Sustainability in Coloration

Chris Pask

Black and Green Conference

York

November 2010

DyeCat

UNIVERSITY OF LEEDS

- Introduction to DyeCat

- Initial DyeCat Work

- Cosmetics Applications
    - Hair Dyes

- Summary

DyeCat

UNIVERSITY OF LEEDS

- Founded 2006

- Spin-out company from University of Leeds
  - First UK University to create Technology Transfer Unit

- Funded by Techtran Ltd and the Viking Fund

- Housed within University
  - Access to specialist laboratory facilities

- Vision
  - Improve performance, environmental impact and sustainability of coloration technology

DyeCat
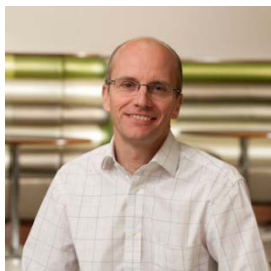
Professor Chris Rayner
- Head of Organic Chemistry
- Natural product extraction
- Natural Dyes
- Supercritical CO_2

Dr Patrick McGowan
- Organometallic catalysis
- New polymerisation methods
- Organometallic anti-cancer agents

Dr Richard Blackburn
- Colour Chemistry
- Sustainable Coloration and Polymers
- Natural Dyes

DyeCat

- Peak Oil
  - Production declines while demand increases
  - Reached at 50% total reserve consumption
  - 1956 Hubbert used mathematical model to predict US peak between 1965 and 1970. Recession in 1973.

Average Monthly Production of Crude Oil Within the US versus Year of Production
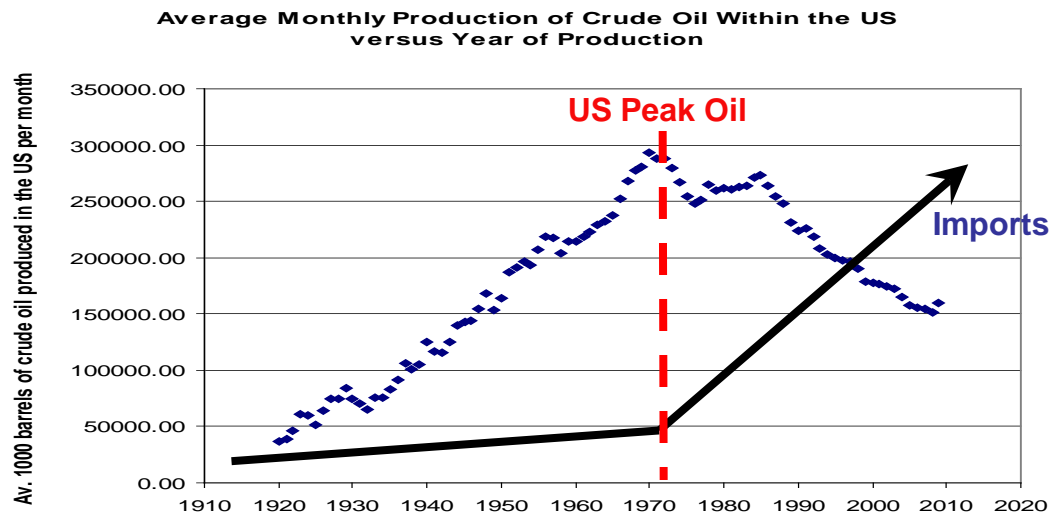
Graph generated using data from US Energy Information Administration (http://www.eia.doe.gov/)

