Utilization of Animal and Tannery By-products

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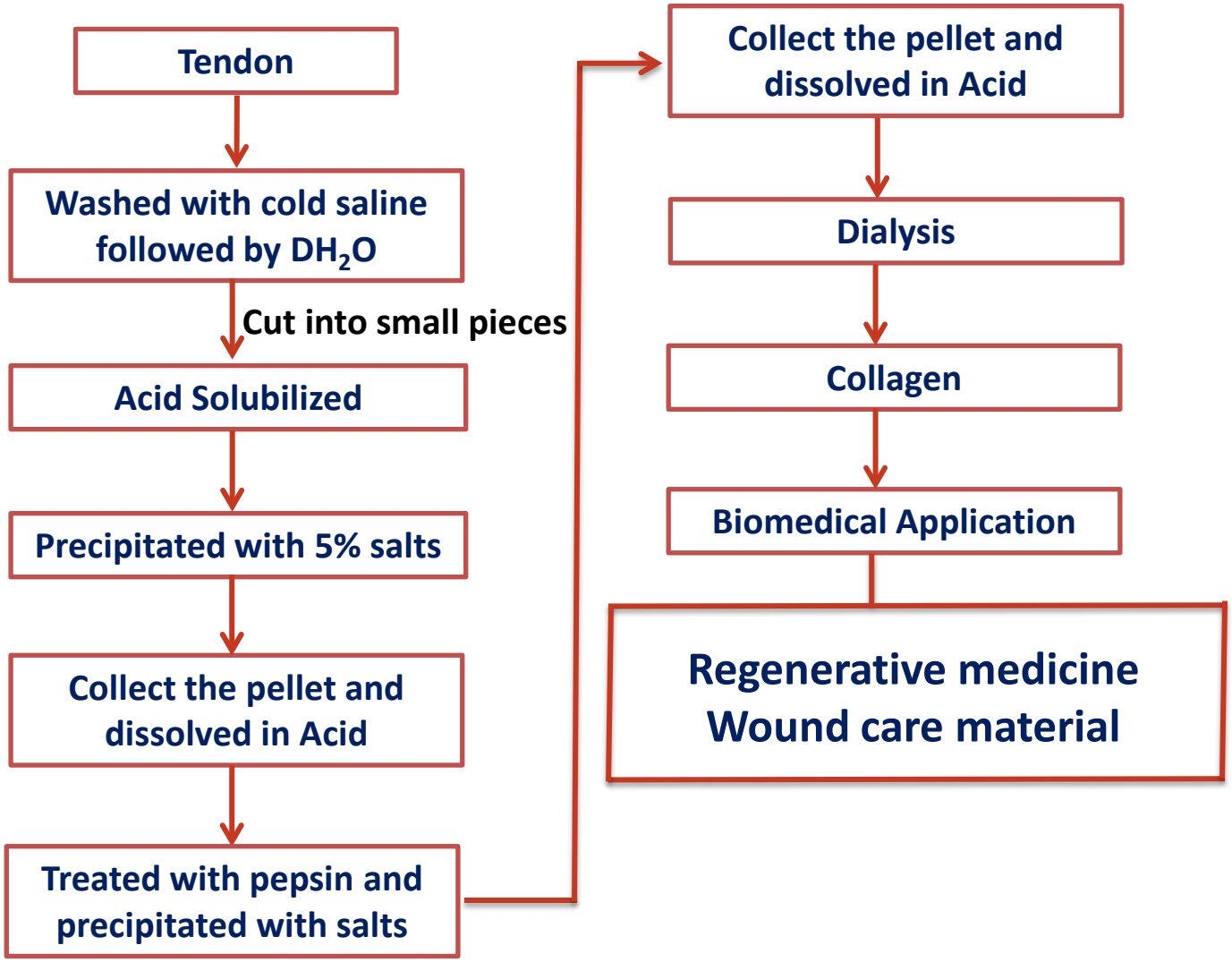
Animal Byproducts

Process of Collagen from Tendon

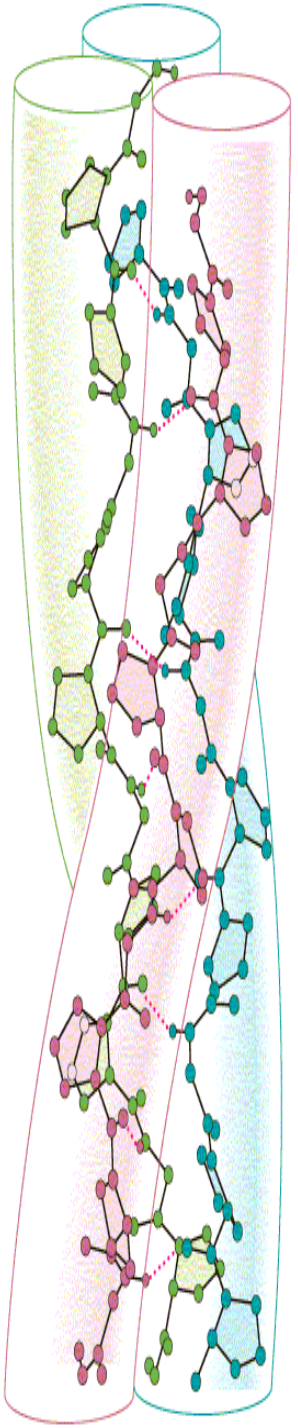


Collagen: Smart Biomaterials

- A natural material of low immunogenicity and is therefore seen by the body as a normal constituent rather than a foreign matter

- Collagen can be processed into a number of forms such as sheets, tubes, sponges, powders, fleeces, injectable solutions and dispersions

