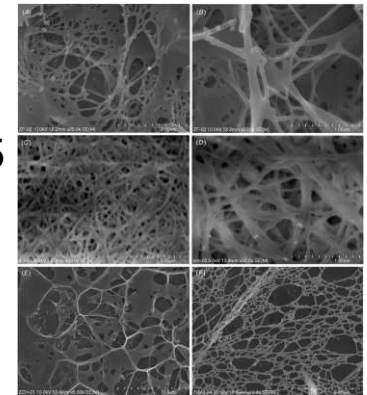


Recovery of value from meat processing streams

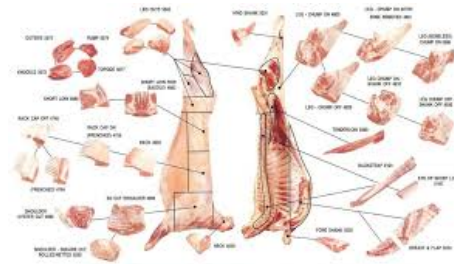
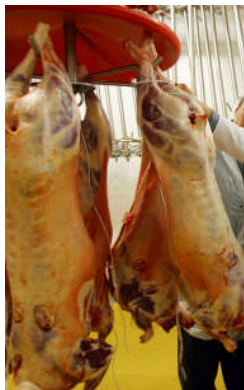
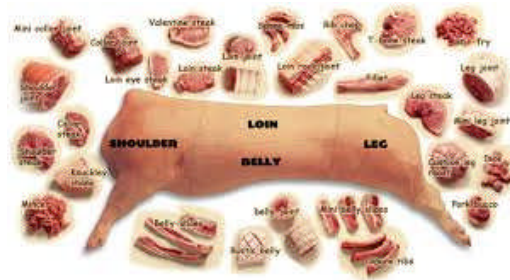
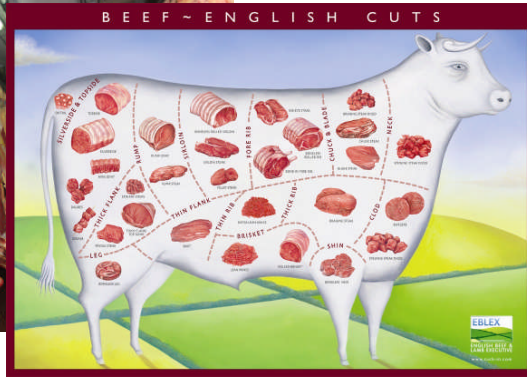
Anne Maria Mullen

Teagasc Food Research Centre Ashtown, Ashtown, Dublin 15



The Irish Agriculture and Food Development Authority

Anne Maria Mullen, Waste not Want not, Teagasc Ashtown, 2014



- Average live weight - ~550kg
- Boned meat ~ 220kg (40%)
- Average live weight - ~90kg
- Boned meat ~ ~57kg (64%)
- Average live weight – 18-55 kg
- Boned meat 40-50%

