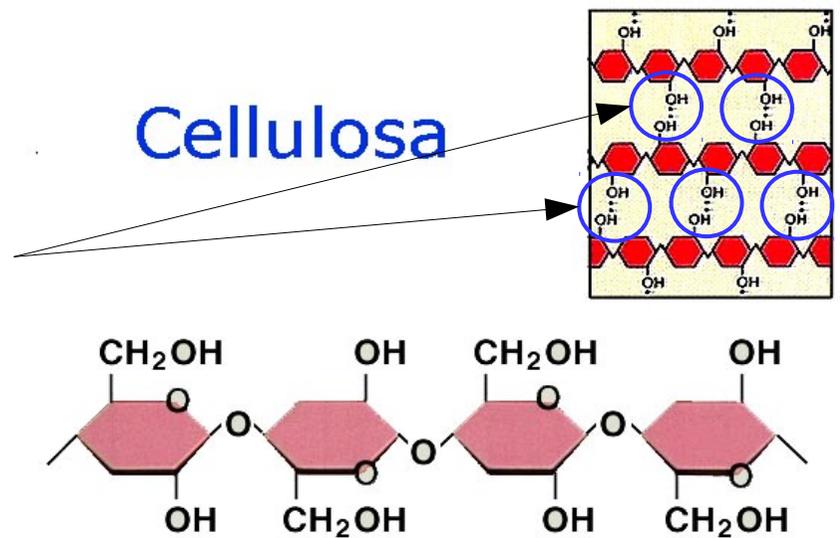
	CHEMICAL COMPOSITION OF THE MAIN VEGETABLE FIBRES (%)						
	CELLULOSE	EMICELLULOSE	PECTIN	LIGNIN	WATER SOLUBLE	WAXES	H2O
<b>COTTON</b>	82,7	5,7		--	1	0,6	10
<b>RET LINEN</b>	64,1	16,7	1,8	2	3,9	1,5	10
<b>HEMP</b>	67	16,1	0,8	3,3	2,1	0,7	10
<b>JUTE</b>	64,4	12	0,2	11,8	1,1	0,5	10
<b>RAMIE</b>	68,6	13,1	1,9	0,6	5,5	0,3	10

# Natural fibres – Vegetable Origin- Cotton

Cottons derives from the seed of some plants of *Gossypium* genus. In particular, cotton fibres are hairs that grow around the seed.

Cotton is composed for more than 80% of cellulose.

Hydrogen bonds that grow among the chains give an excellent resistance to traction but they limit the elasticity and deformability.



# Natural fibres – Vegetable Origin- Cotton

Hydrogen bonds have an affinity with water molecules, so this fibre absorbs water very well leaving onto the skin a fresh sensation.

This because water molecules contained into the sweat absorb body heat and then they are absorbed by the fibre, reducing in this way heat on the skin.



Moreover cotton is a garment resistant to weak acid and bases too, for this reason this garment reacts well to chemical spotting agents stress.

# Natural fibres – Vegetable Origin- Cotton

Its cellulose composition, derived by glucose, makes it resistant to moth (because it is not a food for this species). But it can be attacked by moulds and bacteria that feed on glucose and fibres.



To remove these stains and sanitize garment it is better to use oxygen based additives.



Excellent and ideal for these purposes is Hygienfresh® Oxon. It can be used for both whites and coloured. Its action already starts at 30 °C



# Natural fibres – Vegetable Origin- Linen

Linen derives from the dried trunk of the plant *Linum Usitatissimum*.

Its main composition is cellulose, but the conformation of its fibres gives it enough tenacity. It is a rigid fibre with a wrinkle appearance.

Also this fibre keeps the characteristic of giving the sensation of a fresh garment.



# Natural fibres – Vegetable origin- Hemp and Jute

Hemp derives from the trunk of the plant *Cannabis sativa*



Jute derives from plants of *Corchorus* genus.

