



innospec 

Touching Everyday Lives

A Brief Introduction to Hair and Science of Hair Care Products

Dr Matthew Giles

2nd September 2016

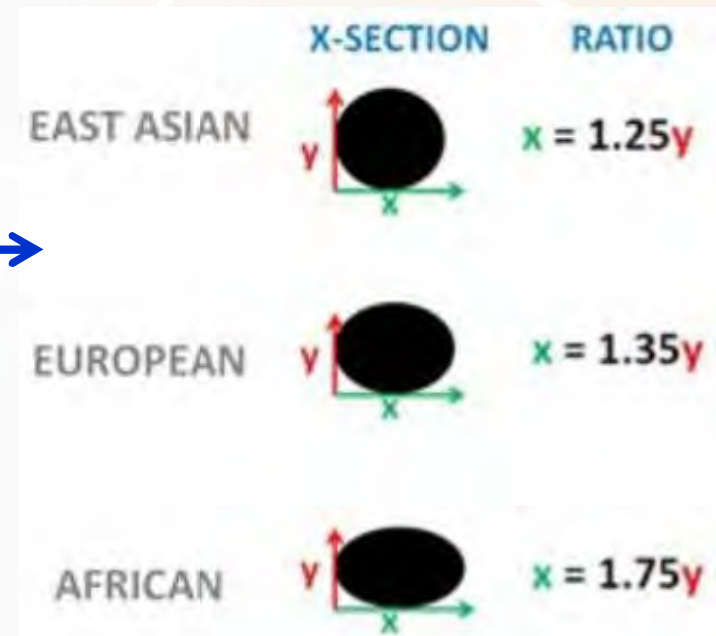
Contents

- ▶ Hair and hair structure
- ▶ The hair care market
- ▶ The science of hair care products
 - Shampoos
 - Conditioners
 - Styling products
 - Perms
 - Relaxers

Hair Facts

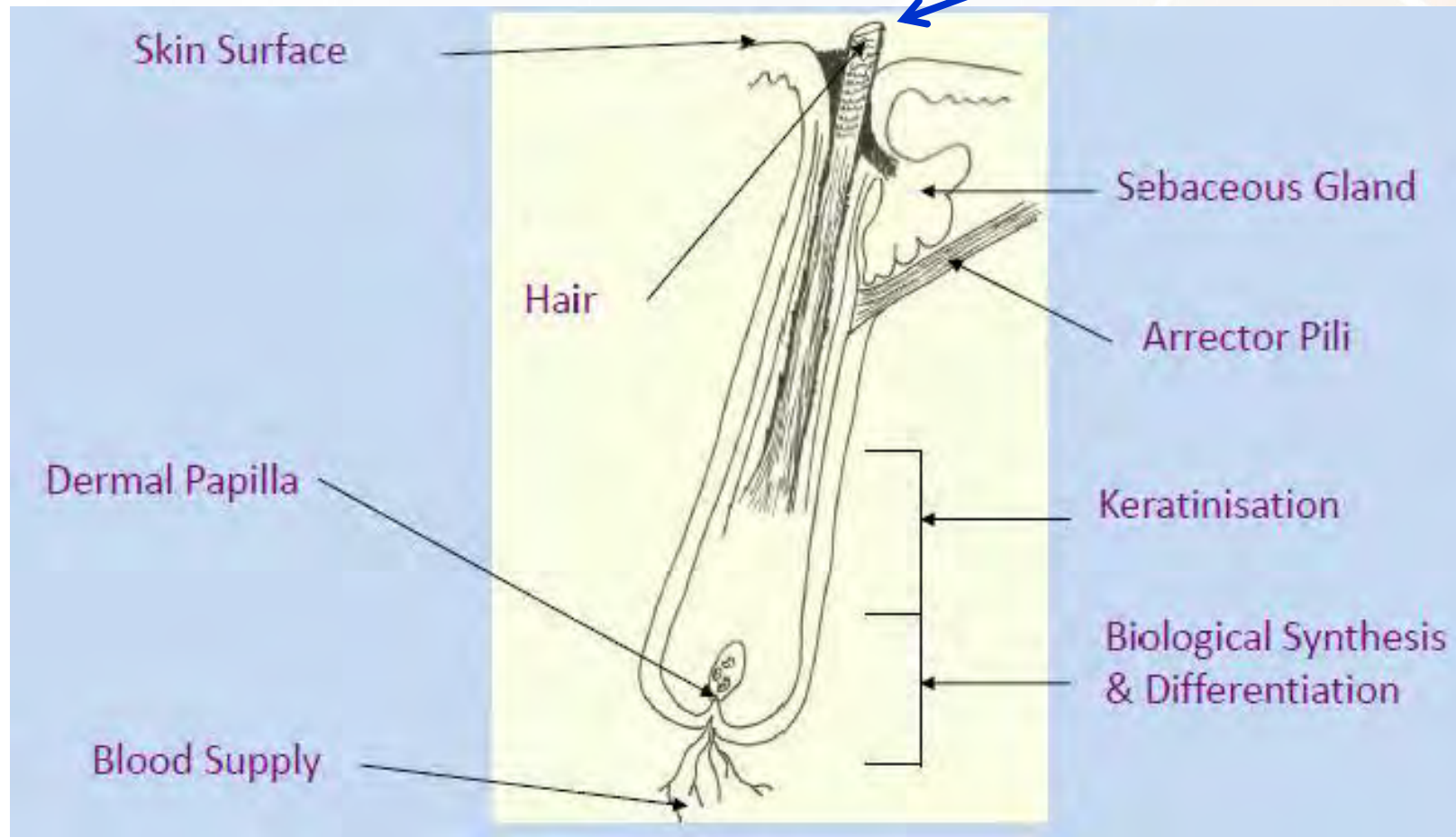
- Hair grows from a pocket in the skin – the follicle.
- There are c. 100,000 hairs on the head.
- The hair fibre grows around 0.4 mm/day.
- Average of 70 micron diameter (genetically dependent).
- Varies from round through to very oval. →
- Surface area of a full head of hair - 6.6 sq. m/head.
- Hair grows in repeated 5-7 year life cycles
- Each cycle has three phases:
 - Anagen - Growth Phase
 - Catagen - Transitional phase
 - Telogen - Resting Phase
- 100 - 200 hairs lost each day.
- Baldness more likely in men to be genetically determined.
- Hair Colour is also genetically determined.

Fibre-cross section of different racial types:



