Surgical dressings

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Surgical dressings & sutures

• Composed of fibres
  – A solid characterized by
    • Flexibility
    • Fineness
    • High ratio of length: thickness
      – length at least 1000 times their breadth

• Important to:
  – Forensic science
  – Pharmacy
    • For quality control
    • To determine price v quality for bulk purchasing

• Identification
  – Macroscopical examination
  – Chemical tests
    • Performed on a microscope slide
    • Observed under the microscope
Classification of fibres used in surgical dressings

- Dressings
  - Natural
    - Animal
      - Protein
        - wool
        - silk
    - Vegetable
    - Cellulose
      - cotton
      - chemical wood pulp
  - Man-made
    - Regenerated
    - Cellulose
      - viscose rayon
    - Synthetic
      - Polyamide
        - nylon
      - Polyester
        - terylene
Animal fibres

• WOOL
  – From the fleece of the sheep *Ovis aries*
    • Treated before use to degrease it
      – Washed with water, then soap solution, then bleached with sulphuric acid, (acetone removes wool fat), combed, graded
  – Made of
    • protein (keratin) [flame tested by burning]
      – Stretched (unstable) form $\beta$ keratin
        » Elastic when let go
      – Unstretched (stable) form $\alpha$ keratin
        » Forms peptide links in chain strands
      – Also contains cysteine in sulphur bridges which give elasticity
        » [test for sulphur]
- **Made of**
  - 2 silk or fibroin fibres
  - cemented together with silk glue / sericin
  - Sericin removed by hot soap solution
  - fully extended chains of alanine and glycine
  - Non-elastic, don’t double up like wool
  - Contain no sulphur [negative sulphur test]

- **Uses**
  - Dressings a bit
    - eg Oil Silk BPC in surgery
    - to stop other dressings drying out, cover them
  - Sutures, ligatures
    - Non-absorbable
    - Quite strong
    - Do not disintegrate when wet

- **Microscopically**
  - A solid rod-like fibre
  - Lack of cellular structure
  - No distinguishing features
Animal fibres - different microscopically, differentiated by following chemical tests:

<table>
<thead>
<tr>
<th>Test</th>
<th>Wool</th>
<th>Silk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burn in flame</td>
<td>Smell of &quot;burnt hair&quot;</td>
<td>Smell of &quot;burnt hair&quot;</td>
</tr>
<tr>
<td>Millon's reagent. Immerse in a hot soln. for 2 mins.</td>
<td>Red to pink colour</td>
<td>Red to pink colour</td>
</tr>
<tr>
<td>Picric Acid. Immerse for 5 mins in a hot saturated aqueous soln. Wash well with water.</td>
<td>Stained yellow</td>
<td>Stained yellow</td>
</tr>
<tr>
<td>Warm 5% KOH</td>
<td>Soluble</td>
<td>Insoluble</td>
</tr>
<tr>
<td>Conc. HCl</td>
<td>Insoluble</td>
<td>Soluble</td>
</tr>
<tr>
<td>CuOxam</td>
<td>Stains blue</td>
<td>Soluble</td>
</tr>
<tr>
<td>Sulphoprotein test. Dissolve in warm 20% NaOH, and add a few drops 10% lead acetate solution.</td>
<td>Black precipitate of lead sulphide</td>
<td>No precipitate</td>
</tr>
</tbody>
</table>
Vegetable fibres

• COTTON
  • Cheap and used a lot
  • USA produces about half; rest Egypt, India, South America

  – Source
    • epidermal trichomes covering seeds of *Gossypium herbaceum*
      – Ginning – removes long hairs (better quality)
      – Linter – removes remaining short hairs
        » Gives poorer quality cotton (→ cotton wool)
        » Made into chemical pulp or viscose rayon
      – Then seeds are pressed to get cotton seed oil
      – Then seeds used as animal crop
- **Production**
  - Raw cotton has a waxy (fatty) cuticle covering the trichome
    - Making it fairly non-absorbent
    - Removed by soaking (or pressure heating) loosened cotton in alkali (NaOH, KOH)
    - To get absorbent cotton (trichome wall is absorbent)
    - Then washed, bleached and mechanically loosened ‘scutched’