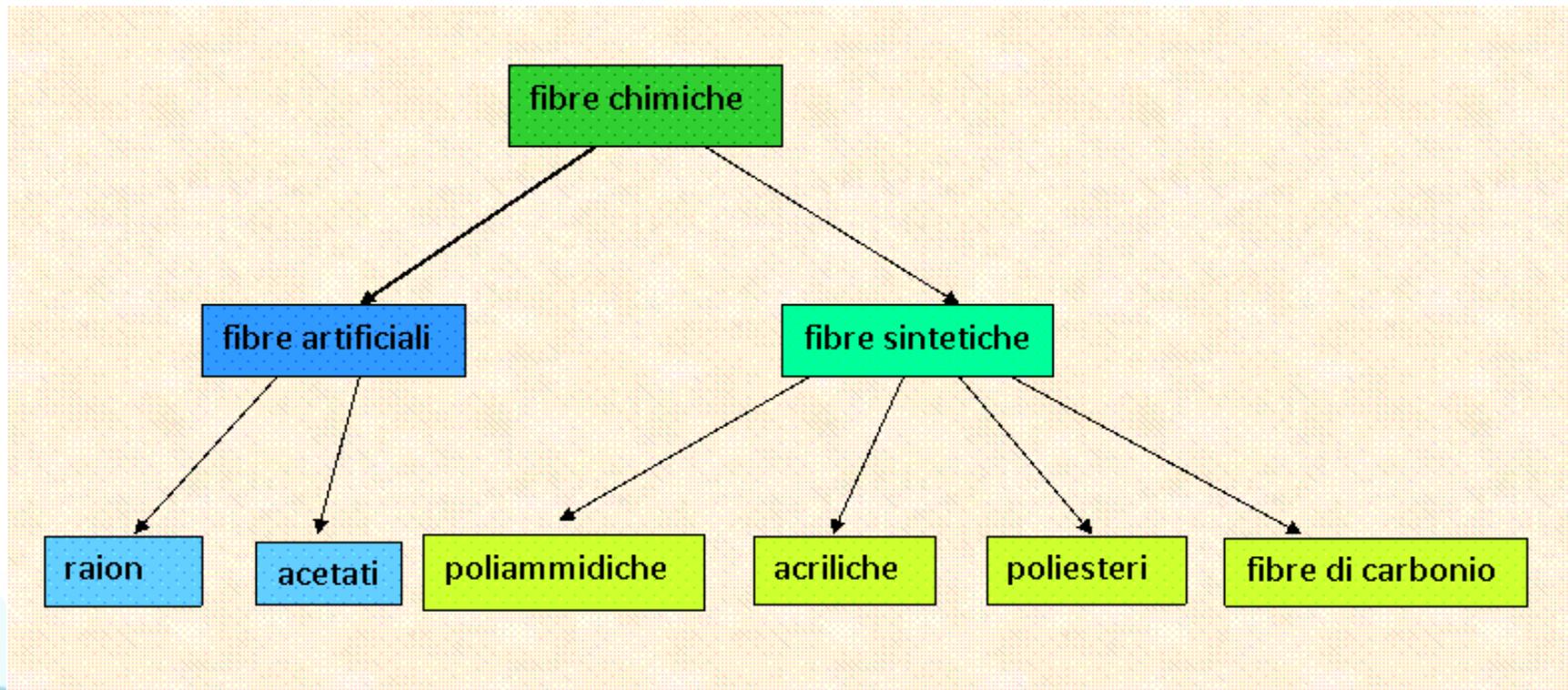


They are two very similar fibres for both resistance and use. The main difference is that jute plant doesn't produce alkaloids. Jute, after cotton, is the most used fibre.

# SYNTHETIC FIBRES

Synthetic fibres, also called chemical fibres, are the ones realised by man.  
We can divide them in 2 sub-classes:

- Man-made fibres: they are the ones in which cellulose is treated and modified by a re-agent
- Synthetic fibres: they are the ones obtained by synthesis molecules, generally obtained by oil derivatives



# SYNTHETIC FIBRES

This kind of fibres has some ameliorative features in comparison to natural fibres :

- Resistance to tear
- Thermal capacity
- Impermeability
- Lightness
- Resistance to fire
- Resistance to biologic agents (moulds, bacteria,etc..)



They have some disadvantages:

- They are not biodegradable
- Sometimes they cause allergies
- Some fibres burn quickly in comparison with natural fibres

# Synthetic fibres – Man-made fibres

Synthetic fibres have been produced to guarantee an independent production from the influence of seasonal and environmental conditions.

Indeed these fibres use cellulose derived from plants, such as trees trunks or paper, so they can reduce costs production.