Steps to control & optimise

Chilling regime

Aitch bone hanging

Postmortem ageing

Hot boning

Electrical stimulation

Intrinsic value

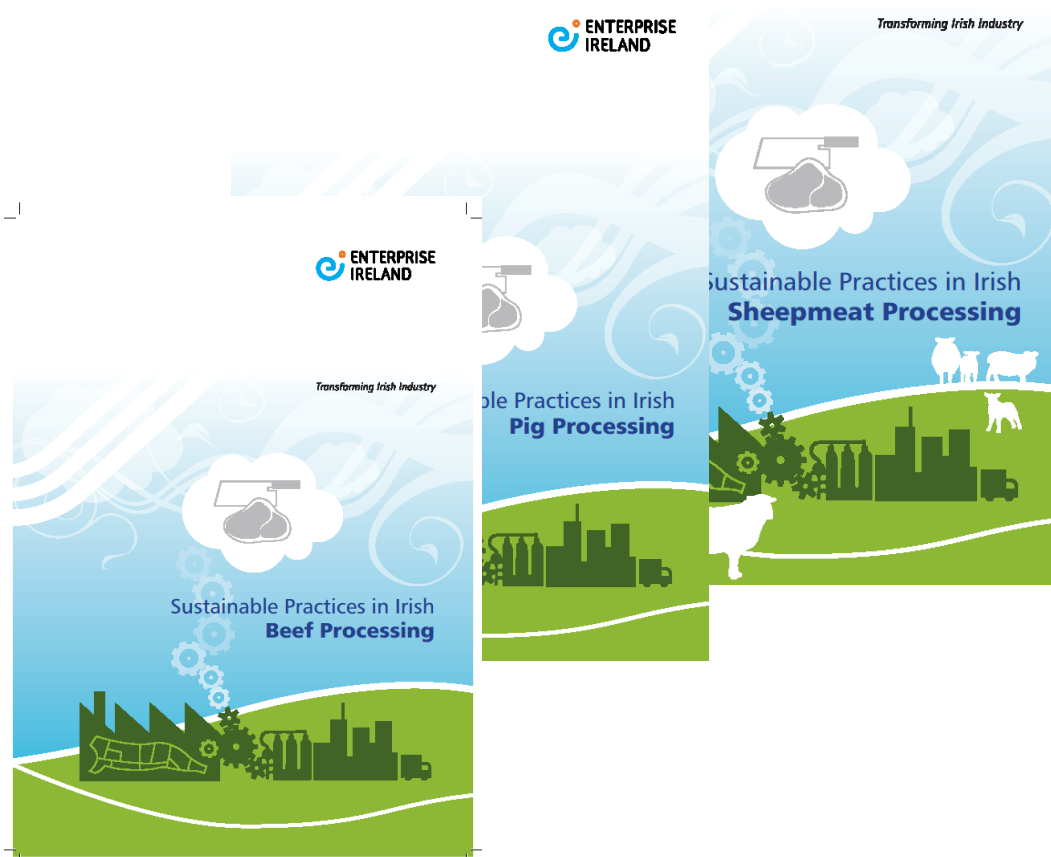
Formulation...

Breeding indices

for eating quality

Steps to optimise utilisation and value?

'Waste' from processing chain



- BEEF
 - 263kg/head
- SHEEP
 - 19.3kg/head
- PIG
 - 19.3kg/head

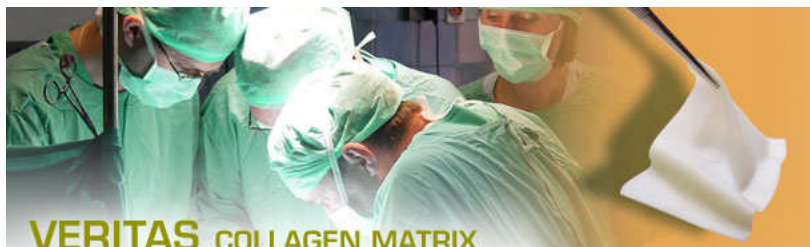
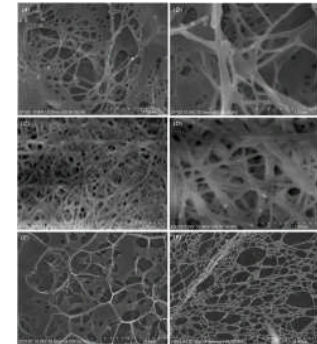
'Waste'/secondary products

- Edible offal and edible fats
- Bones – (soups buttons bone meal)
- Blood (human and animal consumption, pharmaceutical & food additives – emulsifiers, stabilisers, clarifiers, nutritional additives)
- Hide, feet, hair etc
- Inedible offal, fats
- SRM etc
- Current uses – edible, rendering, landsread plus some higher value

Closer look at some by-products and higher value applications

Higher value opportunities

- Process by-product to extract or generate higher value co-products
- Proteins with techno-functionality of interest to the food and beverage sector



Techno-functional activity

- Solubility
- Emulsification
- Foaming
- Gelling
- Water binding
- Protease inhibition