- Collagen materials outsmart body's defense mechanism during implant



Collagen in Skin Tissue Engineering

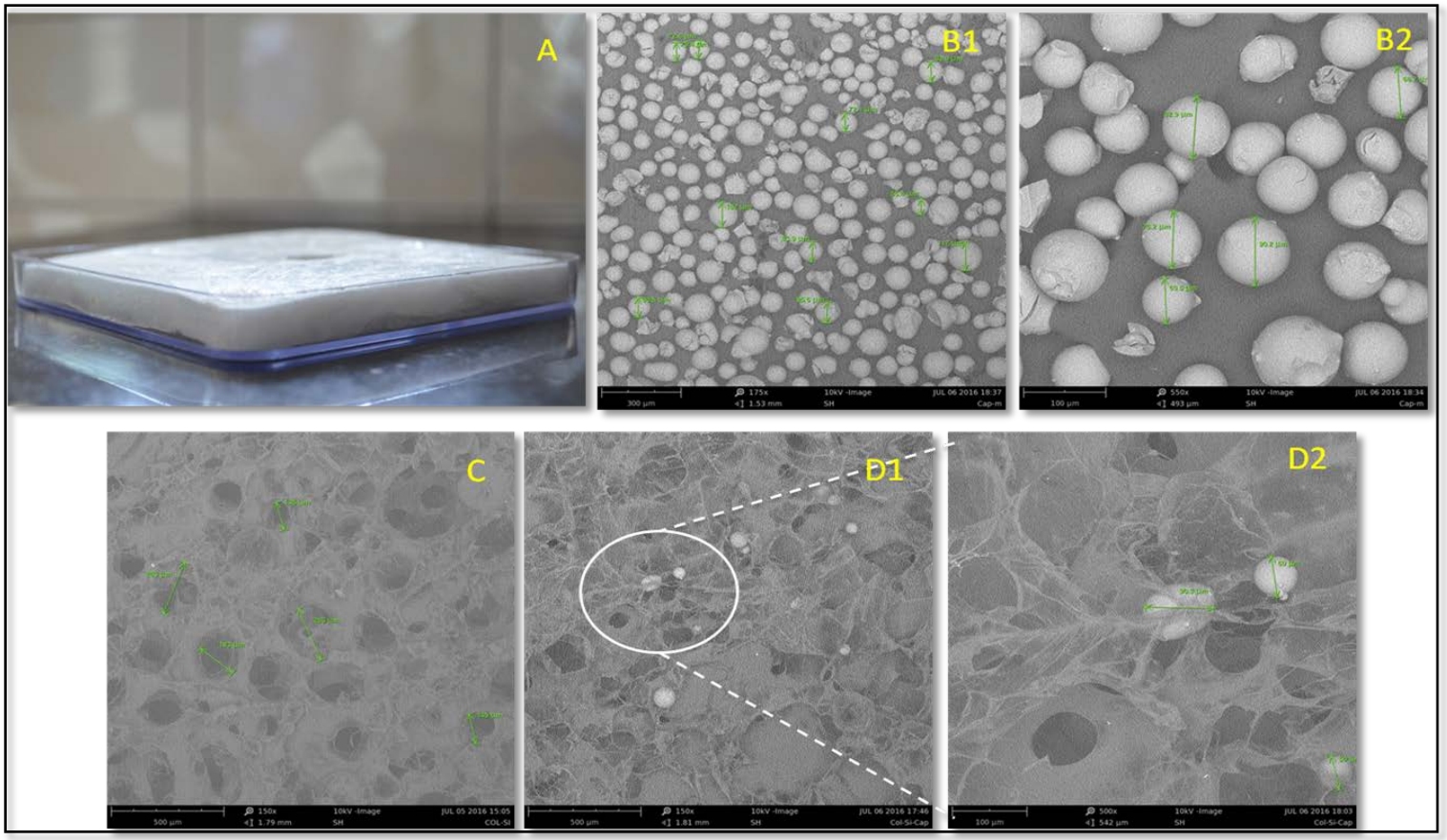
Skin Tissue Engineering = Wound Healing

Collagen is the single most popular material for wound healing applications worldwide.

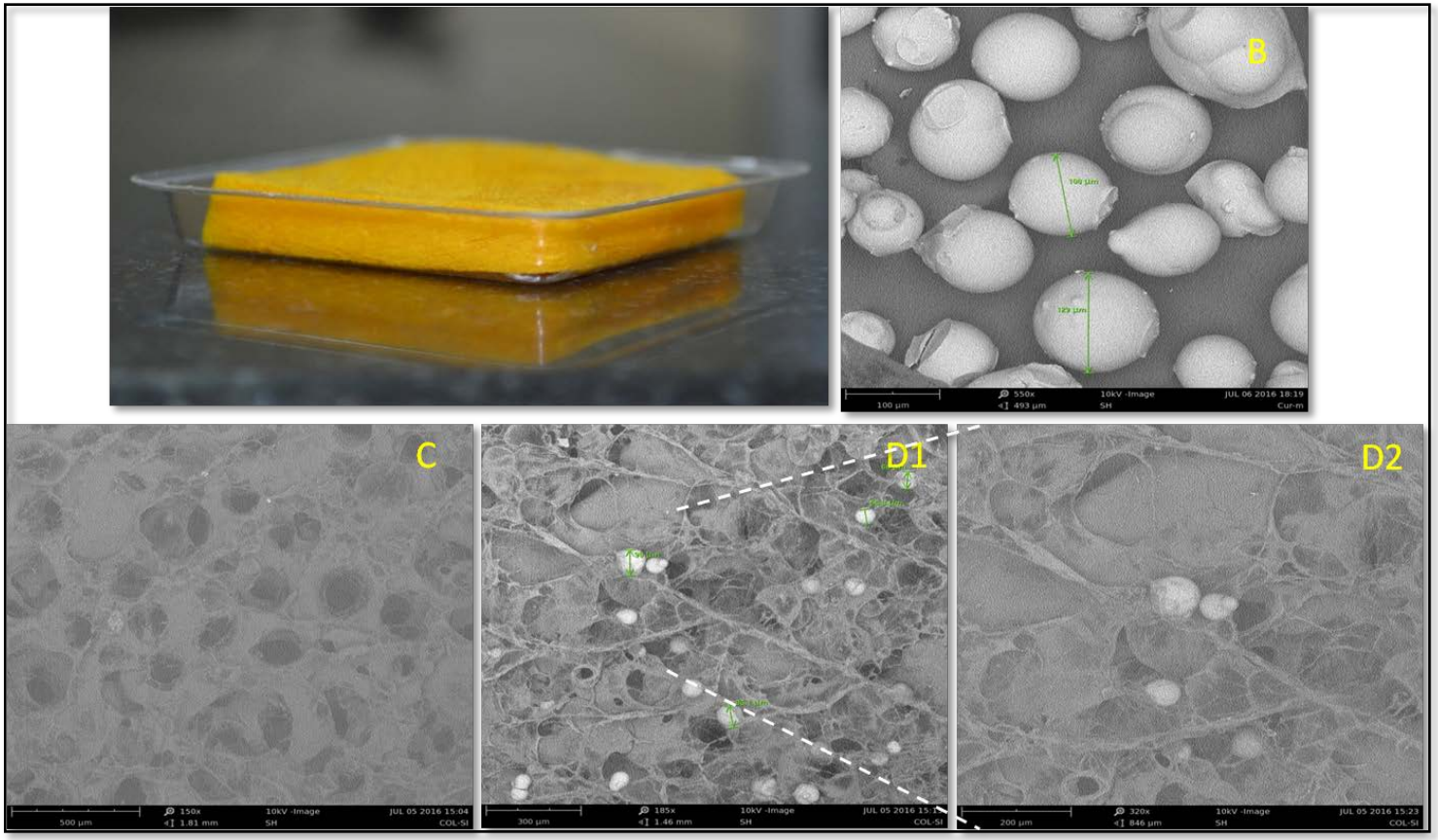
Collagen Sponges Suitable for Chronic Wound Application

- Turnover of the collagen material is an issue for chronic wound applications
- Antibiotics are counterproductive for the cells responsible for matrix restructuring
- Phytochemicals: curcummin, capsacin - natural alternatives
- Composites offer better physical characteristics for the viability and proliferation of cell and tissues