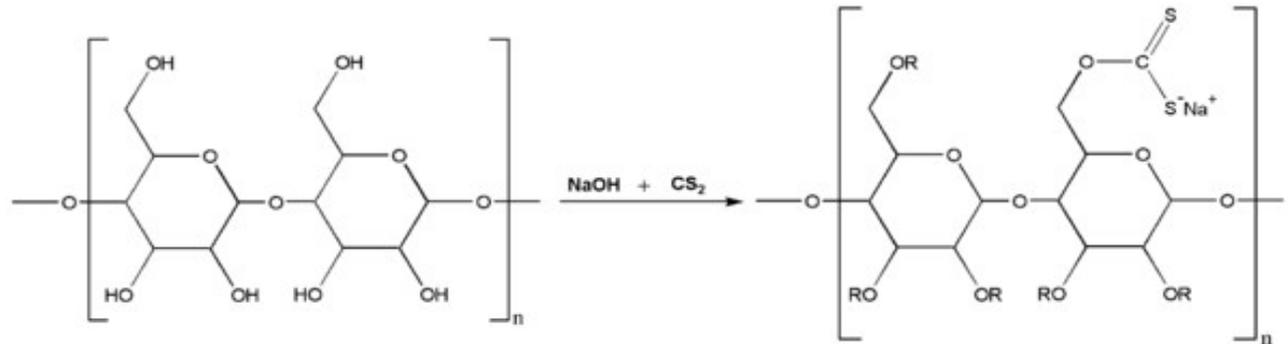
Man-made fibres can be divided in:

- Regenerated Cellulose Fibres → Where cellulose is melt and then trimmed to obtain a fibre with different features (Rayon, Viscose, Cuprammonium rayon)
- Modified cellulose fibres → Where there are chemical interventions to modify cellulose (Acetate, Nitrate etc..)

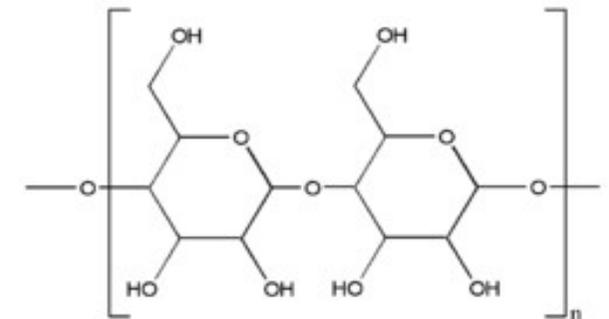
# Synthetic fibres – Man-made fibres- Viscose

Viscose, called also man-made silk, derives from wood pulp of trees treated with NaOH (Potassium hydroxide) and CS<sub>2</sub> (Carbon disulfide).

This modification makes cellulose soft to touch for a higher crystallinity of the fibre.



H<sub>2</sub>SO<sub>4</sub>

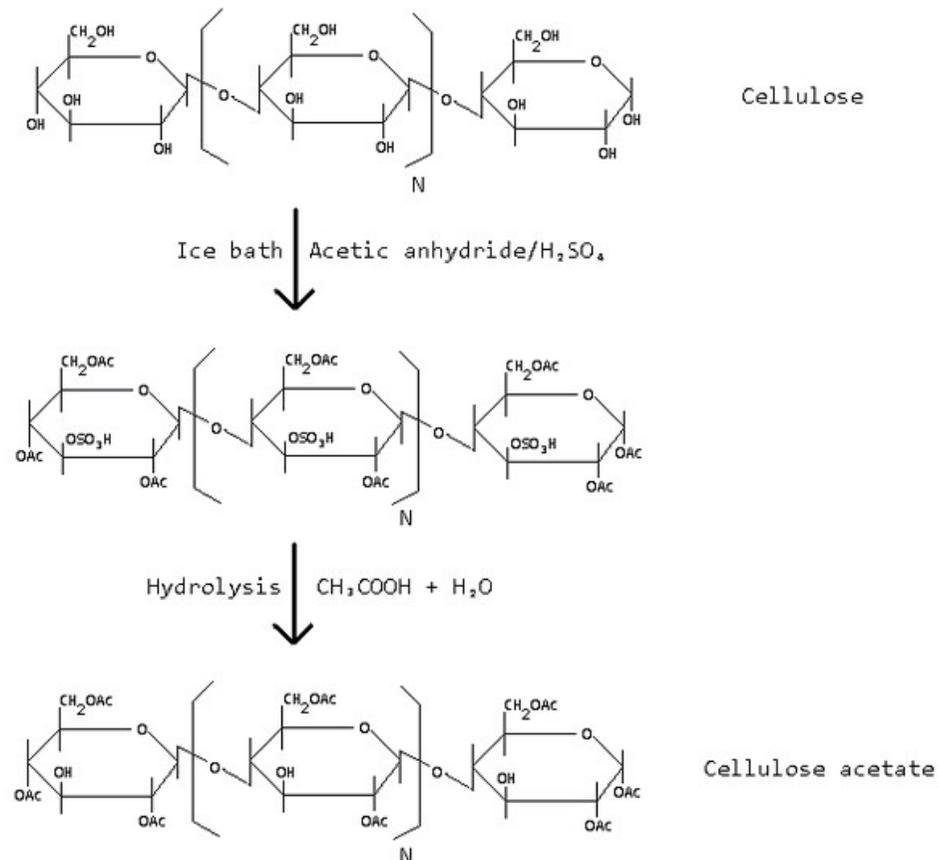


Curiosity:

If we put fibre in nozzles with a bigger diameter and then we put it inside the sulphuric acid again, we can obtain Cellophane.