DyeCat

- Global peak oil expected early this century
- Long term sustainability
- Reduction in environmental damage
- Socio-economic benefits to communities
- Wide selection of biomass
  - Forest biomass
  - Grasses
  - Crops
  - Algae
  - Municipal waste
 - Agricultural waste
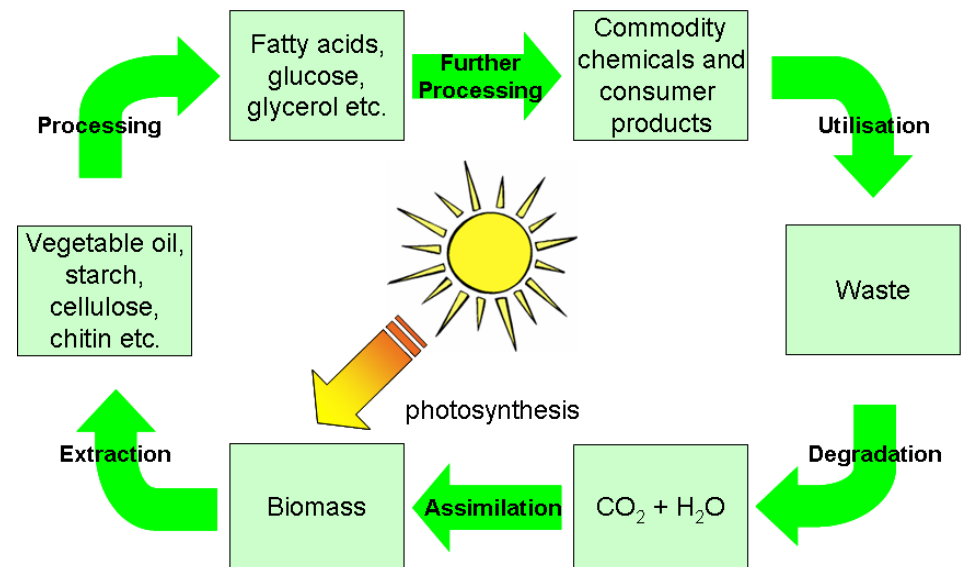
DyeCat

- Founding technology of DyeCat

- Poly(lactic acid) PLA
  - Linear aliphatic polyester viewed as a replacement for PET
  - Derived from lactic acid
  - 100% renewable and compostable
  - Uses 20-50% less fossil fuels than PET
 - Excellent environmental credentials

DyeCat
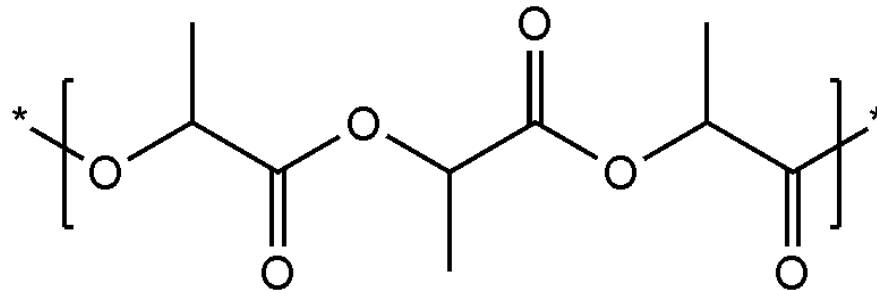
- Current coloration of PLA

- Based on coloration of PET

- Technical issues
  - Uneven coloration
  - High dye loadings required
  - Colour running
  - Degradation of polymer

- Environmental issues
  - Water consumption
  - Energy consumption
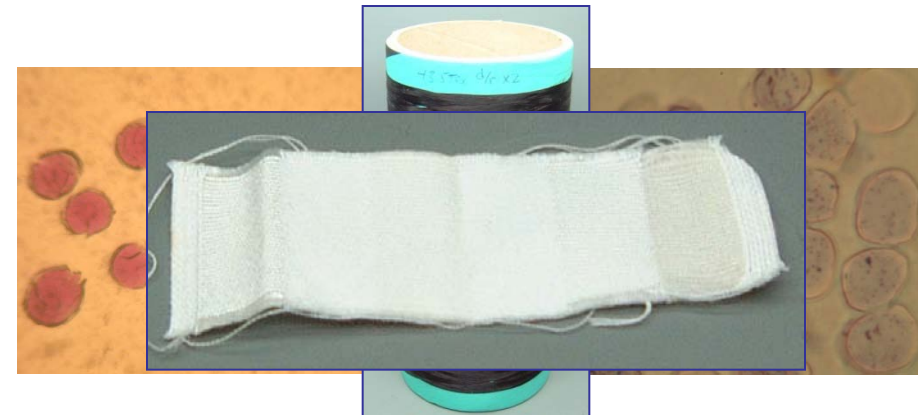 - Large number of chemicals used
  - Waste effluent
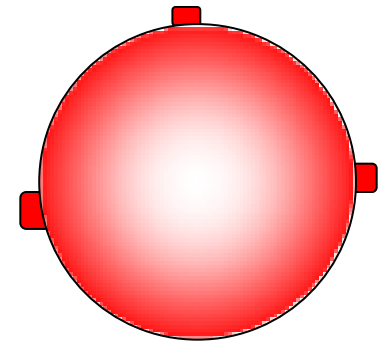
DyeCat