Capsaicin Loaded Collagen Sponge

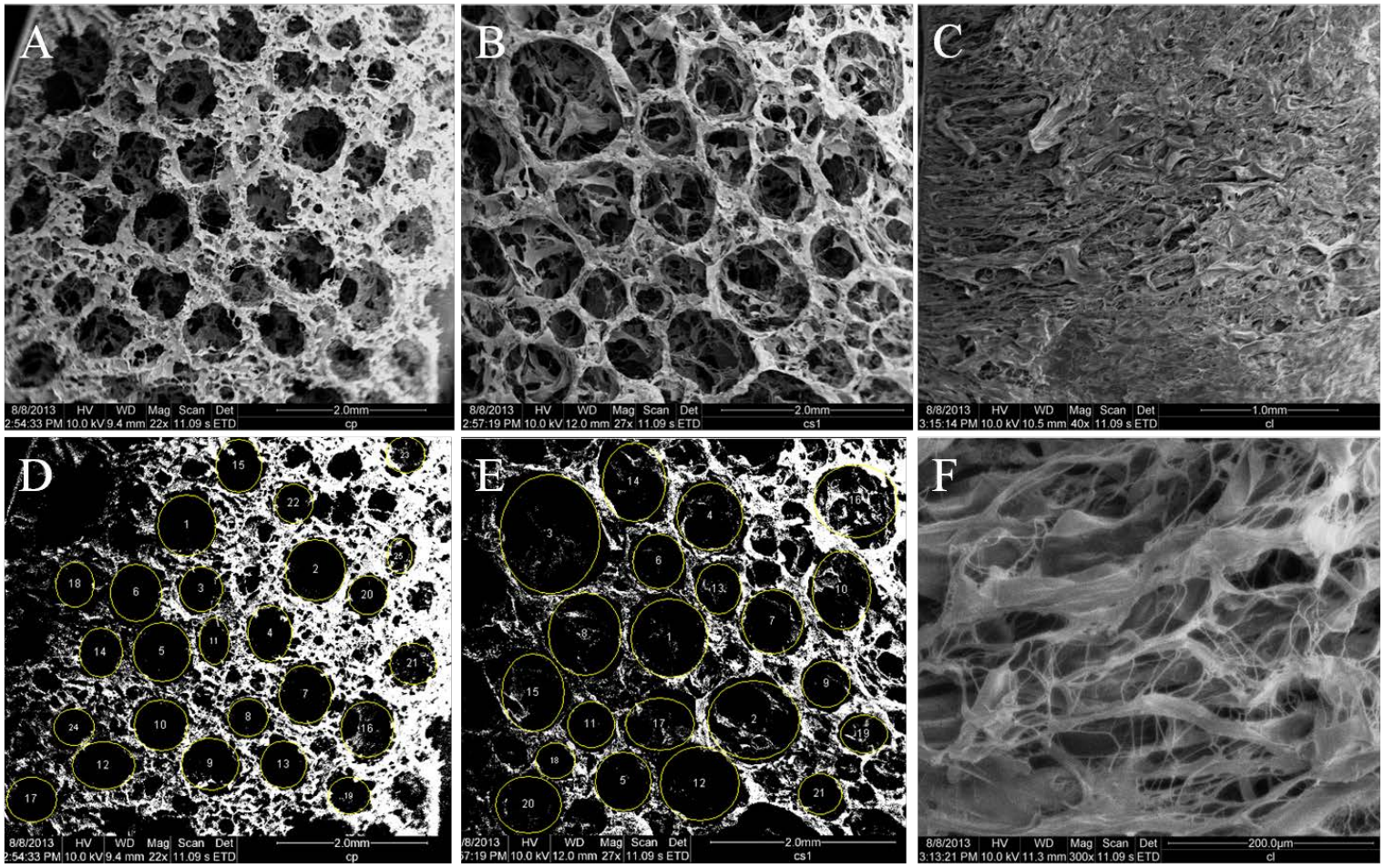


Curcumin Loaded Collagen Sponge

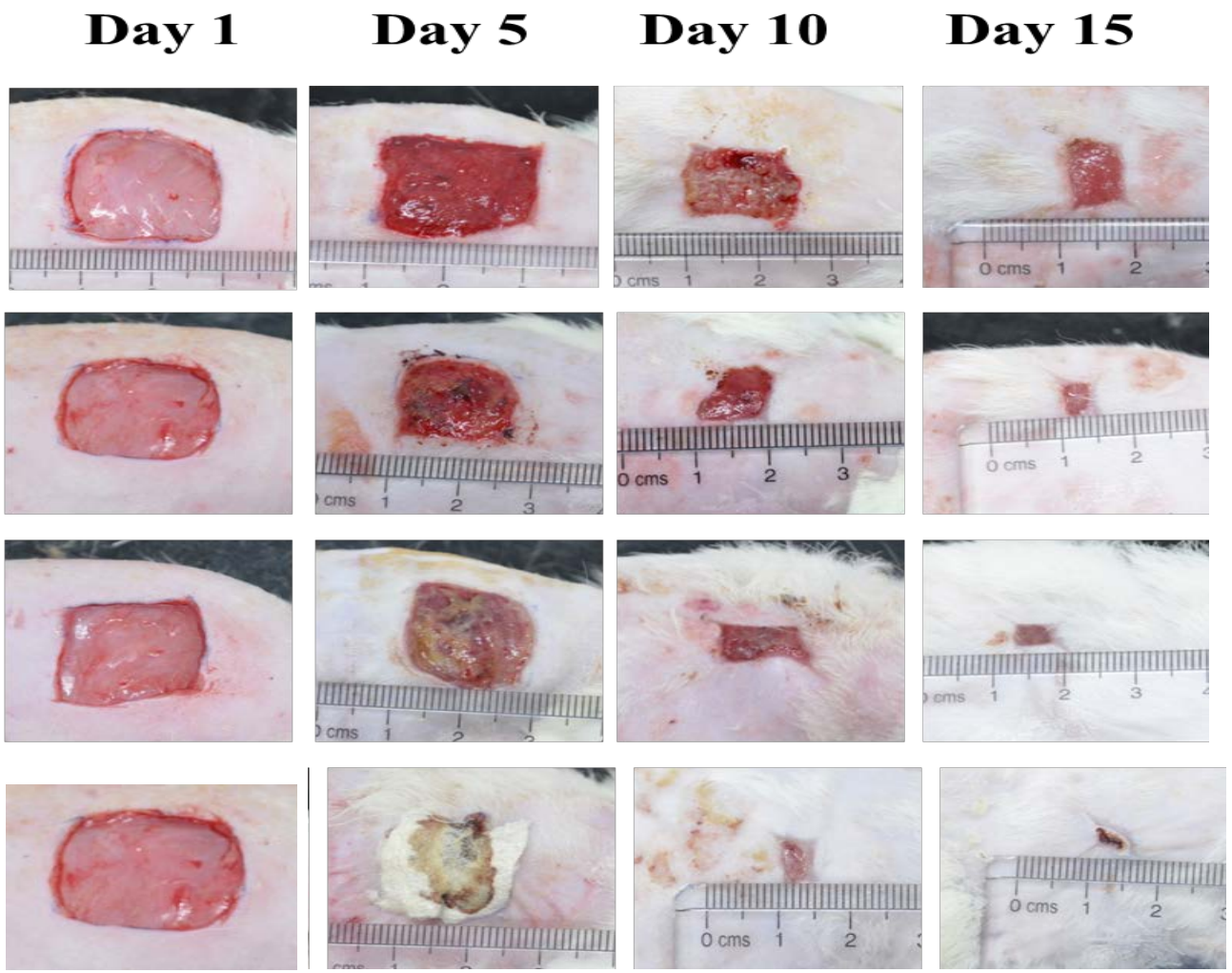


Collagen Composite Scaffold

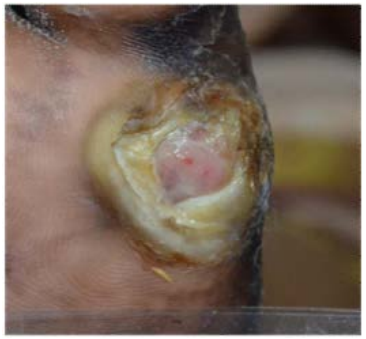
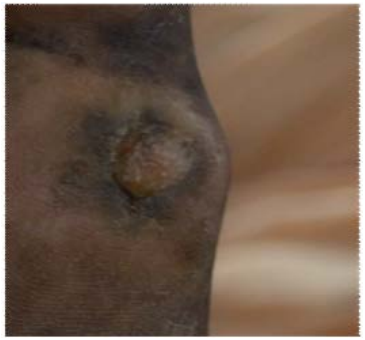
CHCS **Collagen-silica** **Collagen**



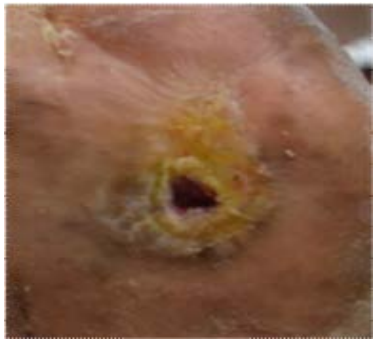
Collagen Composite Scaffold: Innovation from CSIR-CLRI



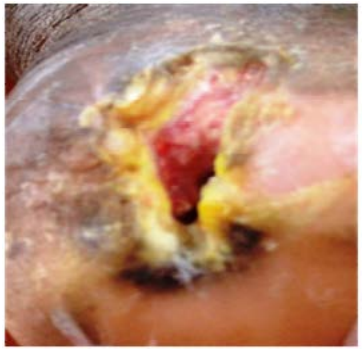
Collagen Composite Scaffold in Treatment of Chronic Wounds of Leprosy Cured but Deformed Personnel