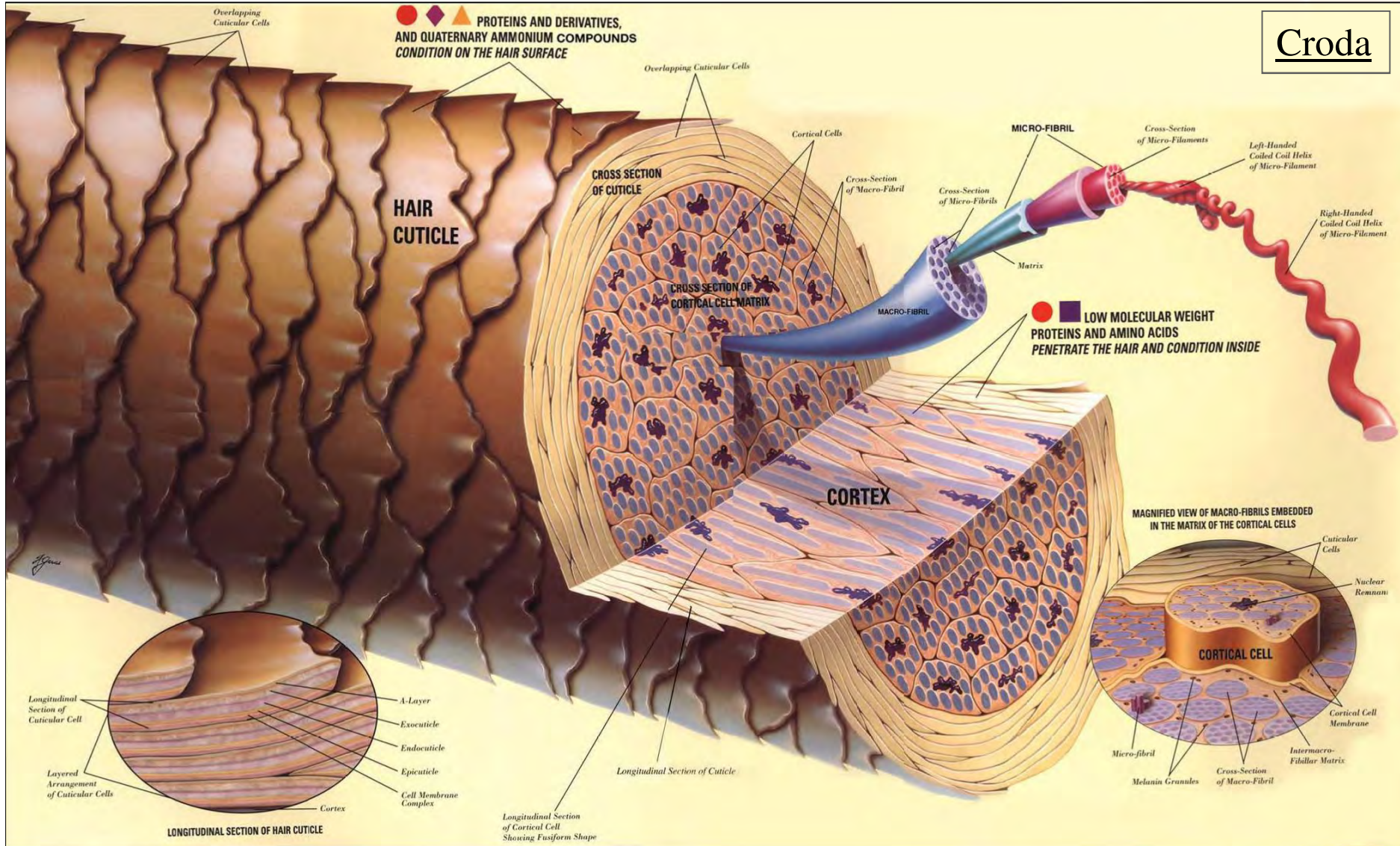
Hair Follicle

Hair is a **dead substrate** when it emerges from the hair follicle



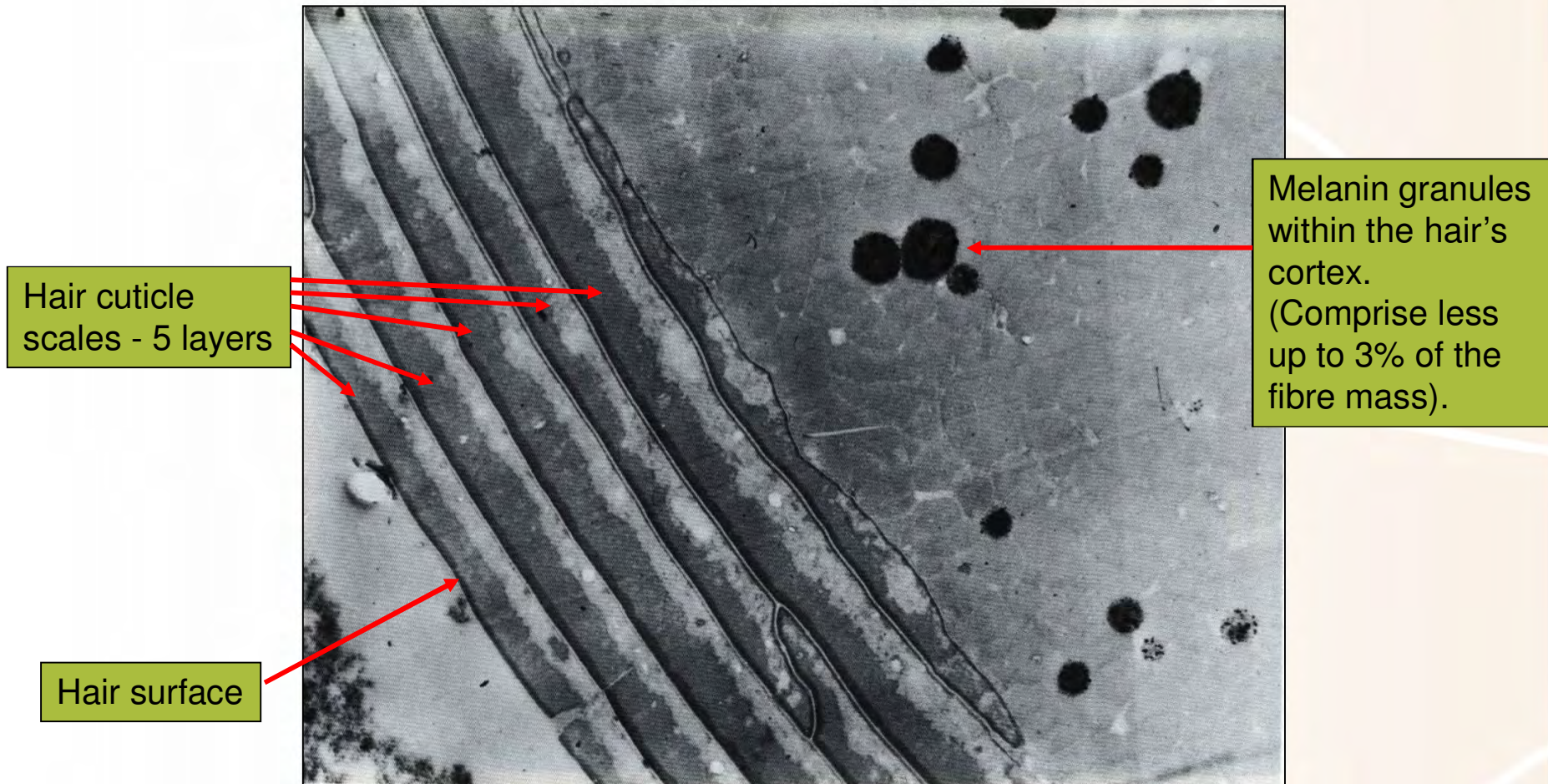
The Complexity of Hair Structure

Croda



Hair composition: Protein (91%), Lipids (4%), **Sulfur (4.7%)**, Sugars (1%), Melanin (black hair) (4%).