# Synthetic fibres – Man-made fibres - Acetate

Acetate derives from the reaction between cellulose and Acetic anhydride.



Curiosity:

If we burn this fibre we can smell an odour like vinegar

# Synthetic fibres – Man-made fibres - Acetate

Acetate is a bright and very soft fibre, for this reason it is often used for wedding dresses.

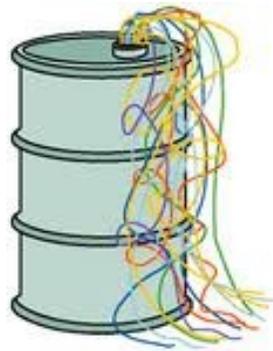


If we wet it, it loses the majority of its tenacity and resistance, so we have to mainly dry clean these garments!!

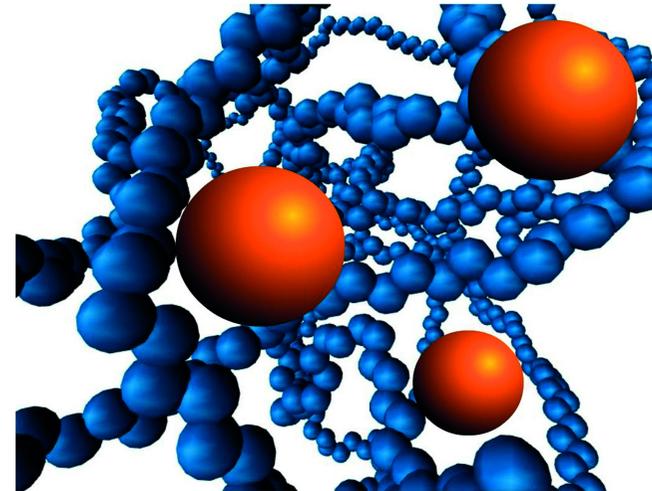
Acetate is very sensitive to heat, so we have to avoid to put garments into dryers with elevated temperatures.

# Synthetic fibres – Man-made fibres

Synthetic fibres are fibres that derive from the process of polymerization of raw materials derived from oil. These polymers can be Homopolymer (composed by an only polymerized molecule) or Copolymer (composed by one or more polymerized molecules among them).

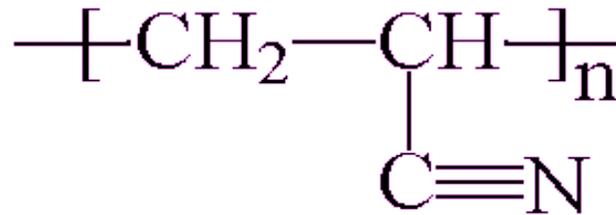


Polymers are macro-structures composed by unities (molecules) repeated billion of times!!

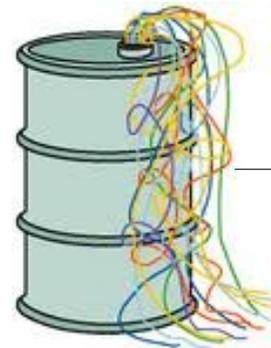


# Synthetic fibres – Man-made fibres- Acrylic

Acrylic derives from polymerization of Acrylonitrile



Acrylic is light, soft and warm, with a similar touch to wool. Its fibres are very resistant in comparison with other synthetic or natural fibres. Some kind of acrylics are used into garments as an alternative cheaper than cashmere.



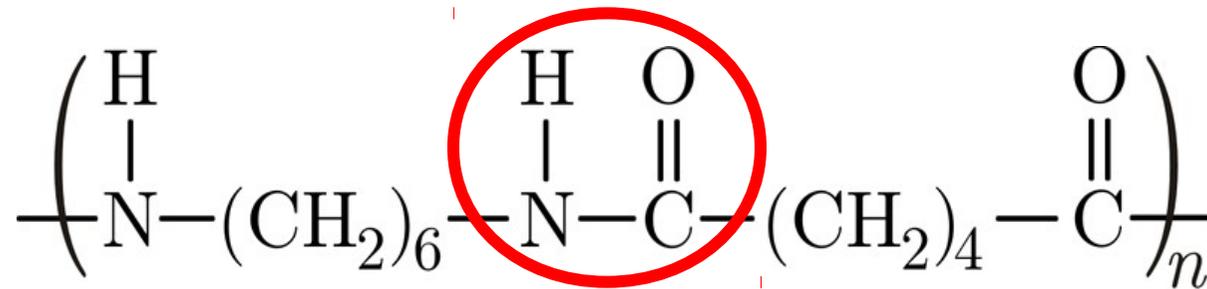
Acrylic is resistant to moths, oils, chemical products, and it is very resistant to deterioration which derives from the exposure to the sun light.