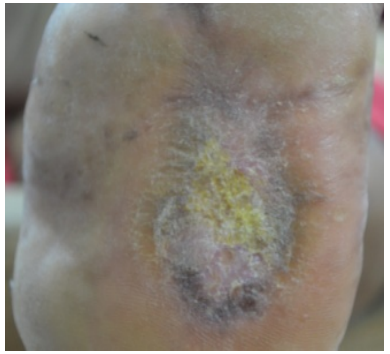
CASE I
Age 60 Ulcer Duration 36 Months
Sex F Treatment Duration 12 week

CASE III
Age 64 Ulcer Duration 84 Months
Sex M Treatment Duration 24 week




CASE II
Age 65 Ulcer Duration 16 Months
Sex M Treatment Duration 8 week

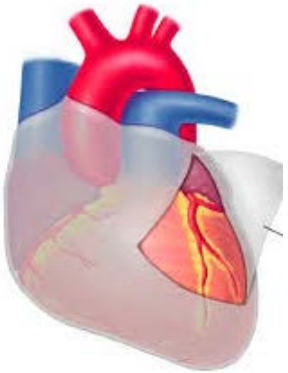



CASE IV
Age 82 Ulcer Duration 60 Month
Sex F Treatment Duration 24 week

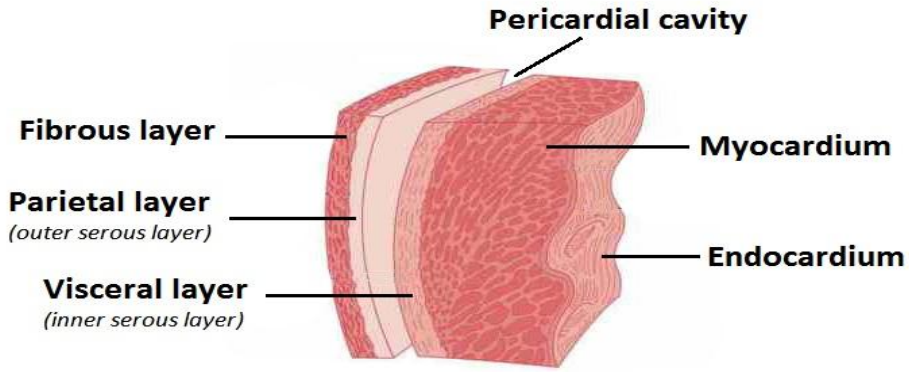
Collagen composite of CLRI: Effective & affordable material

Name of the Product	Company	Indications	Unit Cost
BIOSTEP 	Smith & Nephew Inc, USA	• Diabetic ulcers • Ulcers caused by mixed vascular etiologies • Pressure ulcers (stages I-IV), • Venous ulcers	$ 30
FIBRACOL PLUS 	Systagenix Wound Mngmnt, USA	• Diabetic ulcers • Pressure ulcers • Leg ulcers of multiple aetiologies	$ 11
SEESKIN (Collagen composite)  	**Synerheal (Technology of CSIR-CLRI)**	• All wounds	Rs 300

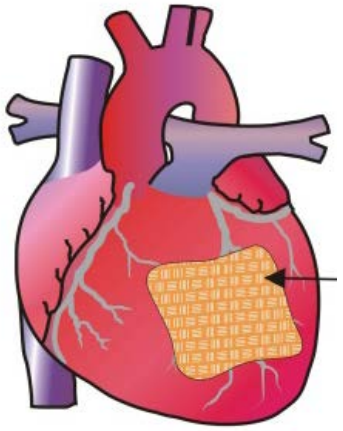
High Value Products from Pericardium



Pericardial sac



High collagen and elastin content ~ 70%. Excellent physical properties, biocompatible and can be modified/coated to improve cell adhesion.

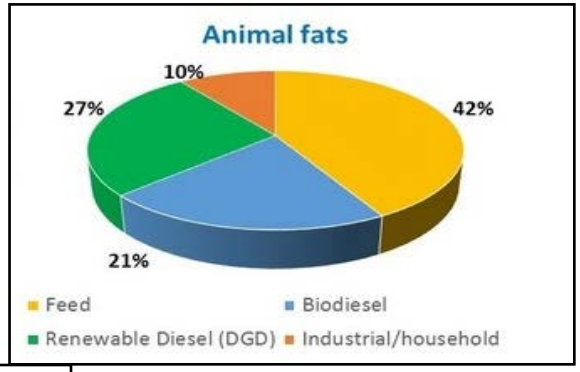


For recuperation after open heart surgery, and for conditions like myocardial infarction.

Major Applications

Pericardial valves for replacement of malfunctioning heart valves

Utilization of Fat



Major edible fats

Tallow from fatty tissues of cattle

Lard from healthy tissues of pig

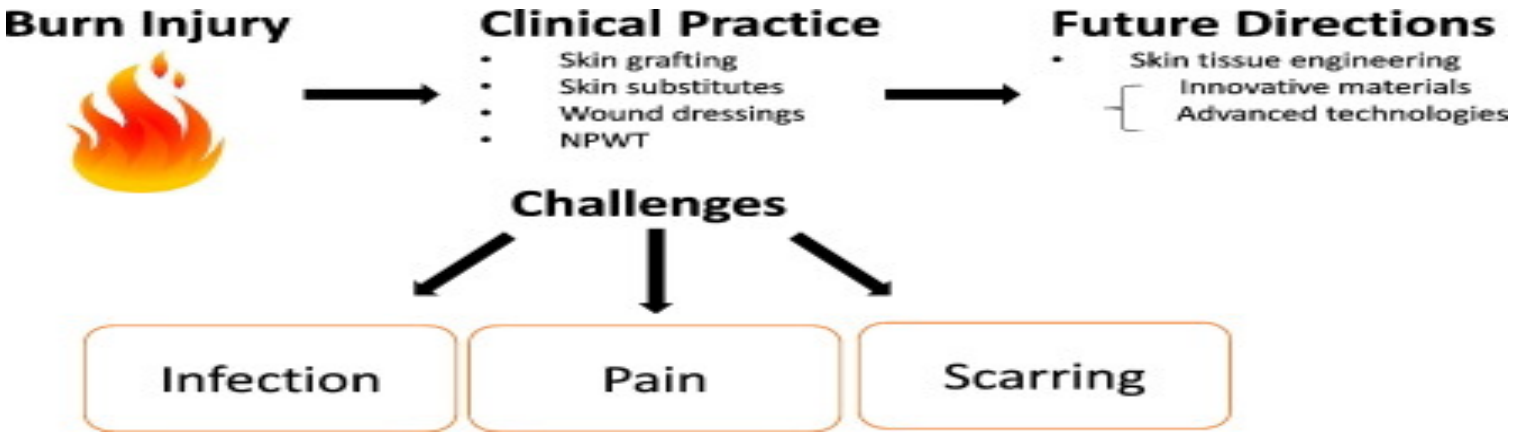
Applications:

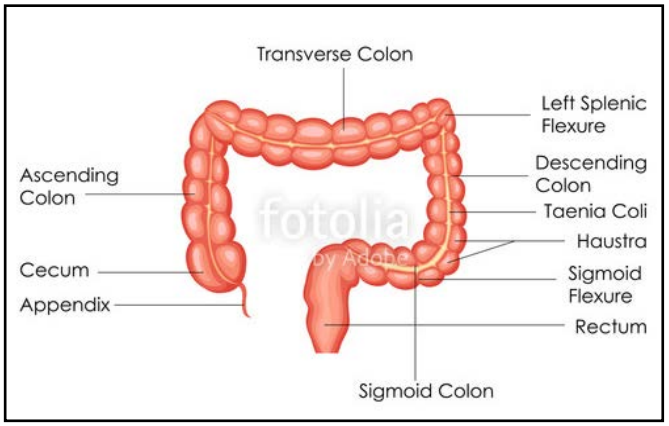
- Deep frying
- Liquid tallow has been used for preparation of french fries since less fat is absorbed
- Used for margarine and shortening
- Lards are used in sausages or emulsified products