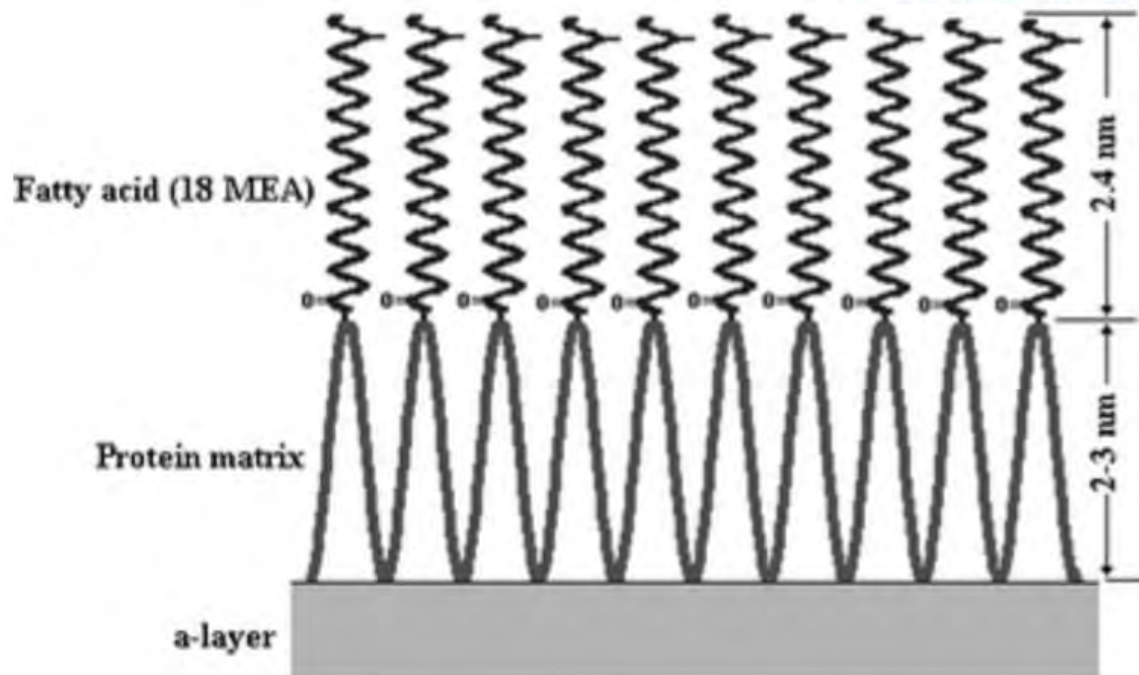
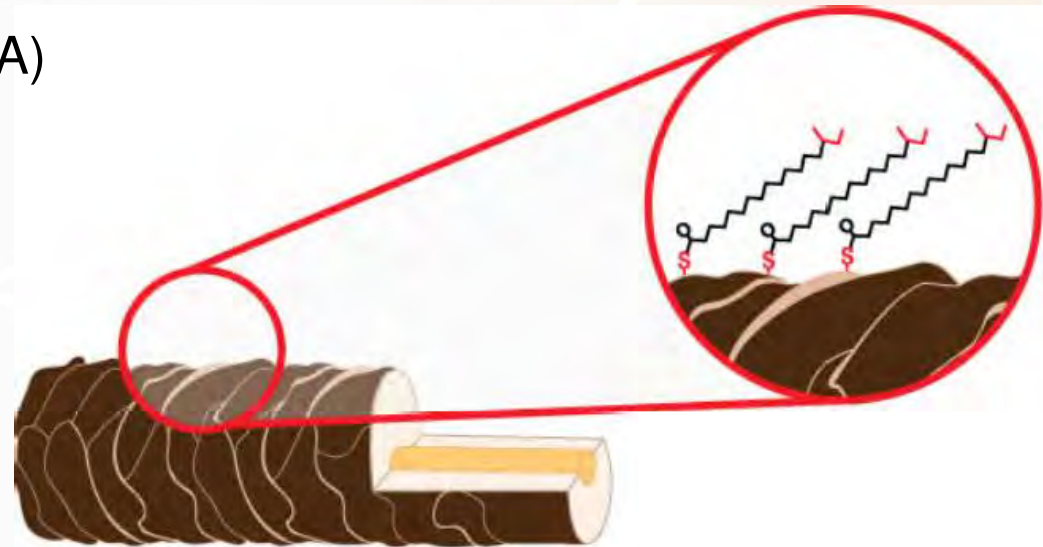
Natural Hair Colour - Melanin



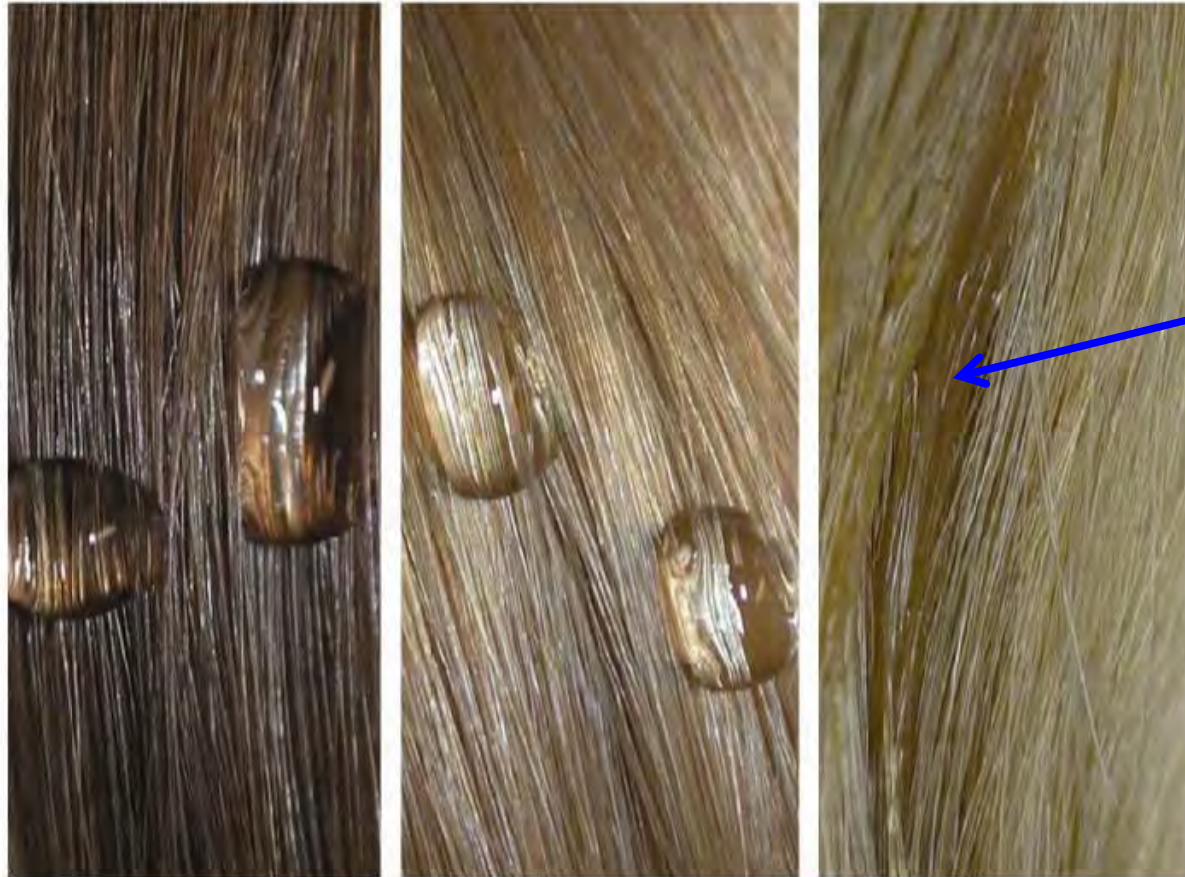
Melanin is only found in the cortex – diffusely spread and as discrete granules. The amount and type determines the hair colour

Lipid Layer Covalently Bound to the Hair Surface

- 18-methyleicosanoic acid (18-MEA)
- The hair's 'natural' conditioner.
- Covalently bound through a thio-ester linkage
- This makes new hair hydrophobic
- This can be lost due to sunlight and/or chemical treatments



Hydrophobic Nature of Hair Which Has Not Been 'Chemically' Treated vs Hydrophilic Nature of Hair Which Has Been Bleached/Oxidatively Coloured



Water absorbs into hair due to lipid layer having been removed making it hydrophilic

Natural light Brown human hair - No chemical treatment. Hair is hydrophobic

Natural blonde human hair - No chemical treatment. Hair is hydrophobic

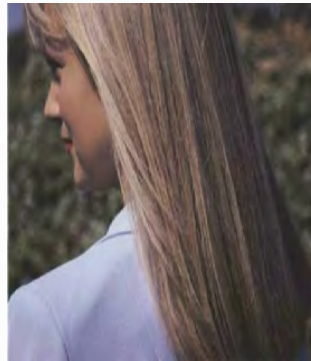
Bleached/oxidatively dyed human hair - . Hair is hydrophilic

Hair Racial Types



Asian

Hair is very straight with large diameter. Nearly always black.



