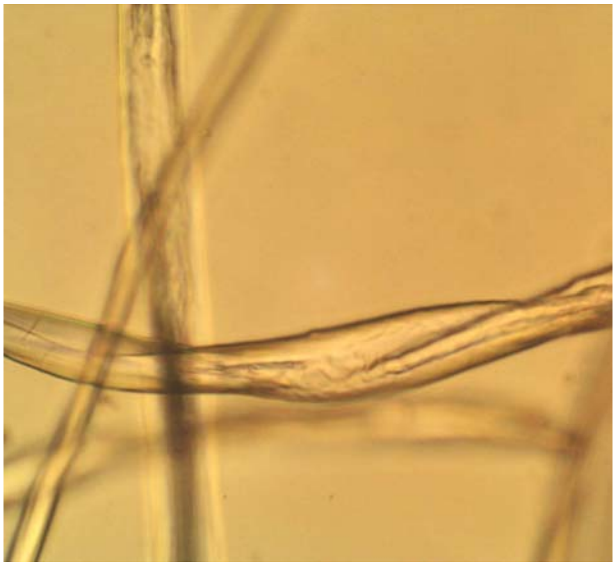
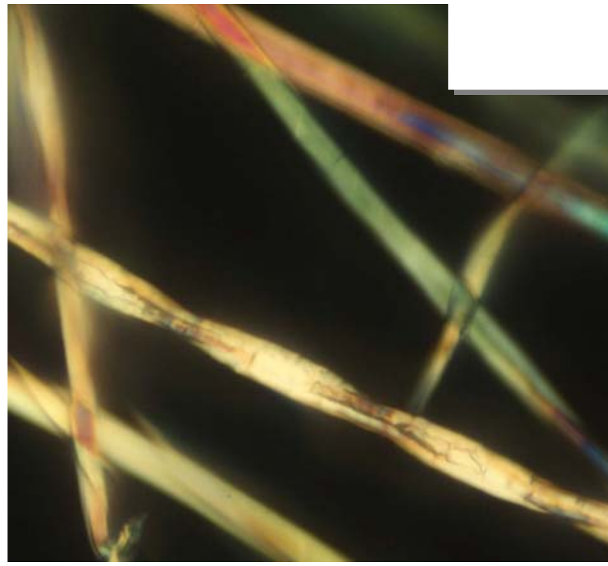
Cotton

Chemical Formula The seed hair of the plant *Gossypium,* Family:*Malvacae*



Microscopic appearance of Egyptian cotton at x500



Microscopic appearance of mercerized cotton at x500

Dates of Use
Prehistoric to today for cloth in both Europe and the Orient.
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Summary of Manufacture
Picked soon after ripening, the seeds are then separated from the fibers (ginning). The short fibers or 'nep' are left on the seed and removed in the second ginning producing cotton linters. Lint to seed cotton varies from 33 to 40%.

Brief History of Usage
Like wool and linen, cotton was made into clothing in prehistoric times and has been used for thousands of years as a fabric in the orient. The plant grows in tropical and sub-tropical regions such as India, Egypt, Russia and Brazil but most of the worlds supply today comes from America. The finest quality cotton is produced today in Egypt and from the islands off the south east coast of the USA.
Despite its long history it does not seem to have been commonly used as a support for easel painting until it was commercially produced in the 20th Century. The canvas is less expensive than linen but more mechanical in its weave and the strength of the fiber is considered to be weaker than linen.

Surface Morphology / Microscopic Description
Fiber length varies from 2 to 5.6 cm and the diameter from 0.0163 to 0.0215mm.
Fibers are smooth and ribbon-like with twists along the length. Mercerized cotton has few twists, however sue to chemical processing, making identification more difficult.
The walls are thick and the lumen in the central canal is broad making the fiber appear like a collapsed, twisted tube.