- Combine polymerisation and coloration steps

- Complete eradication of wet dyeing step

- Dye chemically bound to polymer backbone

- Perfect wash fastness
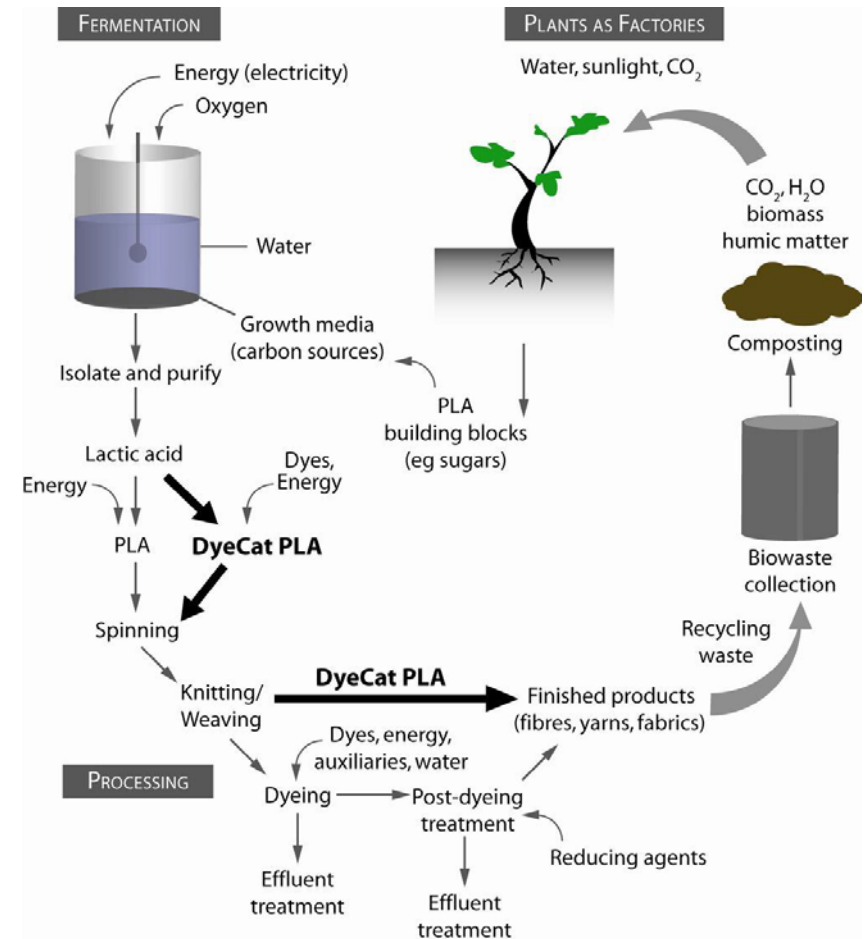
- Economic benefits
  - Elimination of wet dyeing process

- Environmental benefits
  - Reduction in water consumption and energy consumption
  - Reduction in pollution

- Technical benefits
  - Homogeneous coloration
  - Reduced dye requirements
  - Dark colours easily obtained
  - Perfect wash fastness

DyeCat

http://antenna.sciencemuseum.org.uk/trashfashion/home/wearwithoutwaste/to-dye-for/littleblackdress