Protein

- Molecular size
- Charge
- Amino acids present
- Binding with lipids etc

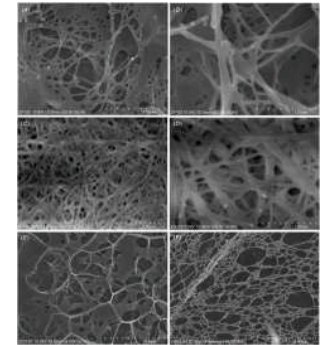
Lipids

Other small molecules,
ingredients

Processing conditions

Higher value opportunities

- Process by-product to extract or generate higher value co-products
- Proteins with techno-functionality of interest to the food and beverage sector
- Functional lipids
- Pet food applications – nutraceuticals etc
- Sports/nutrition
- Cosmetics
- Biomedical – collagen for tissue scaffolds
- Biomedical – bioactive elements – biomolecules, peptides, lipids



Blood

- 5-7% total body weight. ~ 19% protein.
 - ~65% plasma (6-7% protein)
 - ~35% cellular (~35% protein).
-
- Plasma: albumin, globulins, fibrinogen
 - Cellular – erythrocytes (RBC – Haemoglobin (Hg) main protein), leukocytes (white – 3 types neutrophil, eosinophil, basophil) and platelets.
 - Cells enzymes protein and other organic and inorganics.

Blood utilisation: food

- Solubility

- Emulsification

- Foaming

- Gelling

- Water binding

- Protease inhibitor

- Colour

	Stability %	pH , ionic strength etc
Plasma	75-100	Good across 3-8, optimal 4
Serum	70-90	pH3-8, optimal pH8
Albumin	70-100	Across 3-8, only small ionic strength effect
Globulin	40-90	Depends very much on pH and ionic strength
Fibrinogen	<20	Across pH 3-8
Globin	10-90*	Big environmental effect

Other uses of blood

- Life Sciences, diagnostic, biotech applications.
- Compounds with higher value medical applications
 - E.g. thrombin (EC 3.4.21.5) and plasmin, Hemopure, fibrinogen.
- Bioactive compounds: wide range
 - antihypertension, enhancement of mineral absorption/bioavailability, immunomodulatory...
- Pet and livestock feed
 - Lysine supplement, vitamin, nutritional. Porcine/bovine plasma beneficial to young pig performance 1st week after weaning – IgG main contributory factor.
- **Fats**: cosmetic, rubber and plastic polymerisation, lubricants, biodiesel
- **Haemoglobin** – protein, heme iron polypeptide, colour.
 - Colour and flavour can be problematic

Australia

- BSA – technical and diagnostics
- IgG – Functional food, veterinary, technical diagnostic
- Thrombin – medical device therapeutics
- Hg – Veterinary/Animal/Pet, Technical/diagnostic, Nutraceutical
- Return on investment
 - 2-5years
- Petfood – nutraceutical of particular interest

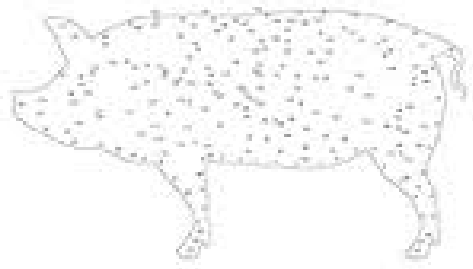
Connective tissue

- Support; Signaling; Nutrient flow.
- Very diverse tissue: cells with abundant extracellular cellular matrix (ECM).
- ECM: collagens, proteoglycans, elastin etc.
- Collagen: most predominant protein in body (~30% total protein). 27 variants. Glycine rich, proline and leucine
 - Fibrous = type I, II, III, V
 - Bone Type I: Cartilage Type II: Skin Type III V.
- Proteoglycans (PGs)
 - Protein core, shorter oligosaccharides, longer GAG chains (e.g. chondroitin sulphate, dermatan sulphate, heparan sulphate, keratin sulphate.). Aggrecan =large PGs. Hyaluronic acid – nonsulphated.

Connective tissue

- Biomedical - can assist in wound repair, tissue scaffolds
- Cosmetic uses – collagen, hydrocolloids
- Gelatin – food, pharma etc
- Nutraceuticals – proteoglycans...
- Added to myofibrillar proteins can bring some benefit to water trapping in gels.