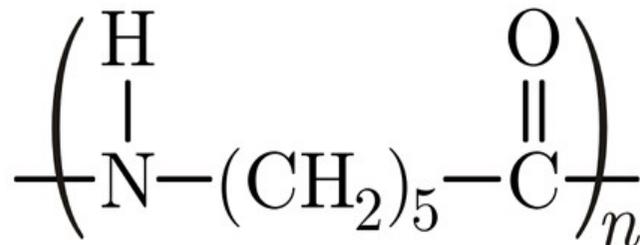
# Synthetic fibres – Man-made fibres - Polyamides

Polyamide fibres are among the most used and with a high technological intrinsic value.

Their name derives from the chemical bond created among molecules that compose it: AMMIDIC bond.



**Nylon 66**



**Nylon 6**

# Synthetic fibres – Man-made fibres - Polyamides

These fibres have different properties according to molecules used. They have some common features with a high technical value:

- Low specific weight
- Resistance to crashes
- Good thermal isolation
- Resistance to solvents, oils, fats and fuels

Among these fibres we can mention three polymers used into textile industry

**Nylon**



**Nomex**



**Kevlar**



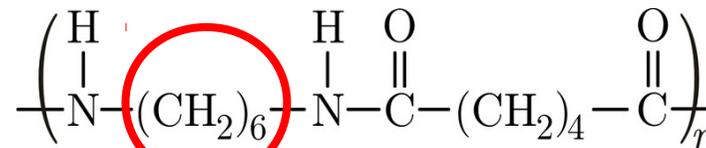
# Synthetic fibres – Man-made fibres - Polyamides

## - Nylon

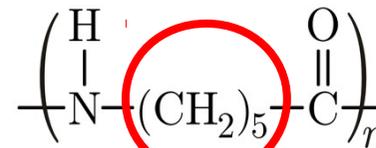
Nylon is one of the most used synthetic fibres all over the world. It has different applications in all fields.



This fibre has different properties according to molecule length (this means according to the number of carbon atoms)



Nylon 66



Nylon 6

# Synthetic fibres – Man-made fibres - Polyamides

## - Nylon

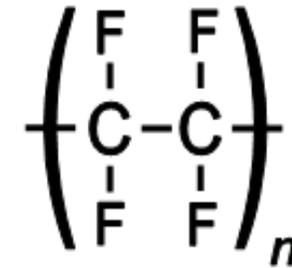
It is very resistant to different solvents and surfactants. One of the weak points of this fibre is represented by the intolerance to strong acids, that hydrolyse fibre, destroying it.

For this reason it is necessary to test some spotting agents generally acids (such as the ones for rust) before using them, in order to avoid problems of fibre degradation.

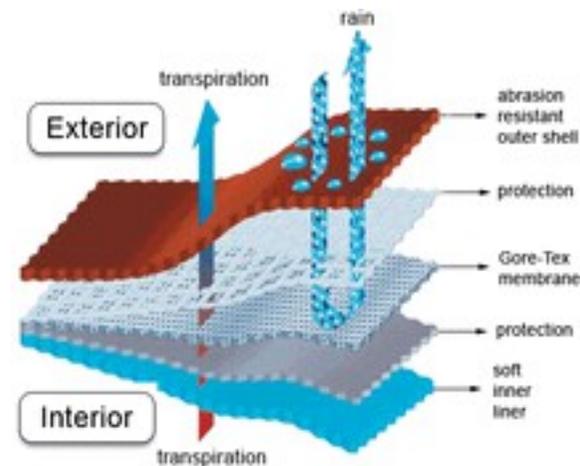


# Synthetic fibres – Man-made fibres- PTFE

PTFE fibre is a fluoro-fibre with a high water proofing power and resistant to external agents and chemicals.



This fibre is used for the creation of GORE-TEX garment. An expensive, but very performing, technical garment.



# Conclusion

Thanks to the combined use of artificial and synthetic fibres we can have many different kinds of garments. Everyone with its characteristics and peculiarity in maintenance.



It is always better to read the garment label and follow producer advice who knows the treatments done.

**THANK YOU**

LOGO