- Prepared a range of coloured PLA
- Patented technology
  - Applicable to a wide range of materials
- Not restricted to textiles applications
- Packaging biggest market for PET
  - Drinks bottles
- Impart additional functionality
- Sustainable packaging solution

DyeCat

- Global hair dye market ~ $7bn

- EU hair dye market €2.6bn in 2004
    - 70-80% colorants are permanent
    - >60% of women dye their hair
    - 5-10% of men
    - 6-8 times per year

  [*European Commission*, 2006]

DyeCat

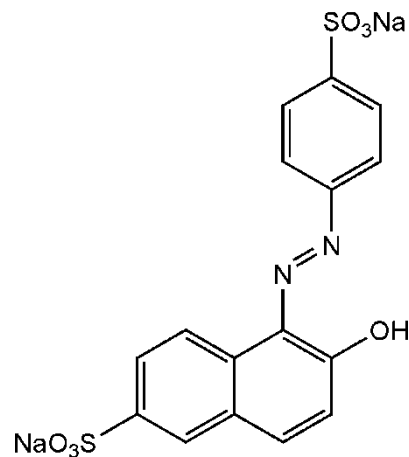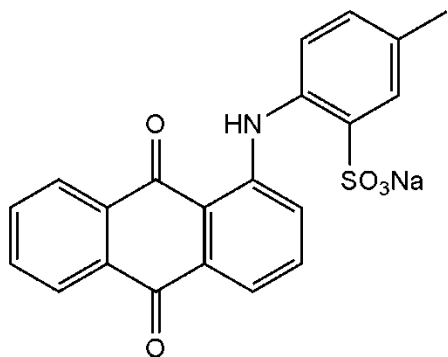- Four classes of hair dyes

  - Temporary

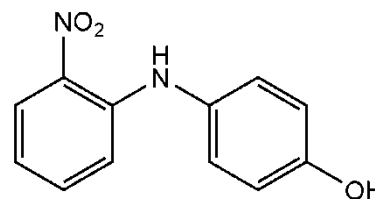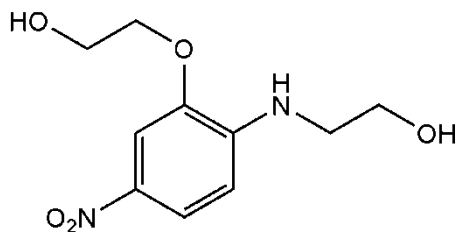 - Semi-permanent

  - Demi-permanent

  - Permanent

DyeCat

Temporary Hair Dyes

- Applied in a variety of forms
- Large dye molecules do not penetrate hair cuticle
- Colour washes out after one or two washes

Semi-Permanent Hair Dyes

- Smaller dye molecules allow cuticle penetration
- Combination of dyes used to achieve desired colour
- Colour lasts four to six washes