Pig05049

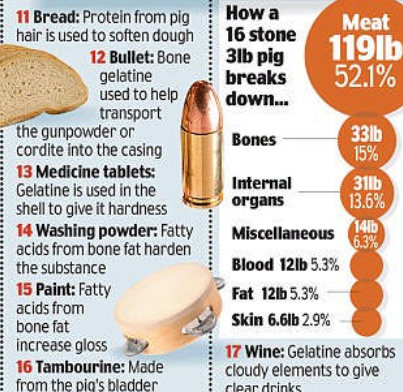
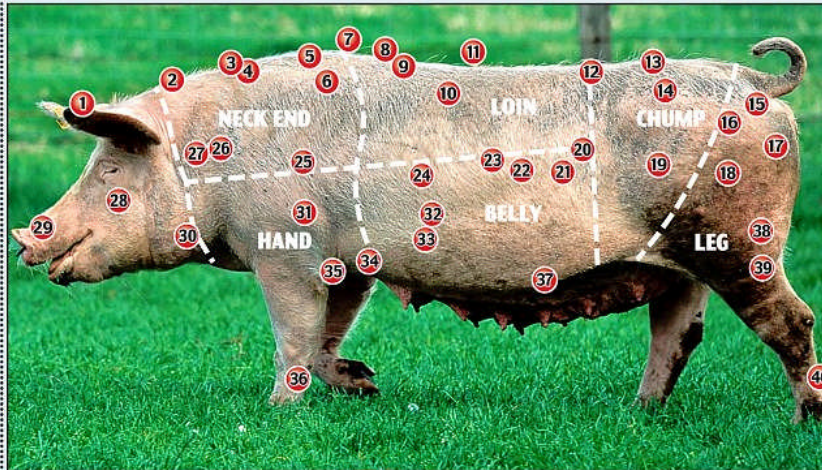


- Author: Christien Meindertsma
- Parts of pig: make their way into at least 185 non-pork products, from bullets to artificial hearts.
- Includes ammunition, medicine, photo paper, heart valves, brakes, chewing gum, porcelain, cosmetics, cigarettes, conditioner and even bio diesel.

...180 other things you can do with a pig

Every ounce of Pig 05049 was used, helping create an astonishing 185 products. Here are some of the more surprising uses for the animal - and a diagram to show just which bit of the beast, from the trotter to the snout, is used where...

- 1 Chemical weapons testing:** Because of the pig's similarity to human tissue
- 2 Ice cream:** Gelatine regulates the sugar crystallisation and slows down the melting process
- 3 Fertiliser:** Made from processed pig hair
- 4 Low fat butter:** Gelatine used for texture
- 5 Beer:** Gelatine used as a clarifying agent. Reacts with bitter substances and tannins to absorb cloudy elements, leaving clear drinks
- 6 Fabric softener:** Fatty acids from bone fat give colour
- 7 Paint brush:** Made from pig hair
- 8 Fruit juice:** Gelatine absorbs cloudy elements to give clear drinks
- 9 Shampoo:** Fatty acids from bone fat are used to give them a pearl-like appearance
- 10 Candle:** Fatty acids from bone fat are used to stiffen the wax and raise the candle's melting point
- 11 Bread:** Protein from pig hair is used to soften dough
- 12 Bullet:** Bone gelatine used to help transport the gunpowder or cordite into the casing
- 13 Medicine tablets:** Gelatine is used in the shell to give it hardness
- 14 Washing powder:** Fatty acids from bone fat harden the substance
- 15 Paint:** Fatty acids from bone fat increase gloss
- 16 Tambourine:** Made from the pig's bladder
- 17 Wine:** Gelatine absorbs cloudy elements to give clear drinks
- 18 Paper:** Bone gelatine is used to improve stiffness and reduce moisture
- 19 Heparin:** Used to stop the formation of blood clots, it is taken from the mucus in the intestines
- 20 Soap:** Fatty acids from bone fat act as a hardening agent and give colour
- 21 Corks:** Bone gelatine is used as a binder
- 22 Insulin:** Taken from the pancreas, as closest to human in chemical structure
- 23 Yoghurt:** Pig bone calcium is used in some yoghurts
- 24 Cigarettes:** Haemoglobin from the blood used in cigarette filters to create an artificial lung that supposedly lessens harmful chemicals reaching the smoker
- 25 Photographic film:** Bone gelatine acts as a bonding agent on the film sheet
- 26 Dog food treat:** Haemoglobin used as a red colouring agent
- 27 Photodynamic therapy:** Haemoglobin used in drug to treat retina decay in the eye. Drug is activated by shining laser into eye
- 28 Moisturisers:** Fatty acids from bone fat used
- 29 Dog snack:** Deep fried pig nose
- 30 Crayons:** Fatty acids are used as a hardening agent
- 31 Shoes:** Bone glue is used to improve the texture and quality of the leather
- 32 Train brakes:** Bone ash used in production
- 33 Toothpaste:** Glycerine from bone fat is used to give toothpaste texture
- 34 Hide glue:** A strong glue used in the woodworking industry derived from collagen
- 35 Face mask:** With collagen to help reduce wrinkles and lines
- 36 Alternative energy:** Waste products used as fuel to produce electricity
- 37 Energy bar:** Treated collagen is cheap source of protein for body builders
- 38 Cream cheese:** Gelatine used to make it stable
- 39 Whipped cream:** Gelatine gives texture
- 40 Sweets:** Porcine gelatine used as a binding and gelling agent and to ensure the right texture is found in the following: liquorice, wine gums, chewing gum