Products from Bone

- Bone has been used for the extraction of gelatin and contributes 27% of total production of gelatin
- Gelatin has many industrial application such as food, pharmaceutical and biomedical industry
- Demineralized bone matrix is used for various surgical procedures for bone regeneration

Dressing materials from Cecum Memrane

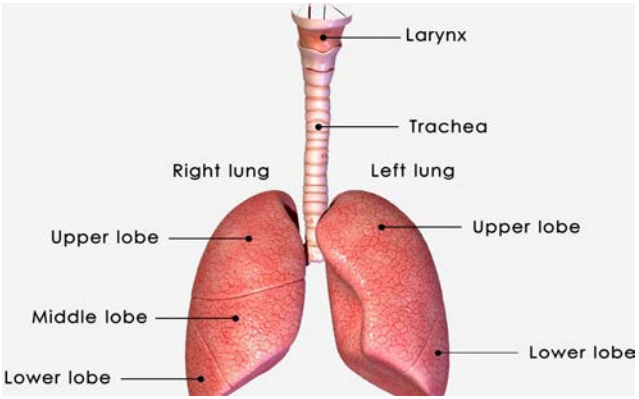




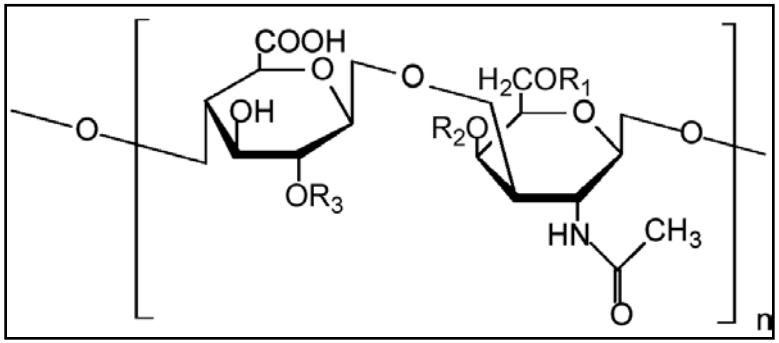
Cecum has high content of collagen and it can be processed into wet collagen sheet for burn wounds

Kollagen, Coloskin and Tempograft Products developed by CSIR-CLRI

Chondrotin Sulphate: A product of high value



Structure of Chondroitin sulfate



- Large amount of cartilage is produced as a by-product from slaughter house and fishery industries
- Cartilage matrix is composed of glycosaminoglycans (GAGs) which are mainly chondroitin-4-sulfate and chondroitin-6-sulfate, present in the form of proteoglycans
- Chondroitin sulfate is extracted from the cartilage tissue of cow, Trachea and used to treat Osteoarthritis
- Chondroitin sulfate form rings of bovine trachea has been used in nutritional supplements

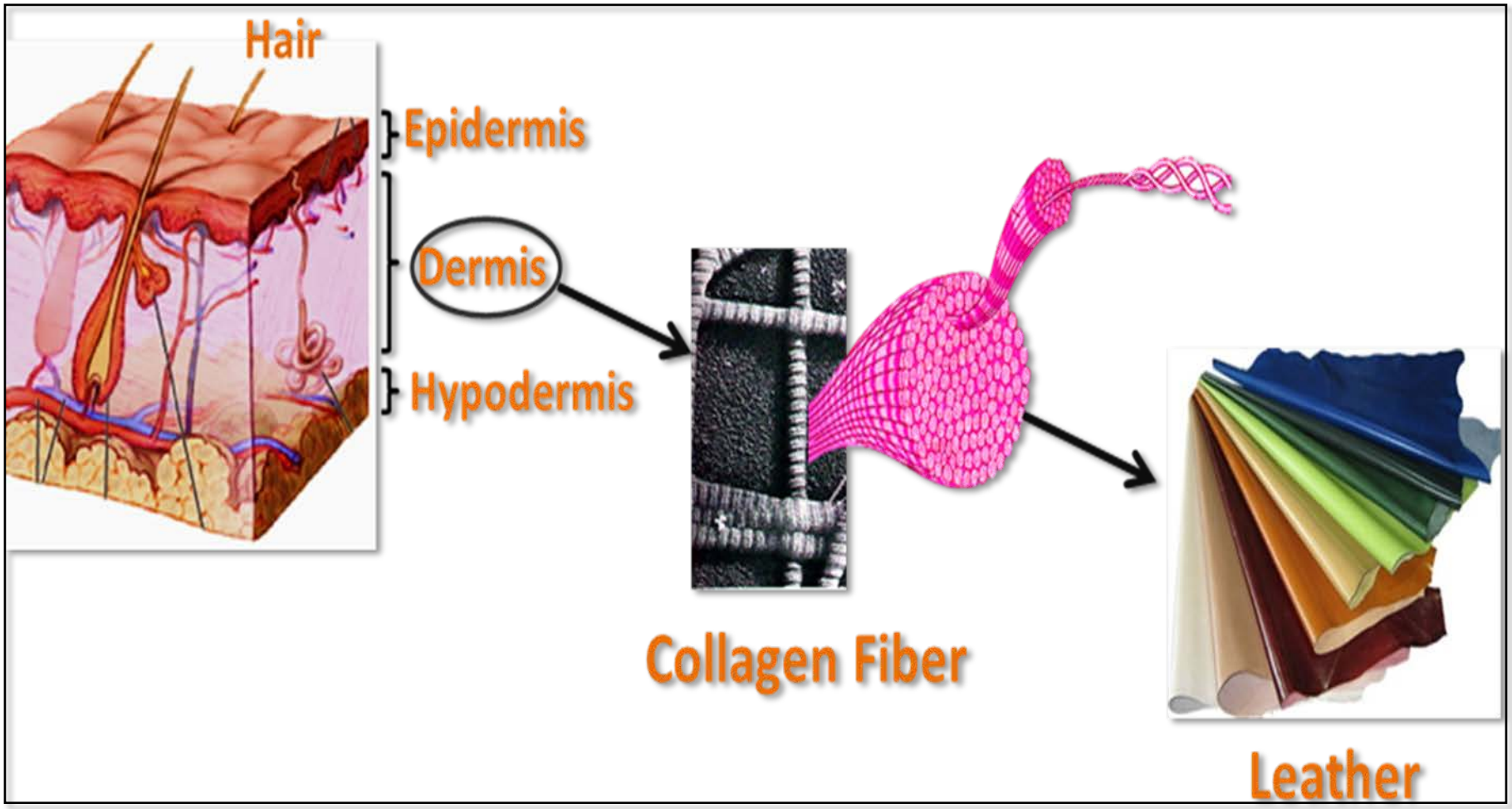
Utilization of Horns and Hooves

- Horns and hooves contains high content of keratin and nitrogen
- Keratin has various industrial application such as biomedical, cosmetics industries
- Ground horns used as fertilizer and poultry feeds
- Used for making buttons

Raw Materials for Leather Manufacture

- HIDES: Bovine, buffalo
- SKINS: Goat, Sheep, Pig;
- Exotic animals such as alligator, ostrich, fish and kangaroo

Skin: An Architectural Marvel



Leather Sector: Connects rural farmer and fashion world

Animal rearing → Slaughter houses → Preservation → Tanning → Semi processed → Finished leather → Leather Products

More than 4 million people of employed by Indian Leather & Leather Products sector