- Permanent/oxidation Hair Dyes

    - Four components
        - Primary intermediate
        - Couplers
        - Base (typically ammonia)
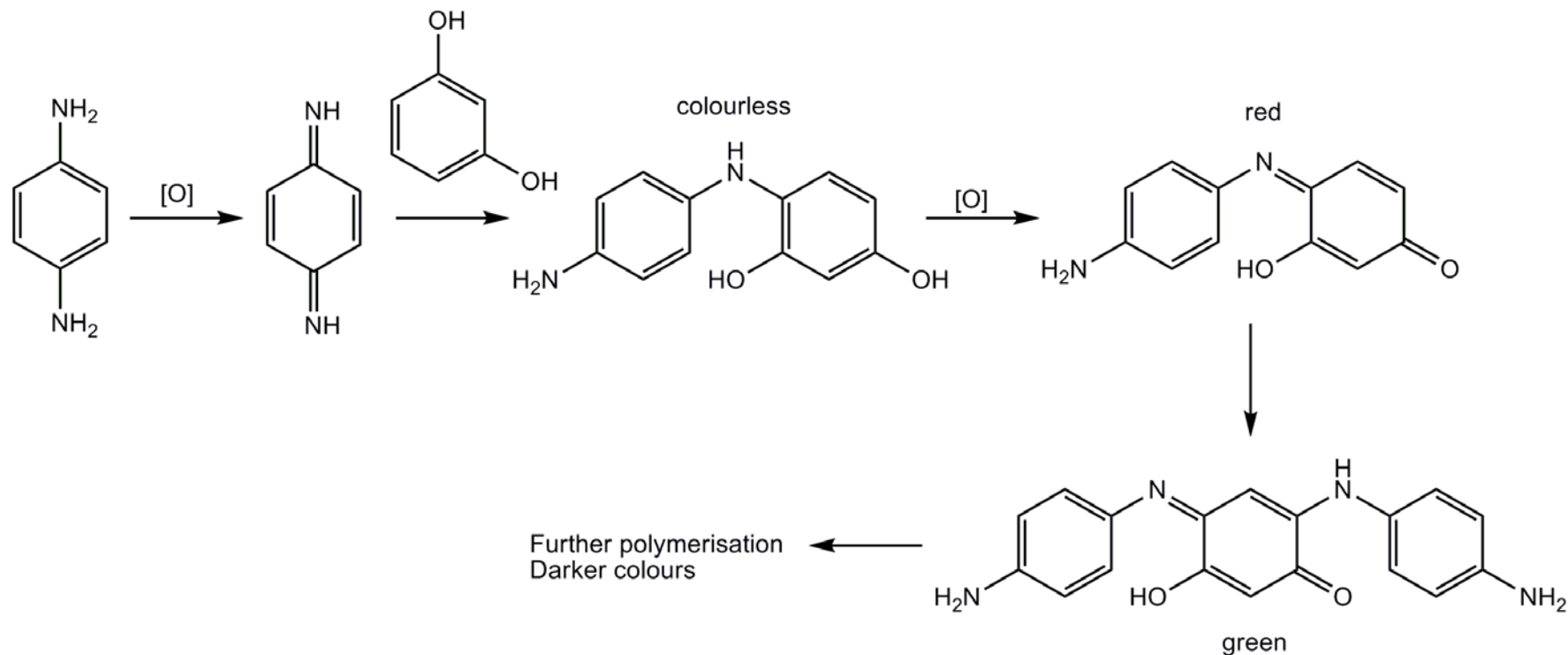   - Oxidant (typically hydrogen peroxide)

    - Penetration of dye precursors followed by oxidative coupling

    - Dye molecules formed too large to diffuse out of hair

    - Colour effectively permanent

DyeCat

Permanent/oxidation Hair Dyes

- Demi-Permanent Hair Dyes

    - Similar chemistry to permanent hair dyes

    - Alkaline agent other than ammonia

    - Lower hydrogen peroxide levels

    - Less damaging to hair than permanent hair dyes

    - Colour lasts 20-24 washes

DyeCat

- Concern over safety in some permanent hair dyes
  - PPD, PTD, Resorcinol
  - Ammonia

Hair dye allergy left woman looking like 'Elephan[t]
Daily Telegraph 17th June 2009

SAFETY INSTRUCTIONS

IMPORTANT: HAIR COLOURANTS CAN CAUSE AN ALLERGIC REACTION, WHICH IN CERTAIN RARE CASES MAY BE SEVERE.

- **A SKIN ALLERGY TEST MUST BE DONE 48 HOURS BEFORE EACH TIME YOU WISH TO USE THIS PRODUCT** (see the instruction leaflet).
- **DO NOT USE :**
  - If you have already had a reaction to hair colourant.
  - If you have an itchy or damaged scalp.
- **BLACK HENNA TATTOO:** if you have ever had a black henna tattoo, even a long time ago, you are very likely to have become allergic without realising it. Take no risk. Never use this product unless you have done the skin allergy test 48 hours before use.

BUY THE PRODUCT IN ADVANCE TO ALLOW FOR THE 48 HOURS ALLERGY TEST.