- **Grades**
  - Raw cotton
    - very impure, only used to absorb spillages
  - Hospital quality absorbent cotton wool
    - poorer quality to BPC
  - BPC
    - has some impurities
    - almost impossible to remove all as too expensive
    - BPC has limits
      » certain amount of shell & leaf material allowable
      » Want a minimum for surgical procedures
      » (rarely used in the body cavity or wrapped in gauze first to prevent loose fibres going into the body)
- Made of
  - Primary and secondary cellulose cell walls
    - Secondary wall constitutes the main bulk of cotton
    - Raw cotton consists of 90% cellulose
  - Cellulose molecule made of glucose residues
    - Repeating unit is ‘cellibiose’ = 2 glucose residues linked by a 1-4β glucosidic bond

- Uses
  - Bandages – gauze linen in very absorbent

- Microscopically (of unbleached cotton)
  - Unicellular hairs look like flattened twisted hose pipes
  - [Staining with CuOxam -> ballooning]
• CHEMICAL WOOD PULP (WOOD)

– Derived from pine and spruce wood ‘off cuts’

– Production
  • ‘Delignified wood’ produced by “Sulphite process” to leave the cellulose
    – Wood chopped into chips – allows penetration
    – Calcium bisulphite and H₂SO₄ added to hydrolyse any material other than cellulose
    – Then washed, bleached, rolled, pressed into board and dried

– Composed of cellibiose

– Uses
  • Cellulose wadding BPC
    – Easily disintegrated
      » no intrinsic structure so falls apart when wet
      » not used for dressings
    – but to catch and absorb spillage of wounds, heavy discharge and incontinence

– Microscopically
  • Looks like tracheids with border pits [distinguishes it from cotton]
• JUTE
  • Phloem fibres from stem bark
  • *Corchorus capsularis*, *C. olitorius*, other species
  • Bengal delta region, Assam, Bihar, Orissa
  • Fibres separated -> hesian and sacking
  • Remaining short fibres ‘tow’ – jute in pharmacy
  • Lignocellulose; nitric acid, potassium chlorate used to disintegrate bundles

• FLAX
  • Pericyclic fibres of *Linum usitatissimum* stem
  • Commercial fibres show fine tranverse injuries from preparation
  • Good quality fibre only lignified in middle lamella

• HEMP
  • pericyclic fibres of *Cannabis sativa* stem
  • Mostly cellulose, minimal lignification
  • Fibre ends bluntly rounded, some forked from injury
  • Lumen flattened or oval
• **CELLULOSE ACETATE**

  • Largely superseded by synthetic fibres

  – **Production:**
    • Cotton linters and delignified wood pulp -> purified cellulose
      – Partially acetylated by mixing with glacial acetic acid, acetic anhydride and a catalyst
      – Precipitates as acid-resin flakes
      – These are dissolved in acetone
      – Then the solution is filtered and spun down a column of warm air
    • Produces filaments made of 200-300 ‘glucose’ residue units

  – **Properties:**
    – Less absorbent that viscose rayon
      » Unsuitable for surgical dressings
    – Loses less strength when wet
      » Use: component of plastic splinting bandage
    – Like Nylon produces static electricity

  – **Macro/microscopically**
    – Similar to viscose rayon
• **ALGINATE**

*Laminaria hyperborea, other sp, Ascophyllum*

– Alginic acid comes from cell walls of brown algae

– **Production:**
  • Alginate fibres are produced by a similar process to viscose rayon
    – Sodium alginate solution is pumped through a spinneret immersed in a bath of CaCl solution (acidified with HCl)
    – Water insoluble calcium alginate is precipitated as continuous filaments
    – Collected, washed, dried, reduced to staple form which is processed to calcium alginate wool or a fabric Eg gauze

– **Composed of**
  • polymers of mannuronic and guluronic acids

– **Uses**
  • absorbable haemostatic surgical dressings
    – internal – neurosurgery; external – burns, skin graft sites
  • bacterial swabs

– **Microscopy**
  • Similar to viscose rayon (solid grooved rods)
Synthetic fibres

• Polyamides
  – NYLON
    • Condensation polymer
    • Made of adipic acid and hexamethylene diamine
    • Polypeptide chain
    • Like silk structurally
    • Can be autoclaved
    • Very strong material
    • Use: sutures

• Polyesters
  – TERYLENE
    • Condensation polymer resin
    • Made of ethylene glycol and terephthalic acid
    • Can be autoclaved
    • [Distinguished by chemical tests]
    • Use: sutures, (preparation of artificial grafts)