Aging Characteristics
The paper produced can vary in colour from a white if bleaching agents have been added to the pulp to a yellow/ brown if little or no chemicals have been added in paper manufacture.
Cotton itself is over 90% cellulose.
Fiber preparation usually involves a long cooking process with the addition of lye. Lye itself is ……..
Cotton is very reactive with acids and moderately strong oxidising agents but relatively unaffected by alkali hypochlorites.

Technical Examination Techniques/ Chemical Staining Tests
The herzberg staining test turns cotton fibers red/brown.

Chemical Woodpulp

$(C_6H_{10}O_5)_n$
Goss

Microscopic appearance of coniferous wood at x500

Microscopic appearance of non-coniferous wood.

Dates of Use
Developed soon after the mechanical process in the late 1700s whereby chemicals were used to assist in the breakdown of wood's tough fibers.

Summary of Manufacture
The wood requires initial mechanical action in order to break down the fibers. Alkalis or acids are then added to the water during cooking which decomposes the mass. The mixture can then be left to allow the chemicals to putrefy the mass. The most commonly used processes are that of soda pulp, sulphate and sulphite pulp. Caustic soda is added to the cooking pulp in the sulphate process.

Brief History of Usage
The process of adding chemicals to assist in the breakdown of wood fibres was developed soon after mechanical methods. The two processes are commonly used together and the addition of chemicals to the vat usually follows initial mechanical action. More mechanical action than chemical produces shorter, weaker fibres and therefore a weaker paper. However a higher chemical usage reduces the content of shorter fibers but leaves more chemicals in the paper.

Surface Morphology / Microscopic Description
Chemical pulps are cleaner in appearance to mechanical pulps and have a slightly higher strength. Blunt and chopped edges can, however still be seen depending upon the amount of mechanical action used to initially break down the fibers. Often wood varieties were mixed and esparto grass added to increase paper strength. Soda pulp is made from deciduous or broad- leafed trees such as poplar. As high as a 70% yield of cellulose can be produced. Sulphite and sulphate pulp separates the pure cellulose from the impurities in coniferous woods such as pine and spruce. The process produces a stronger paper particularly as the paper is usually left unbleached but as a result the colour quality is poor.

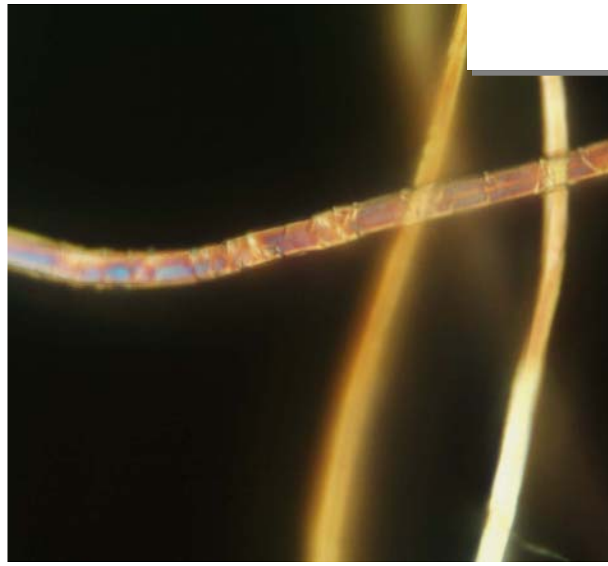
Aging Characteristics
This is dependent upon the chemicals used and coatings, fillers and sizes added. Chemicals from the process are always left in the paper. Acidic chemicals accelerate the breakdown of cellulose and additives intended to aid paper strength may be reactive. Alkaline processes such as the sulphate one however results in a more stable and stronger paper than other processes and mechanically produced pulps.

Technical Examination Techniques/ Chemical Staining Tests
Despite its lesser content in comparison to mechanical pulps, lignin can be detected with the phloroglucinol test. Fibers will become red with the herzberg stain. Note however that cotton, linen, ramie, hemp, manila and paper mulberry fibers will also turn a shade of red. The 'sellengers' stain will turn **sulphite** treated woodpulp red.