- The Developer Gel contains hydrogen peroxide.
- Colourant Gel contains: phenylenediamines, resorcinol and ammonia.
- Avoid contact of the product with skin and eyes. Do not use to dye eyelashes or eyebrows. To do so may cause blindness.
- Rinse eyes immediately with water if product comes into contact with them.
- Wear the gloves supplied in the carton.
- Rinse hair thoroughly after application.
- Do not use immediately after lightening, relaxing or perming the hair.
- Do not use if your hair has been coloured with henna or with a progressive colour.
- Keep out of the reach of children. Do not use on children.

DyeCat

UNIVERSITY OF LEEDS

- Large scope for introducing sustainability into hair dyes

    - Colour forming ingredients

    - Formulation ingredients

- Subject of several projects at Leeds

DyeCat

- Oxidative hair dye system
  - Based on existing oxidative hair dye chemistry

- Eliminated most hazardous materials
  - PPD, PTD

- No ammonia

DyeCat

- Good coloration of a number of hair types

- Comparable wash fastness to current permanent hair dyes

- Range of colours is possible

DyeCat

- Natural products as hair dyes – University of Leeds
  - Full trichromatic palette required to achieve range of shades
  - Most difficult colour to achieve from natural sources is blue

  - Range of natural colours
 - Simple formulations and applications
  - Wash and light fast

DyeCat

UNIVERSITY OF LEEDS

- Successful mixtures
- Shades of brown easily obtained
- Wholly natural colour system

DyeCat

- Use of British seaweed as a resource
  - Develop a range of hair colorants and hair and skin care agents derived from British seaweeds with a whole life cycle of sustainability technology

- Consortium project
  - Böd Ayre Products Ltd
  - University of Leeds
  - Critical Processes Ltd
  - DyeCat Ltd
  - L'Oreal
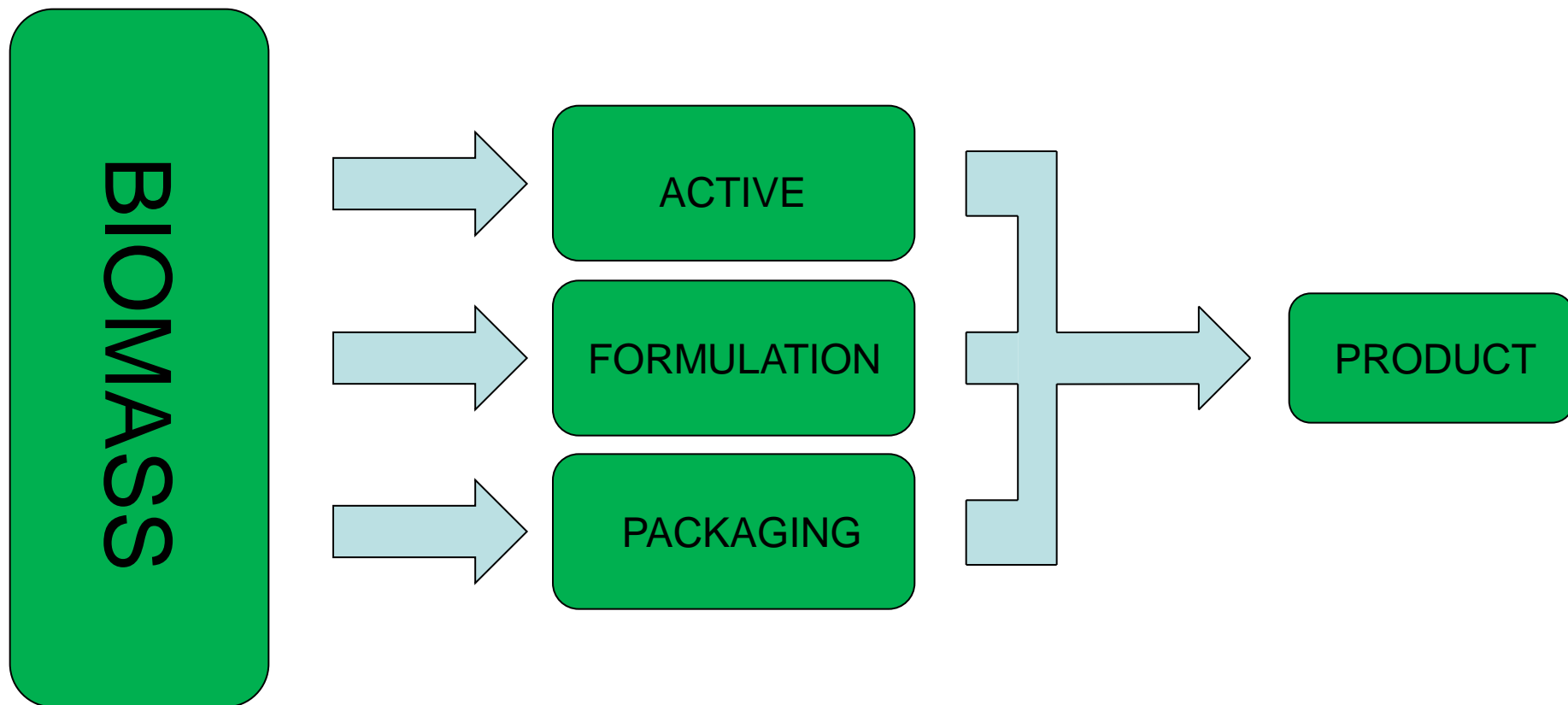 - Independent Cosmetic Advice Ltd
  - Higgins' Consultancy Ltd