Caucasian

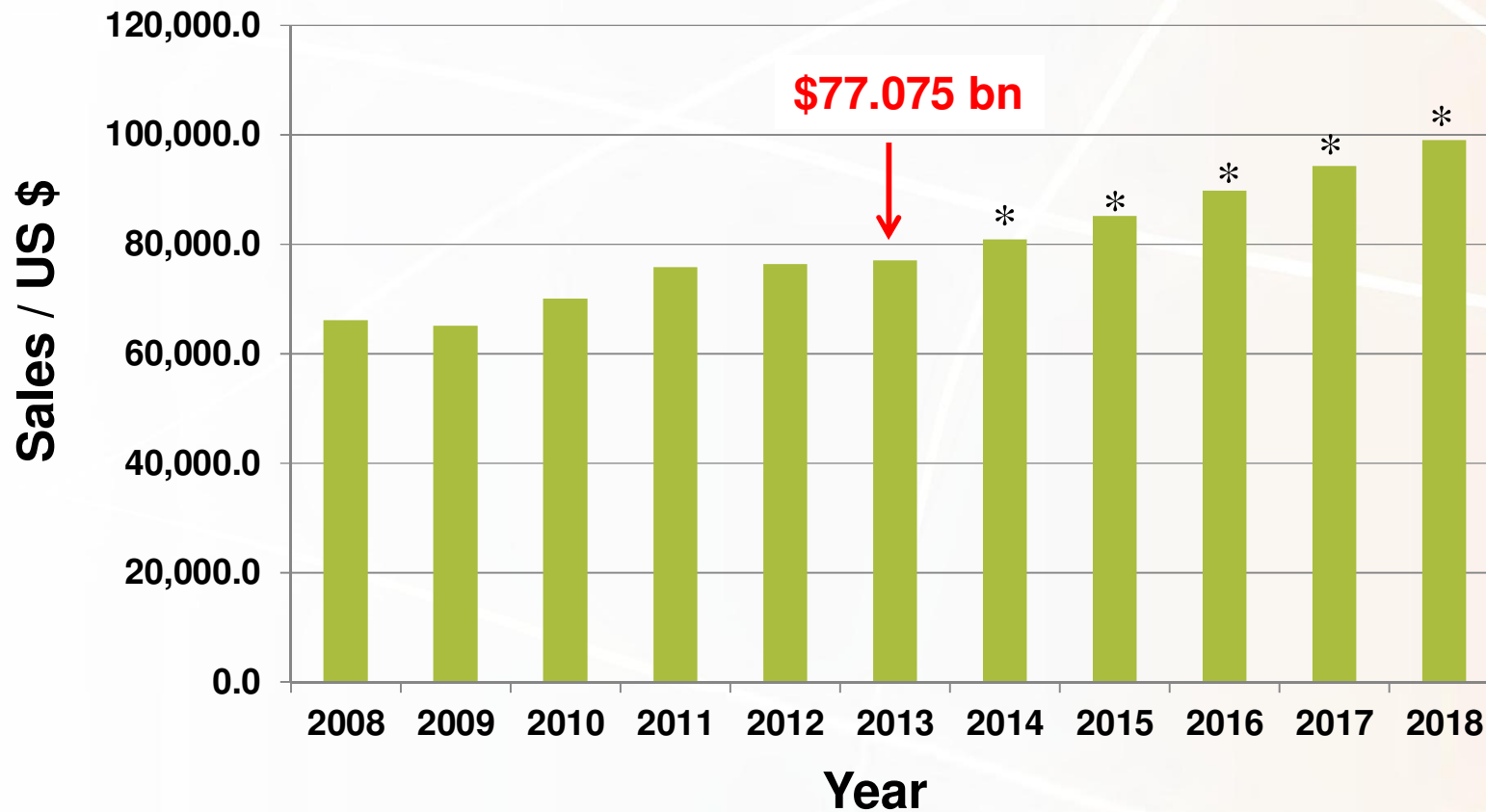
Hair can be wavy or straight. Diameter can range from very fine to moderate. Colour ranges from black to blond.