Esparto

Chemical Formula
Esparto grass, Stipa tenacissima

Microscopic appearance at x500 mag



Microscopic appearance under slightly crossed polars

Dates of Use
Since Ancient times to the present day as a fiber for ropes and mats etc and not commonly, paper.

Summary of Manufacture
A spear grass plant with long leaves. The stems and leaves are cut into smaller pieces and soaked in clean water for at least a day prior to cooking. The fibers are very strong and are separated by a process of boiling with caustic soda.

Brief History of Usage
Used particularly in England in the manufacture of paper more prolifically when paper makers were finding rags in short supply and other possible fibers were being tested and added to supplement the pulp prior to the invention of wood-pulp paper. Use of esparto was has a longer history of use for papermaking in the Mediterranean where it had already been used for centuries in the manufacture of ropes, mats and sails. Stipa comata is a variety of esparto growing in the USA where it is used in the Western States for cattle forage.

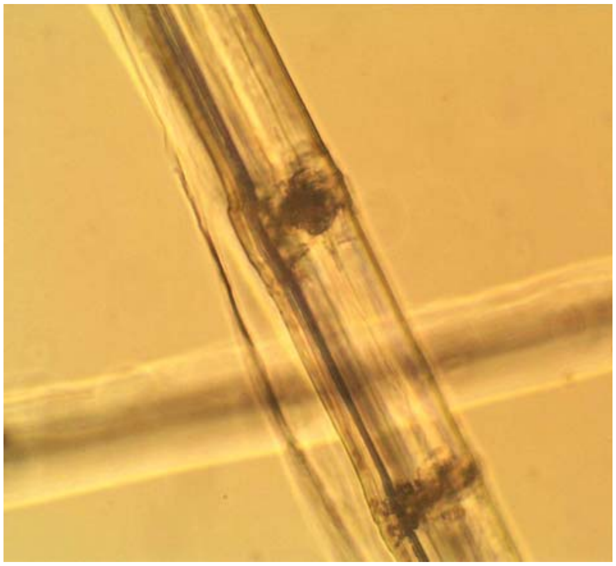
Surface Morphology / Microscopic Description
Fibers are very strong and flexible.

Aging Characteristics

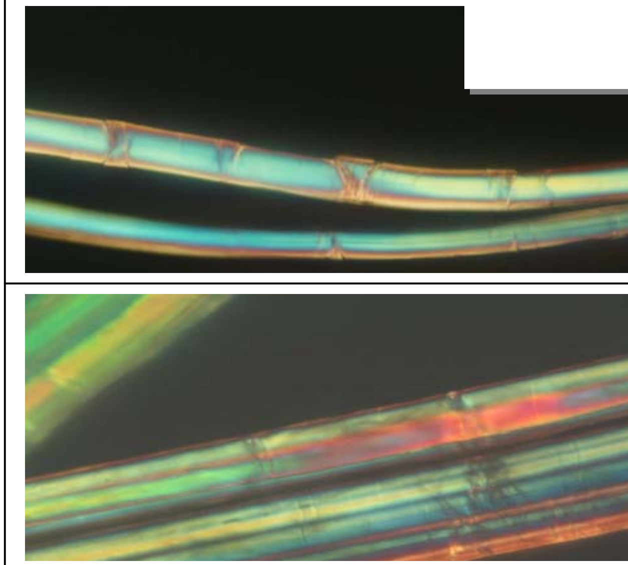
Technical Examination Techniques/ Chemical Staining Tests
Turns green/ yellow with the Hertzberg stain.

Linen

Chemical Formula
Flax, *Lium Usitatissimum*



Microscopic appearance of flax at x500 mag



Microscopic appearance crossed polars (Irish linen –

Dates of Use
Prehistoric times tot he present day.