The Tanning industry

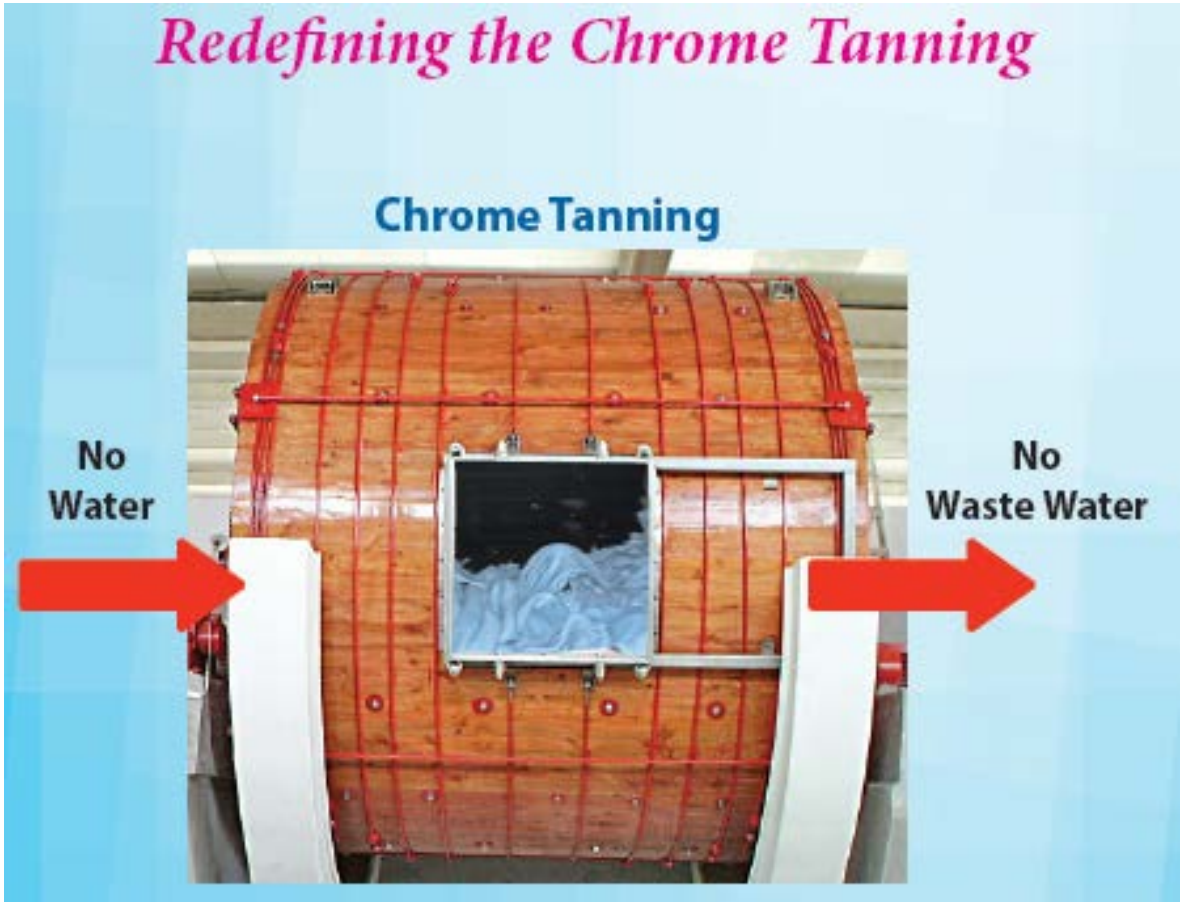
- Raw material intensive
- Labour intensive
- Technologically mature
- Despite its impressive growth, has a negative image due to pollution related problems
- Due to enactment of strict environmental compliances, there was a huge shift of tanning activity from developed to developing countries during 70s in the last millennium

Impact of Current Leather Manufacture

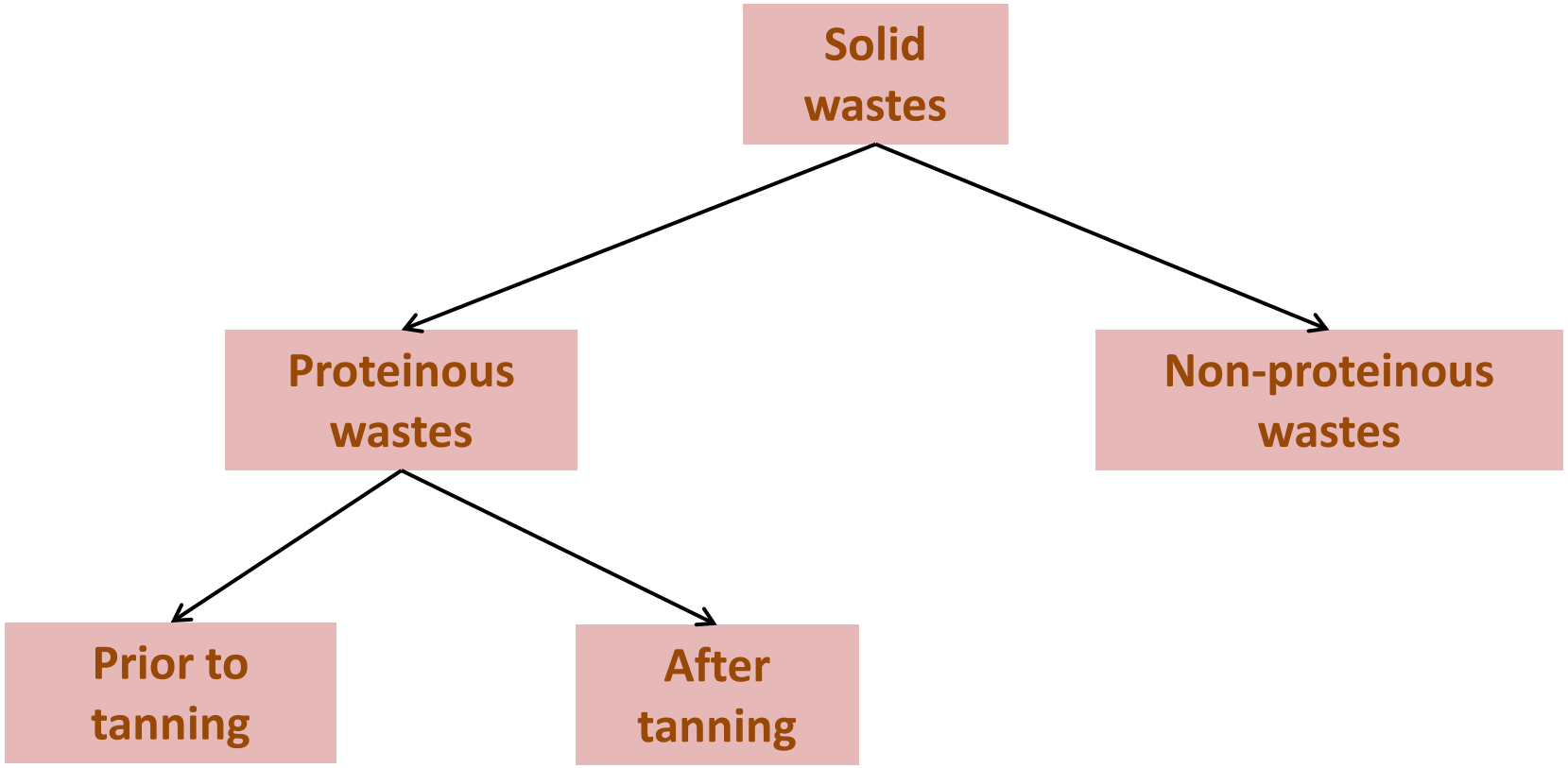
- The impact of the conventional leather processing on the environment is due to
  - High water consumption
  - Significant discharge of wastewater
  - High treatment cost

- Hence, newer process innovations towards sustainable leather processing is needed

Waterless Chrome Tanning Technology



Solid Wastes from Tannery



Collagen distribution wet salted hide, finished leather and solid waste

(*Starting material:* 1,000 kg wet salted raw hides, splitting in chrome)