African

The hair is usually black and tightly curled. It is extremely easily damaged

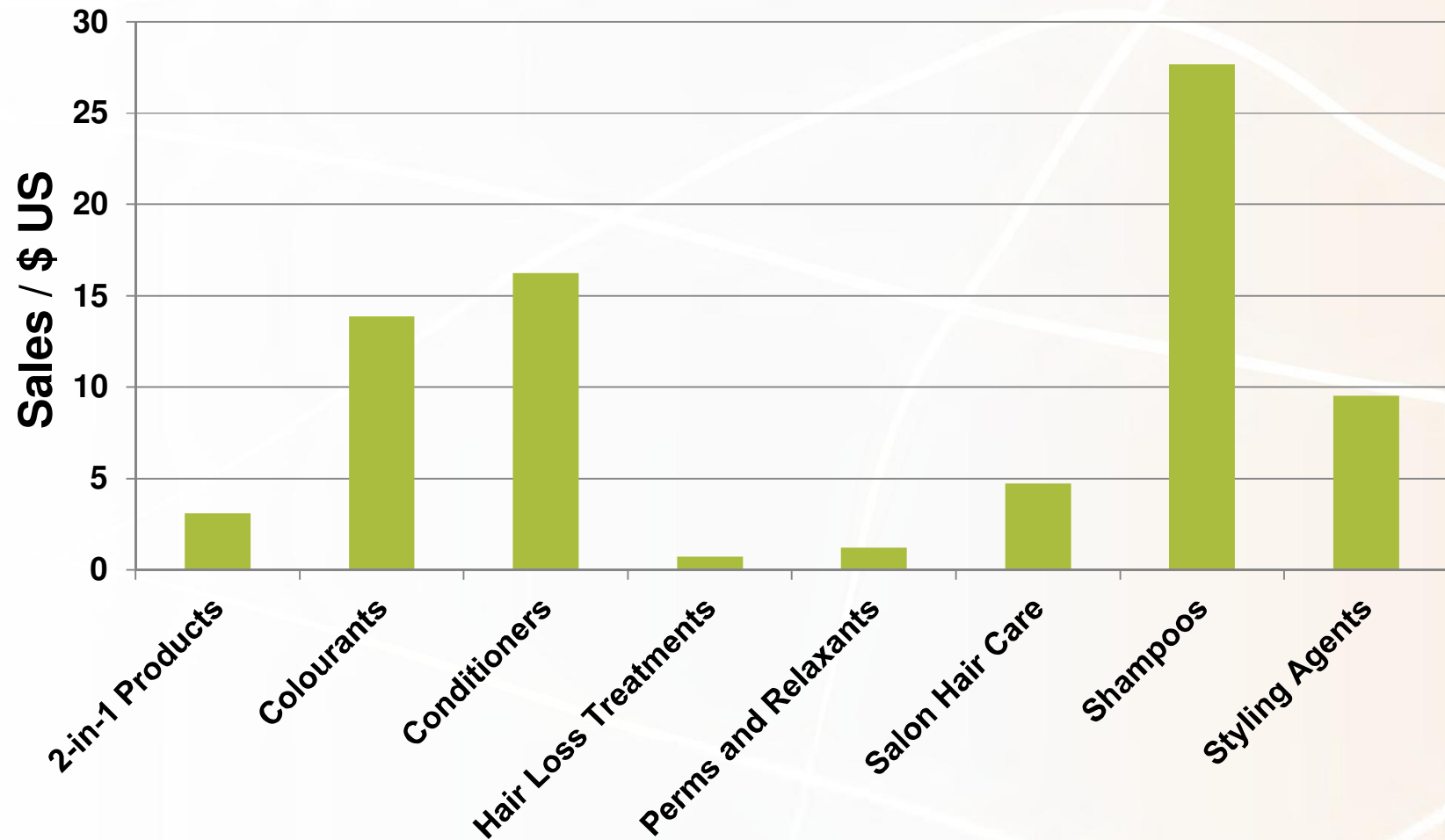
Hair Care Products Total Global Sales



* Forecasted values

Data provided by Euromonitor

2013 Global Hair Care Product Sales By Category



Data provided by Euromonitor

UK Hair Product Category Split 2013



Total UK Haircare = £1.5 bn

Major Hair Product Types

- **Shampoos**
 - Non-conditioning
 - Conditioning (2 in 1)
 - Dry
- **Conditioners**
 - Rinse-off
 - Leave-on
 - Serums
- **Styling agents - Temporary**
 - Hair sprays – aerosol and non-aerosol (pump)
 - Mousses
 - Gels
 - Lotions
 - Waxes
 - Putties/Pastes/Pomades
- **Styling treatments - Permanent**
 - Permanent waves
 - Permanent straighteners (two-step) (Japanese)
 - Permanent straighteners (one-step) (Formaldehyde based) (Brazilian hair straightening)
 - Relaxers (for Afro hair) (Sodium hydroxide, etc based)
- **Colourants (dyes)**

Purpose of a Shampoo

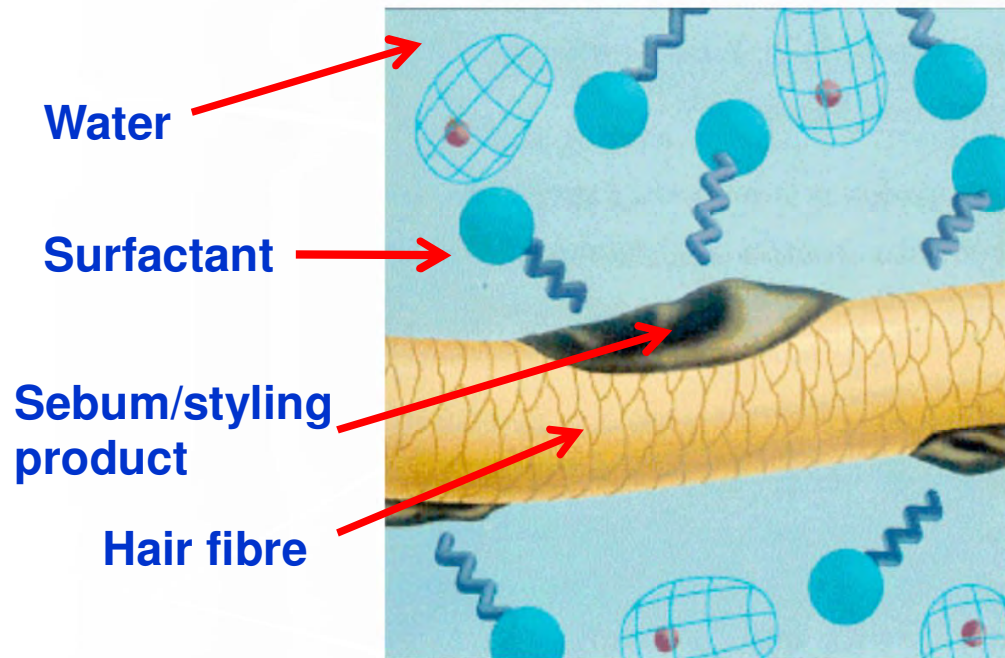
- **Primary function**

- Cleans the hair and scalp of sebum, dirt and styling products, etc – and removes odiferous materials.

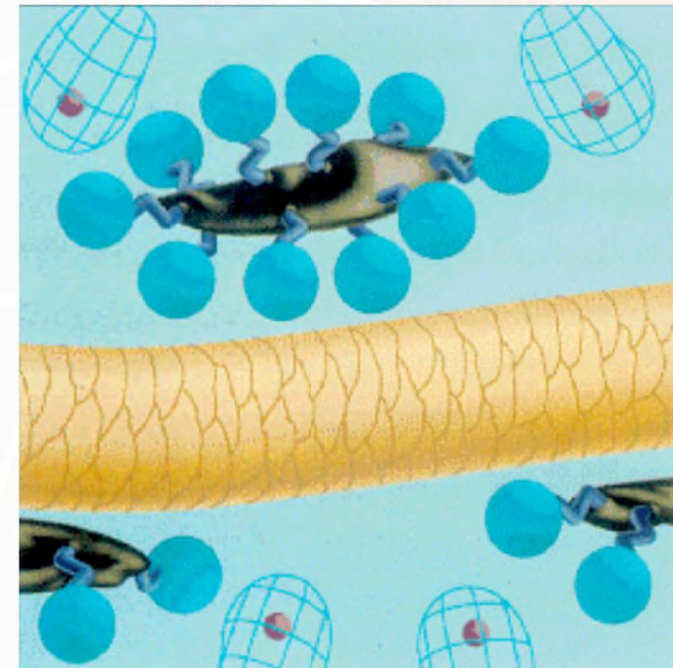
- **Secondary functions**

- Conditions the hair (gives combability, softness, protection from damage and shine).
- Gives body/volume
- Makes the hair smell pleasant.