DyeCat

Shetland Seaweed

UNIVERSITY OF LEEDS
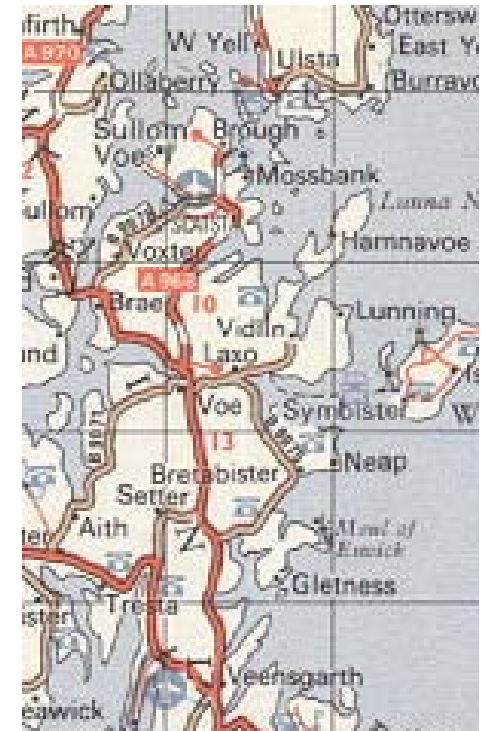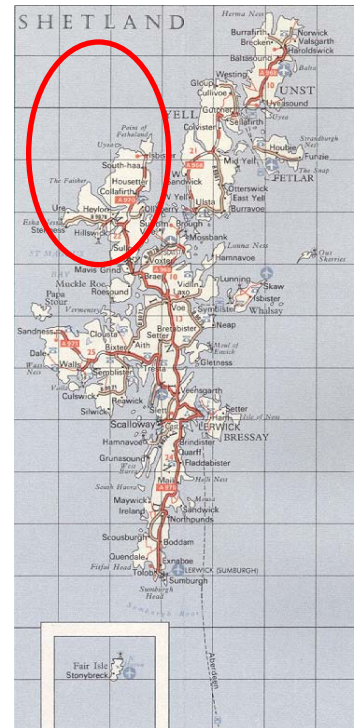
- Why seaweed?

  - Natural ingredients

  - Sustainable source

  - Already well used

  - Doesn't compete with land for crops

  - Incredible array of potential applications

  - New industry for Shetland

DyeCat

Control

DyeCat

UNIVERSITY OF LEEDS

DyeCat

UNIVERSITY OF LEEDS

DyeCat