Component	Amount of Collagen		
	Kg	% Corium Collagen	% total collagen
INPUT			
Corium collagen (leather building collagen)	282	100	93
Subcutis collagen	22		7
Total Collagen Input	304	-	100
OUTPUT			
Grain Leather	113	40	37.2
Split leather	36	13	11.8
TOTAL COLLAGEN IN FINISHED LEATHER	149	53	49
TOTAL COLLAGEN IN SOLID WASTE	155	47	51

Breakdown of Collagen in Solid Waste

Component	Amount of Collagen		
	Kg	% Corium Collagen	% total collagen
Trimmings	20	7.1	6.6
Fleshing	22	From subcutus	7.4
Unusable chrome split	49	17.5	16.1
Shavings	45	16.0	15.0
Wet blue trimmings	9	3.0	2.8
Crust leather waste	5	1.8	1.6
Buffing dust	1	0.4	0.3
Finished leather off-cuts	4	1.6	1.3
TOTAL COLLAGEN IN SOLID WASTE	**155**	**47**	**51**

Managing the solid wastes

Utilization of solid wastes (particularly the proteinous wastes) is an economically lucrative solid waste management option

Technological Options:

- Manufacture glue or gelatin from hide trimmings
- Manufacture of animal (or bird) feed from fleshings
- Manufacture of compost from hair/fleshings
- Generation of energy from fleshings
- Manufacture of leather boards from shavings/buffing dust

Beam house (Pre-Tanning): Solid Wastes

Raw trimmings → 60-80 Kg/ton

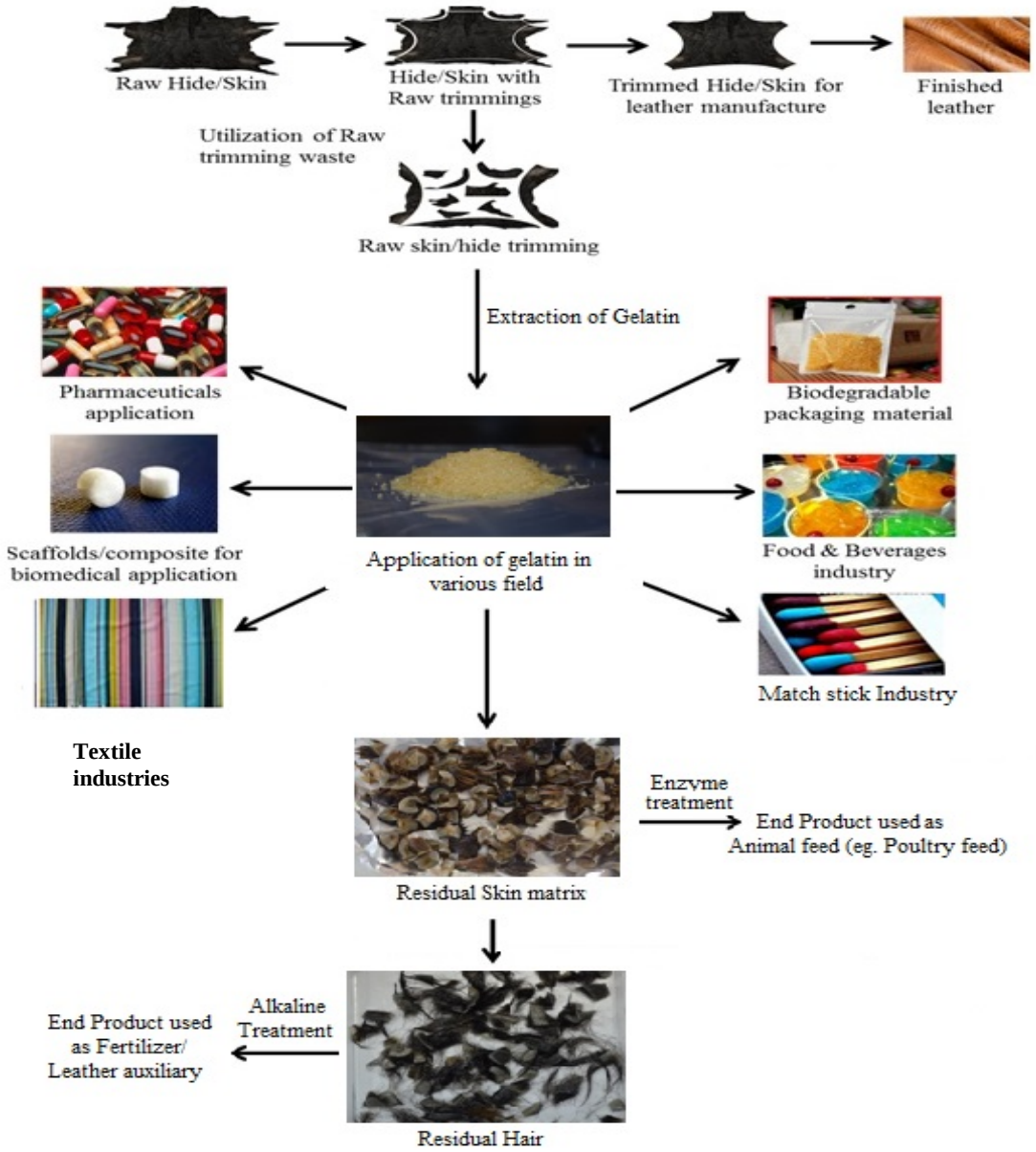
Hair → 30-60 Kg/ton

Limed trimmings & fleshings → 100-150 Kg/ton

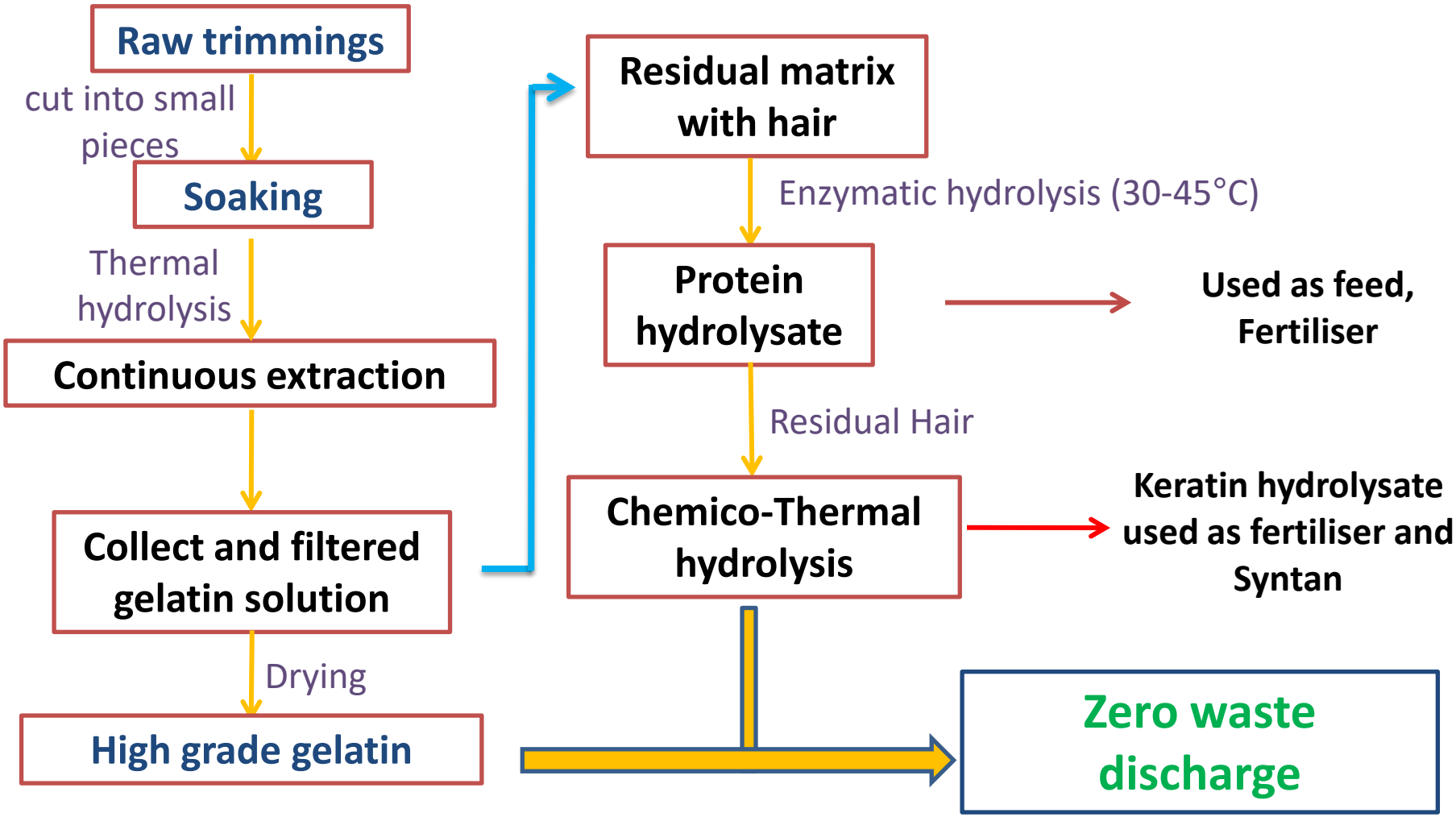
Trimmings: Opportunity for Wealth from Waste