Shampoo Cleaning Mechanism



Sebum and styling products are usually the major soils on the hair



Sebum/styling product removal by the "roll-up" mechanism

Hair Conditioning

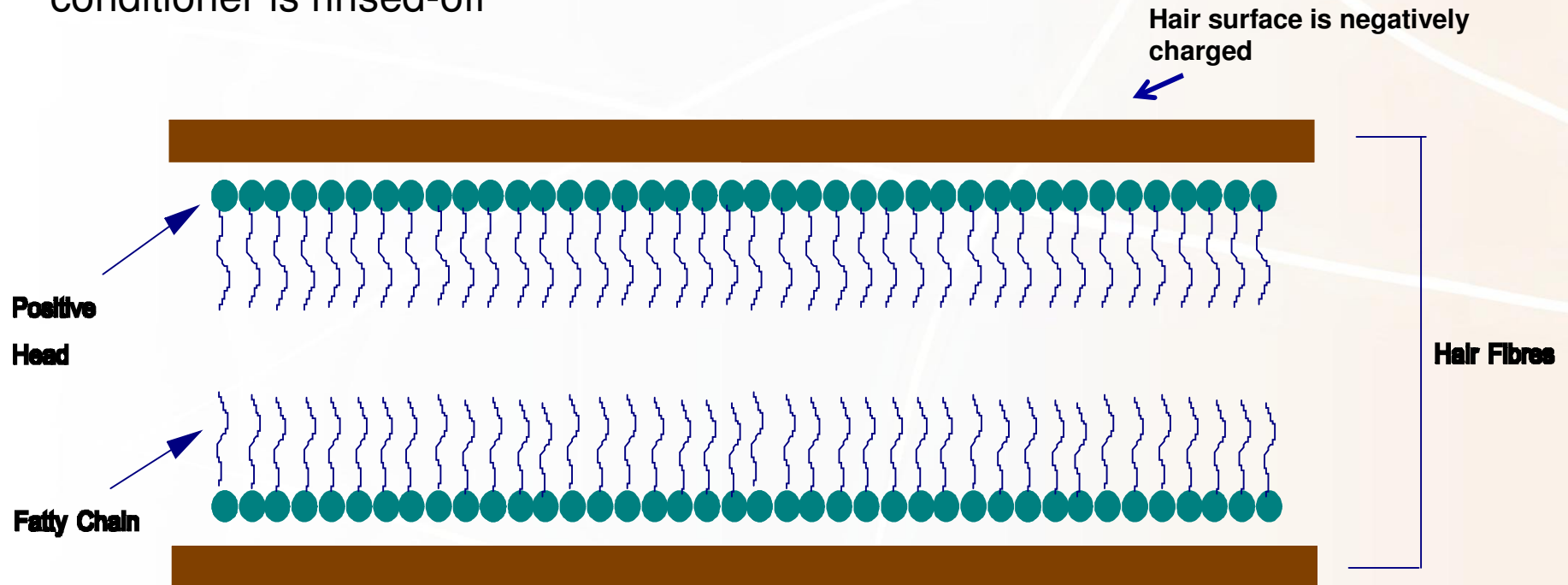
- Ways to confer conditioning to hair:
 - Conditioning '2-in-1' shampoo.
 - Rinse-conditioner
 - Leave-in conditioner
- The benefit from hair conditioners is that they leave a deposit of lubricious material on the hair that dramatically reduces the friction coefficient of the hair fibre surface:
 - Improves combability /stylability
 - Improves fibre alignment to give shine
 - Gives soft feel
 - Reduces static flyaway
 - Inhibits mechanical damage

Nicely Conditioned (and Iron Straightened!) Hair



Mechanism For Hair Conditioning from Rinse-Conditioners

- Positively charged cationic surfactants (eg cetrimonium chloride) electrostatically bind to the negatively charged hair surface and reside on the hair after the conditioner is rinsed-off



- Dramatically reduces the friction coefficient of the hair:
 - Improves combability /stylability
 - Improves fibre alignment to give shine
 - Gives soft feel
 - Reduces static flyaway
 - Inhibits mechanical damage

Hair Styling Products

- **Styling agents - Temporary**

- Hair sprays – aerosol and non-aerosol (pump)
- Mousses
- Gels
- Lotions
- Waxes
- Putties/Pastes/Pomades



- **Plethora of different types of styling polymers based on PVP, PVP/VA and vinyl acrylates. etc chemistries.**
- **Lots of different product formats.**
- **Polymers, etc dry on the hair and temporarily 'weld' fibres together to hold the hair in the desired style.**

- **Styling treatments - Permanent**

- Permanent waves
- Permanent straighteners (two-step) (Japanese)
- Permanent straighteners (one-step) (Formaldehyde based) ('Brazilian' hair straightening)
- Relaxers (for Afro hair) (Sodium hydroxide, etc based)



- **All involve chemistries which react with the hair:**
 - Thioglycolate
 - Formaldehyde
 - Sodium hydroxide
- **Hair is permanently 'reconfigured' to maintain the desired new style (curly or straight).**