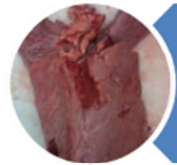
DailyMail, Bullets, bread and beer, tambourines and toothpaste... and the 180 other things you can do with a pig
<http://www.dailymail.co.uk/sciencetech/article-1217794/From-bullets-bread-beer-tambourines-toothpaste--plus-180-things-pig.html#ixzz2sMWQgZF7>
 3 October 2009

Challenges

- Legislation
- Variability – optimising functionality, preventing unwanted effects e.g. bitterness. Understand drivers of yield
- Efficacy
- Toxicity, bioavailability
- Scale or lack of (...collaborate/partnership)
- Freedom to operate
- Consumer attitudes
- Environmental issues associated with new processing
-

Progress to date

Extraction of Protein from Lung



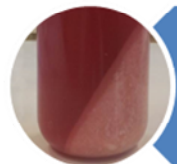
Starting Material



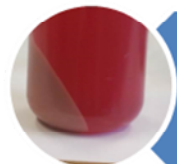
Size Reduction



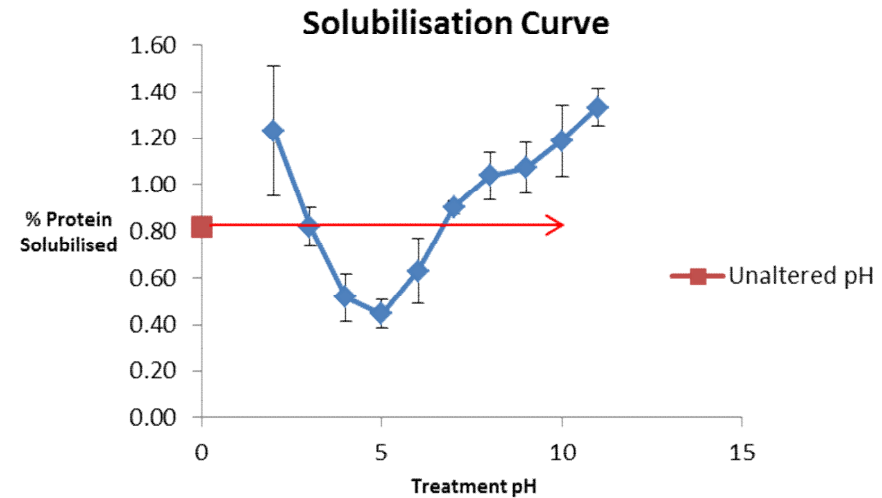
Solubilisation of Protein



Separation of soluble and insoluble proteins



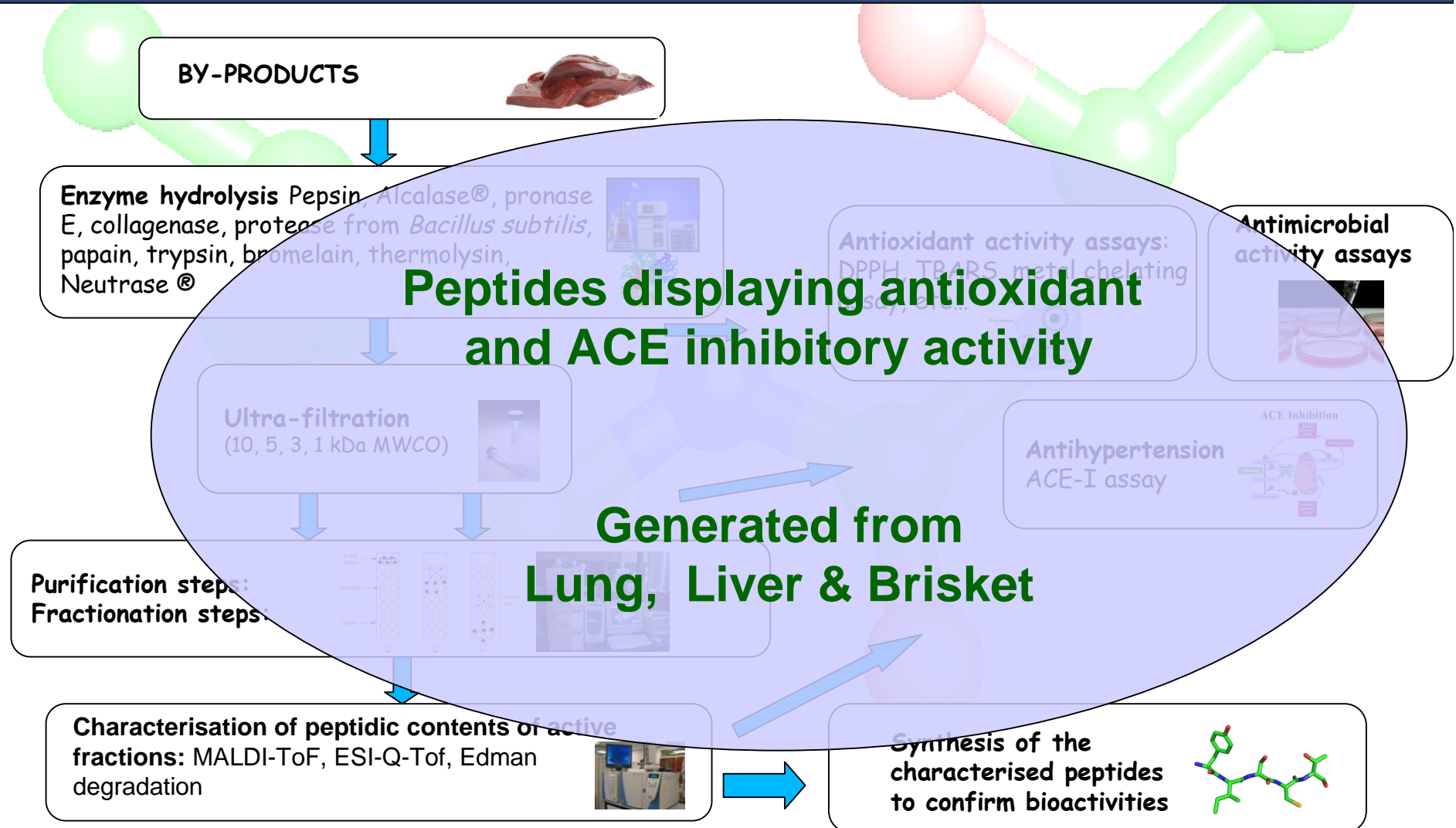
Recovery of Extracted Protein



Protein Functionality

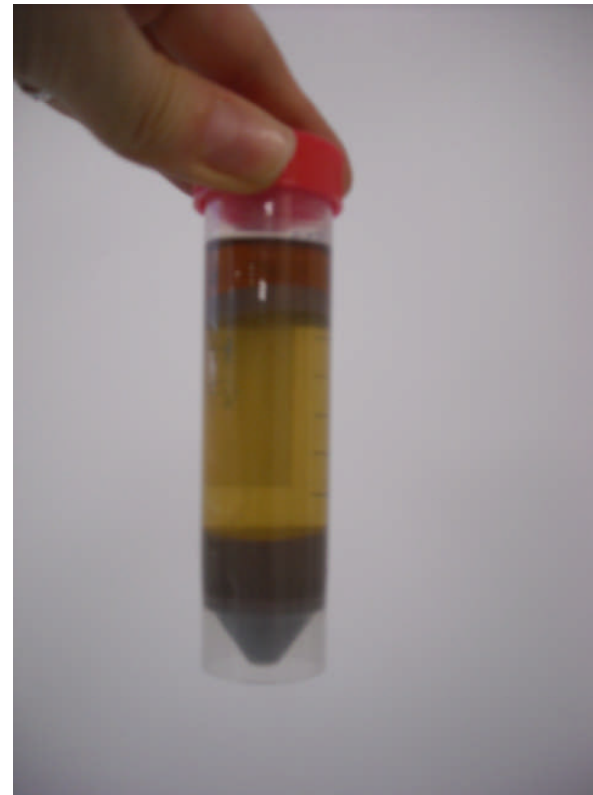
- Gelling quality of protein compares favourably to blood plasma and egg white ¹
- Emulsifying capacity also compares favourably to Na-caseinates ¹
- Gelling qualities (Least gelation concentration) compared to favourably to proteins isolated from legume sources²
(*Selmaine, D. 2007* ¹; *Lynch, S. 2013* ²)

Can we generate bioactive peptides from offal and low value meat?