- About 50,000 tons of raw trimming waste is generated by Indian tanning sector p.a
- Each ton of raw trimmings contain about 250 kgs of collagen
- Potentially about 12,500 tons of gelatin plus protein hydrolysate could be generated from these waste (potential value is ~ Rs. 300 crores p.a)
- Annually India imports gelatin worth about Rs 300 crores, mainly utilized for making capsules

Proposed utilization of trimmings



Process for Complete Utilization of Trimmings



CSIR-CLRI Technology licensed to M/s Anigel Manufacturing Co

Liming - Unhairing

Hair recovery process for skins and hides can be practiced to obtain the hair intact

Hair can be processed further to recover value added compost or protein hydrolysate for making protein syntan

Compost from Hair Waste: Production at Pilot level

- Keratinase production - 750 L fermentor with working volume of 500 L with animal hair (3 days)

- 500 kg of composting materials (Dry leaves - 150 kg, fresh soil - 150 kg and saw dust - 200 kg)

- Composting process was carried out for 7 days with moisture content adjusted to 55±2% w/w and temperature 30±2 ^{o}C

Hair Compost - Field Study Details

- One control and three experiments conducted for Paddy.
  - Control: No hair compost, only recommended dose of NPK
  - Experiment: HC + NPK
- In the case of experiment, the yield was 1.4 to 1.5 times that of control
- Recovery of about 30-60 kg of hair per ton of raw material is feasible

Tannery Fleshing Waste: A New Raw material for rubber sole preparation

Fleshing (25 Kg)

Dried Fleshing Waste (2.5 - 3 Kg)

Carbon black As reinforcing material

Activated Carbon 1 - 1.2 kg

AC Blended with Rubber

13 - 15 pairs of Shoe Sole

(20 parts per 100 parts of rubber)

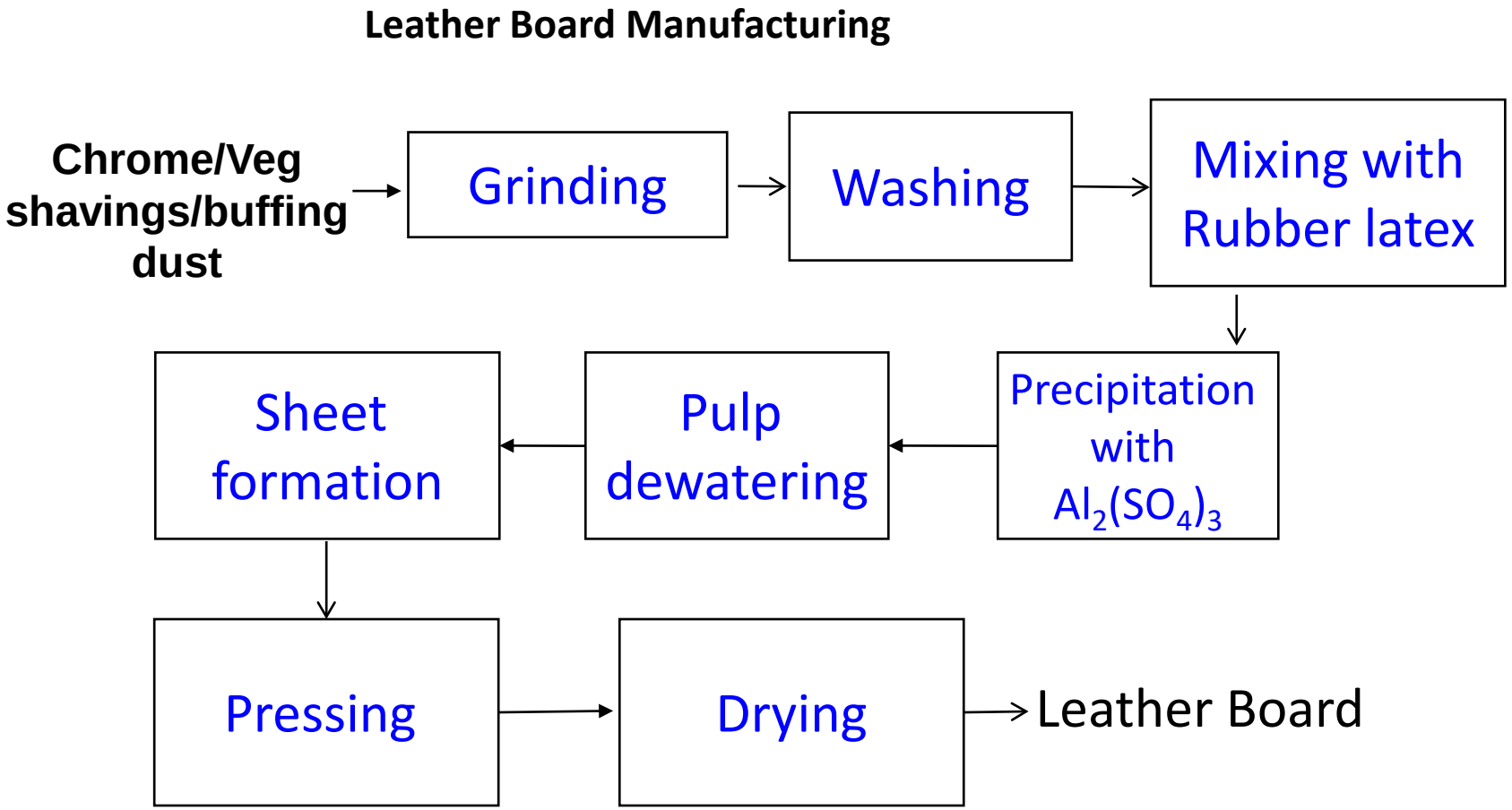
Benefits for Tannery

- ✓ Avoid the disposal of fleshing waste into landfill
- ✓ Tanner can gain revenue from fleshing waste
- ✓ Reduce the environmental pollution load

Benefits for Rubber Industry

- ✓ Avoid the use of carcinogenic filler carbon black
- ✓ Prepare the carbon black free black rubber sole
- ✓ No imprint on carpet
- ✓ Good vulcanized rubber

Shavings/Buffing Wastes



Crust trimmings

Bigger trimmings can be used for making small leather goods

Smaller trimmings can be used for making boards

About 10 – 15 kgs of dyed trimmings obtained per ton of raw material processed

Smile on the faces of Fire victim (in 2004) Children after complete recovery using CSIR-CLRI Collagen Sheets in 30 days

Kumbakonam, Tamil Nadu, India

CSIR-CLRI: Doing better today than yesterday and forever ….

Thank you