Permanent Waving ('Perming') of Hair



Kevin Keegan's perm



Application of a Perm in a Salon

'Professional' perming kit example



Applicator
Nozzles

Instructions

Polythene
Gloves

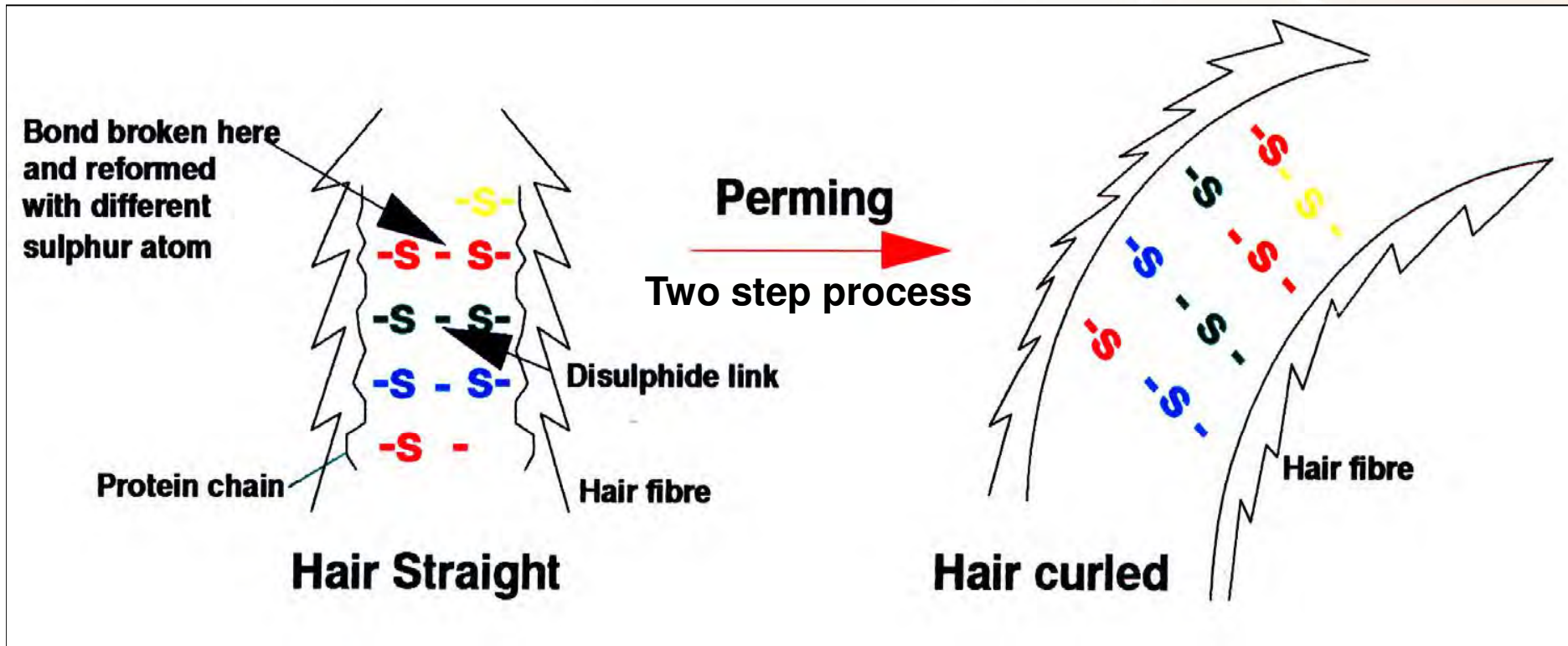
Perm
Lotion

Neutraliser

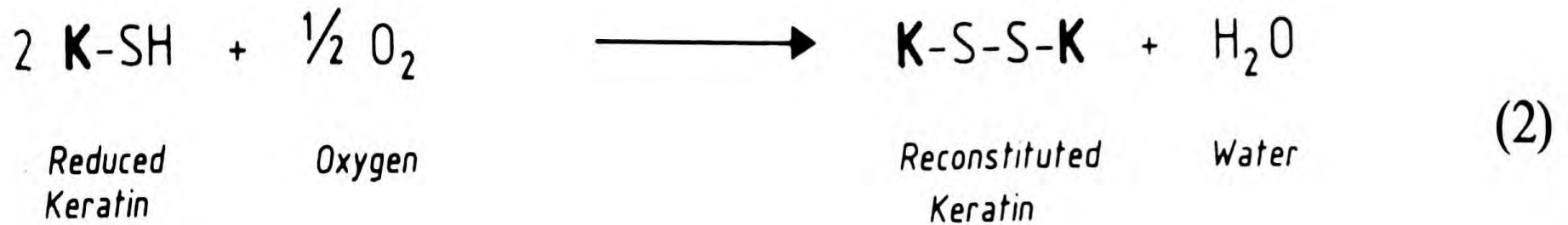
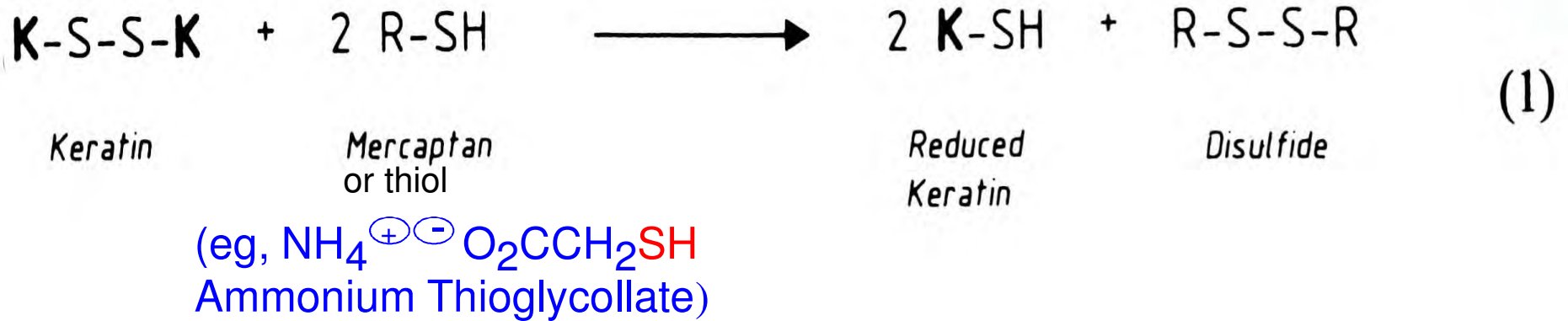
Rollers applied to the head ready for perm
lotion application etc

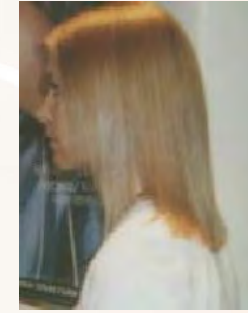
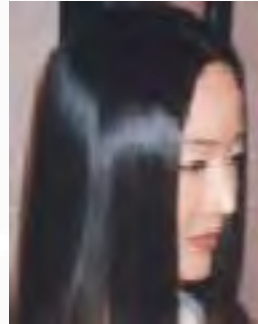


Schematic of Permanent Waving

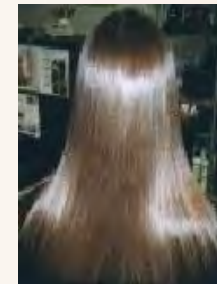


Reactions Involved In Hair Permanent Waving





Straighteners - For Caucasian & Asian Hair

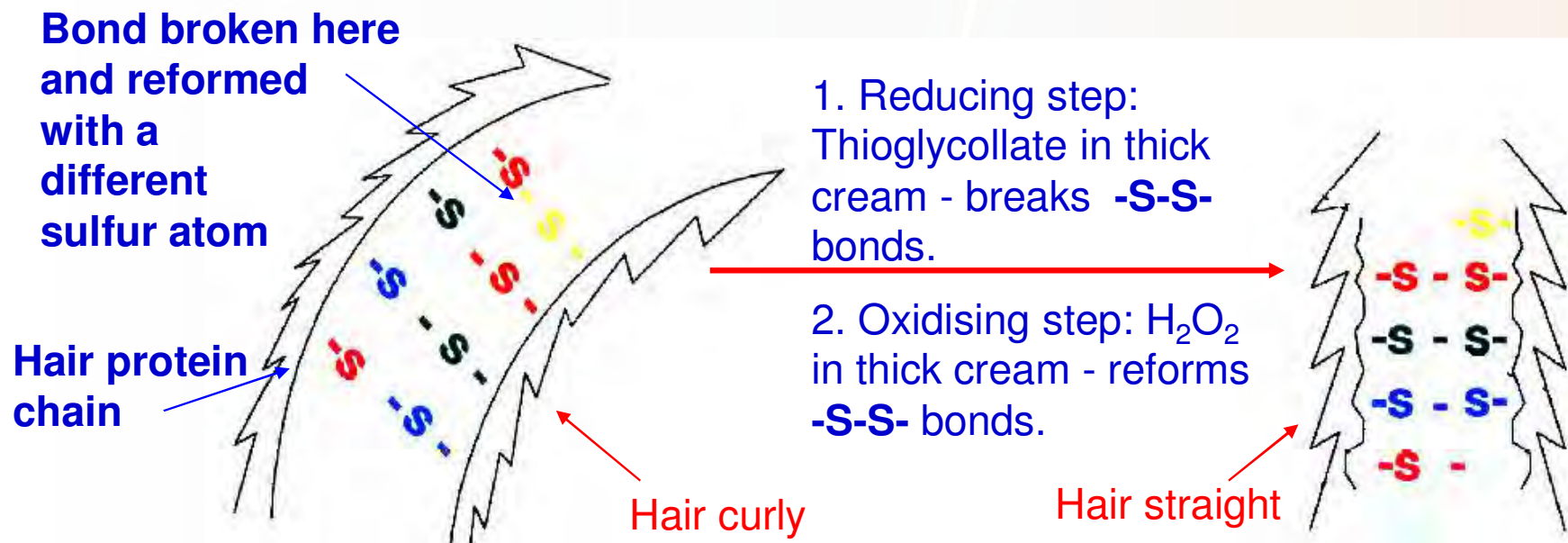


Caucasian & Asian Hair Straightening

Product function: To permanently straighten naturally curly hair or hair that has been permed.

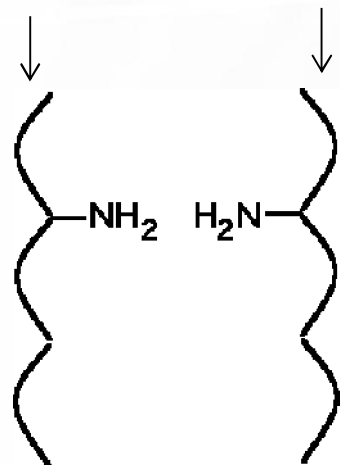
Same 'active' ingredients as used for Permanent Waving (reduction step followed by oxidation step) but the hair is held straight rather than on rollers for the whole process. (ie, uses the same chemistry as permanent Waving).

Products are thick creams to hold the hair straight. Contrast to perm products which are water-thin liquids and require the use of rollers.



'Brazilian Keratin' Hair Permanent Straightening Treatment

Hair protein chains

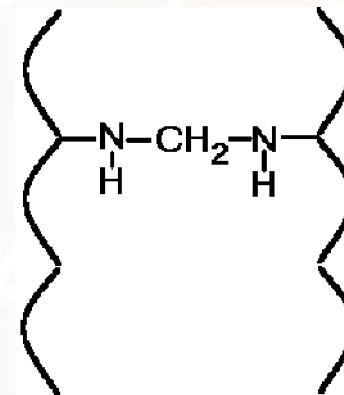


Untreated hair



Formaldehyde

Hair mechanically straightened
with hot ceramic irons

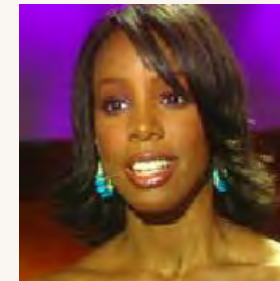
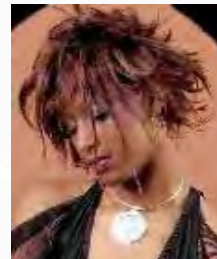


Hair protein chains cross-linked by
methylene group from Formaldehyde

- Started to hit the market in 2007.
- Products on the market containing up to 4% Formaldehyde! (but not allowed in Europe!)
- Exact mechanism of effect is not exactly known but is heat mediated.
- Can apparently be used on both Caucasian and Afro hair types.
- Authorities trying to stamp out illegal use of high levels of formaldehyde used.
- Other, safer hair reactive treatments have been identified but not as effective.