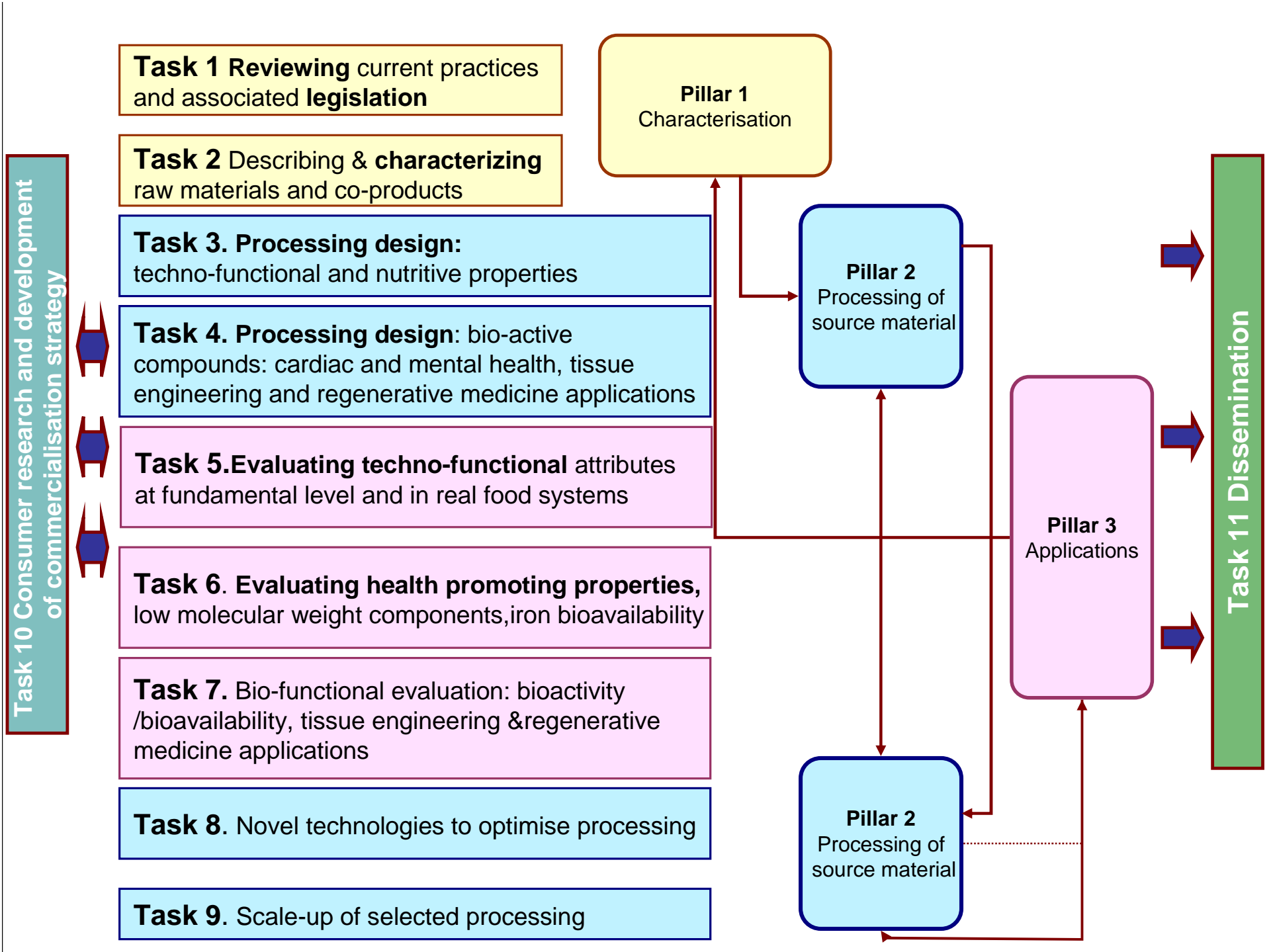
Demonstration activity

- Australian enzyme company
- EI
- Hydrolysing fish and meat by-products
- Three layers/phases
 - Fat
 - Soluble protein
 - Residue/insoluble



ReValueProtein

- FIRM project lead by Ashtown
 - Partners = UCC, UCD, NUIG, Shannon ABC/ITTralee
- Multidisciplinary
 - Techno-functional, sports/nutrition, biomedical, bioactivity
- Variety of raw materials
 - Lung, liver, heart, tendons, cook-out, thaw loss...
- Establish flow process
 - Novel processes, pilot scale
- Consumer attitudes
 - Commercialisation strategy



Global – companies:

- **USA**
 - **Proliant** Inc USA e.g. ImmunoLin® serum concentrate from bovine plasma. For additional to bars and drinks, marketed as a boost for immune system
- **Europe**
 - **Sonac** BV, Netherlands (Vion)
Fibrimex® combination of fibrinogen and thrombin concentrate precipitated from bovine plasma. Binding agent.
 - **Harimix** P, P+ and C proteins – hemoglobin powders derived from bovine and porcine blood which can be used as natural meat colorant.
 - **Veos** Group Belgium – range of products under the Vepro® brand utilising plasma and haemoglobin from animal blood for various applications
- **Australia**
 - **Maverick** Bioscience
 - Nutraceuticals – PS, Bovine plasma, serum, Hg, Cartilage-CS (needs large volumes),
 - Collagen based materials some in clinical trials some in market place – cosmetics to neurosurgery applications
- **South america**
 - **Lican**: Prolican 70 (spray-dried bovine blood) for emulsifying gelling binding, Prietin(spray dried porcine whole blood) Myored (red pigments from blood) for use as natural colourants

Asia

- Bioactives in market place*
 - Blood pressure (milk sardine sesame)
 - Mineral absorption (Bovine Heme-iron, suitable for people with mild anemia and needing iron supplementation. Also from casein)
 - Blood lipid – globin hydrolysate suitable for those with elevated serum cholesterol.
 - Moringa – use globin protein hydrolysate. Moringa have developed diverse range of products including collagen drink. Partner with Weider nutrition.
- Many of the amino acid sequences in peptides generated by DiBernardini et al.(Ashtown)

Acknowledgements

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- Agencies: FIRM, EI