Summary of Manufacture
Plant family *Linacea*
The stems from the perennial weed or annual herb are harvested from the plant.
Fibers are harvested in the summer of autumn when the stems are turning yellow.
The fibers (length approx 33mm) are obtained from the green bark which undergoes rotting, retting, cleaning and bleaching. Each flax plant yields about 8% linen fibers. The fibers are tough and can be bleached or dyed more easily than cotton.

Brief History of Usage
Prehistoric remains of linen have been found across Europe and in the wrappings of many Egyptian mummies fine weaves have been discovered. Scotland, Ireland and Belgium produce some of the finest linens today and Russia the largest amount of flax. Linen cloth for clothes was largely abandoned in favour of commercially produced cotton in the 20th Century but it has always been used as the most common support for easel painting. Today flax is grown widely across the world and various species exist, prolifically throughout the USA.

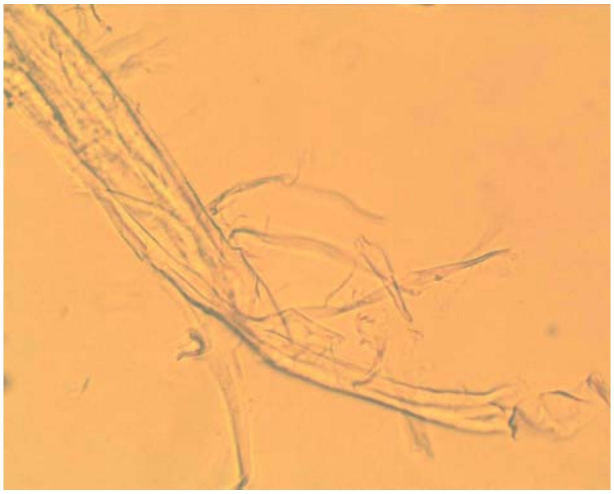
Surface Morphology / Microscopic Description
Fibers are 6 to 60mm long and 0.012 to 0.026mm wide.
The cellulose content is between 70 to 80% cellulose.
Linen can be distinguished from cotton fibers by cross-markings, twists and in particular joints across the width of the fiber and striation markings along the length between the joints.
The stem hollow is filled with pith but in older plants it breaks down so stems become empty.

Aging Characteristics
Linen can range in colour from a white to a grey or a light brown and even white if it has been bleached.
The aging of the material is largely due to the additives within it following the manufacturing process. Bleaching agents, for instance, added to make the material white are inherently acidic causing acidity within the fibers themselves, loss of strength and brown/ buff discolouration.

Technical Examination Techniques/ Chemical Staining Tests

Mechanical Woodpulp

$(C_6H_{10}O_5)_n$



Microscopic appearance of coniferous wood at x500

Microscopic appearance of non-coniferous wood

Dates of Use
1780s to present day

Summary of Manufacture
Produced by the mechanical action on wood in the presence of water. Pulp is produced by cutting wood logs into shorter lengths which are then ground, most commonly against a rotating abrasive stone in the presence of freely floating water. The paper produced has limited strength in comparison to handmade papers because of impurities left in the pulp particularly lignin. Ground-wood pulps contribute absorbency, bulk and opacity and are lower in cost than chemical wood pulp.

Brief History of Usage
In the late 1700s (80s-90s) a French scientist investigated the use of other materials to solve the increasing demand for paper. His use of wood to make pulp stemmed from experiments with the woody pulp produced and used by wasps to make their nests. The process is inexpensive and speedily produces cheap, satisfactory paper used for newsprint, wallpapers and wrapping papers.

Surface Morphology / Microscopic Description
Short, thick fibers with broken, choppy ends.
Signs of mechanical damage should be fairly apparent.
Packing vessels (parenchinal) may be seen.
The fibers tend to break rather than fibrilate and as a result tend to have broken straight edges.
Paper has a high lignin low cellulose content and impurities such as dirt and metal particles can often be seen.
Fillers and sizing agents are often added to aid strength.

Aging Characteristics
The high lignin content accelerates the aging of the paper through acidity.
Some fillers, coatings and sizing agents such as alum rosin can also contribute acids to the deterioration process.

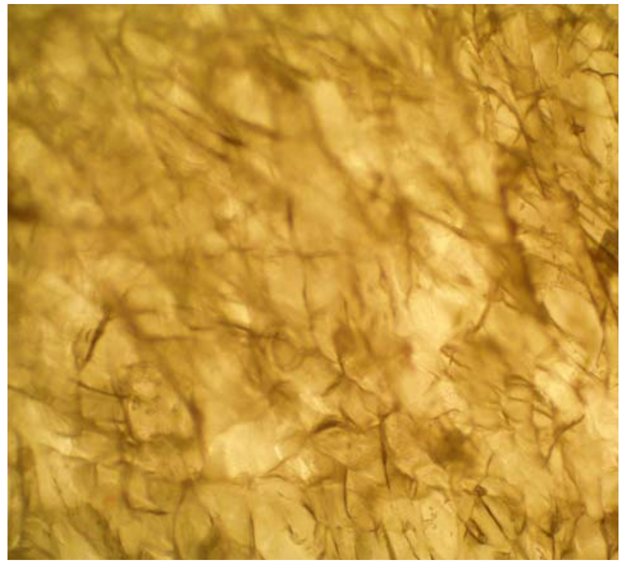
Technical Examination Techniques/ Chemical Staining Tests
Phloroglucinol test for lignin as the pulp contains more of the latter with very little cellulose.
Should become yellow with the herzberg stain. Note however that straw, grass of jute fibers that have undergone little or no chemical treatment will also turn yellow.

Vellum

Chemical Formula

Usually used to term ***calfskin or skins from the aborted feotus.***

Microscopic appearance at x500 mag



Microscopic appearance x100mag

Dates of Use

Used since ancient times along with parchment (general skins from the hides of animals). Used as a support in medieval times particularly for the production of monastic writings, illuminations and choir books etc as other hides were not large enough.

Summary of Manufacture

The carcass of the calf is skinned and de-haired. The flesh side is then scraped down to remove fat and the hide stretched on a frame. The skin is repeatedly washed, often with lime and scraped to remove grease. Followed by drying under tension and the surface smoothed with pumice or burnishing tool.

Brief History of Usage

Vellum is and was a higher quality parchment with a smoother velvety surface, making it preferable for illuminated manuscripts although it was as a result more expensive. Vellum made from the feotus of an aborted calf was favoured by portrait miniature painters in the 16th and 17th Centuries because of its superior fine quality. Its manufacture was largely abandoned as paper production increased. Along with general parchments it is still used in bookbinding, but the skills used to produce fine quality skins have largely been lost.

Surface Morphology / Microscopic Description

Velvety smooth texture.

A network of tensioned protein fiber (collagen) in a matrix of binding mucous (muco-polysaccharide) with a high water binding capacity. The tightness of the fibre network varies from hide to hide and animal but generally the mesh is tighter and finer in comparison to parchment skins. Vellum skins often have finer , less detecible hair foliccles with the skins made from aborted feoutus's with litlle evidence of hair growth. Sometimes skins were coated with an animal or fish size and some with a glaze of egg white.

Aging Characteristics

Oils spots and stains can often be seen arising to the surface over time through the skin. Bad curing of the skin as it was prepared also results in spots or blotches forming from the salts used in putrification.

All skins are extremely sensitive to humidity. They are hydroscopic the extent of which depends upon their age. Skins absorb and desorb water in sympathy with their changing environment. Prolonged exposure can result in breakdown of the fibrous mass; whereas too dry an atmosphere shrinks the material leaving its surface character dry, cockled and hard.

Technical Examination Techniques/ Chemical Staining Tests

Extremely sensitive to humidity changes.