Permanent Straighteners Afro-Hair - 'Relaxers'

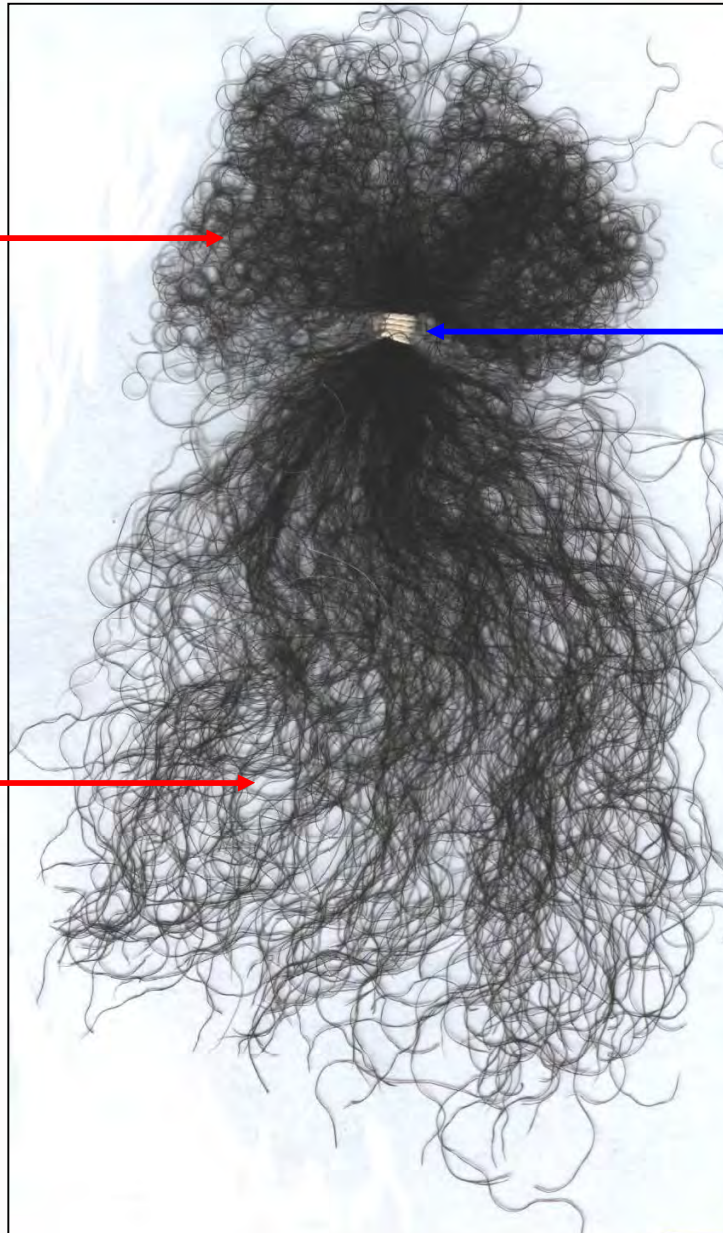


Sample of Afro-Caribbean Hair

Root end.
Tightly curled

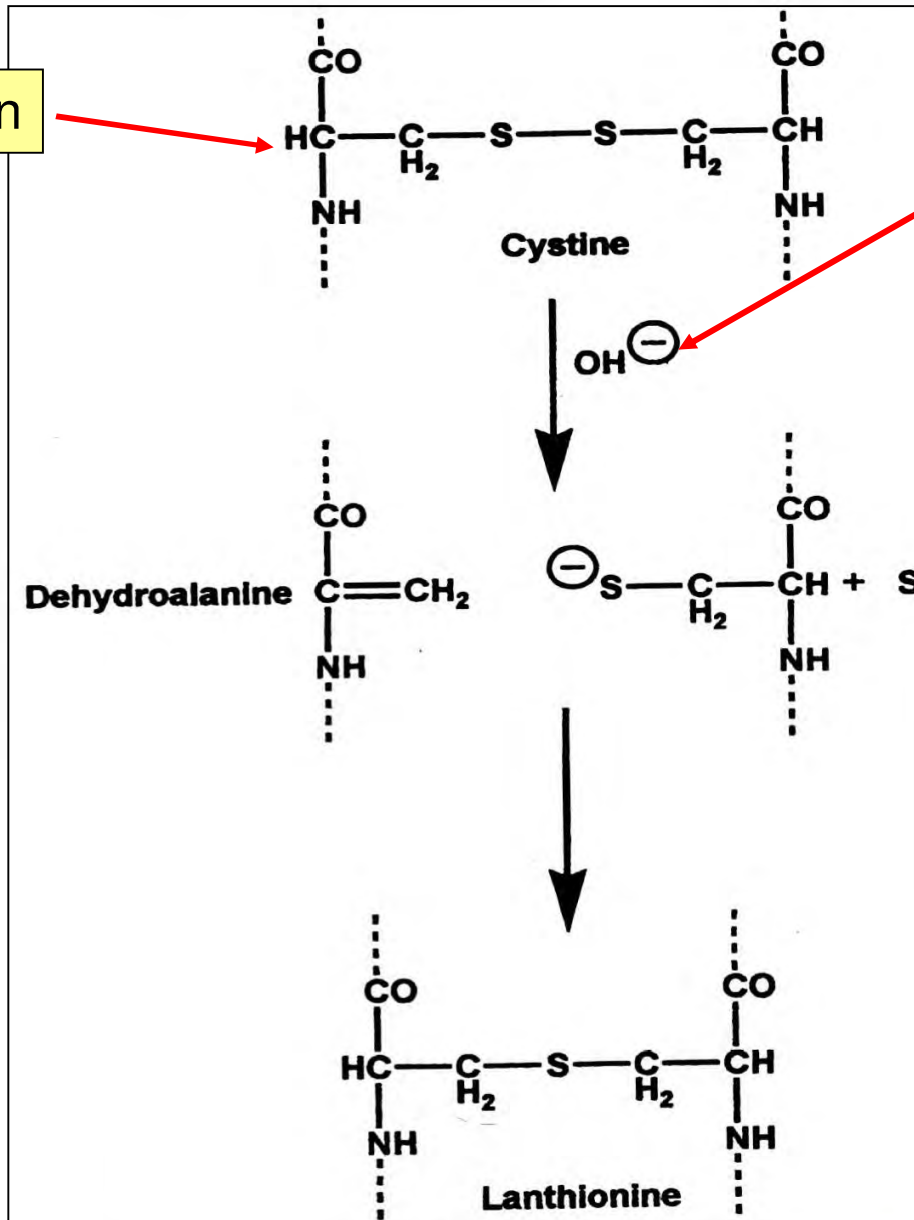
String keeping
bundle of hair
together

Tip end.
Looser curl -
remnants of
'relaxer' treatment



Reaction Involved in Hair 'Relaxing' (Straightening) With Hydroxide - The Formation of Lanthionine

Hair Keratin



Hydroxide anion
(from eg, NaOH)

Unlike perming chemistry, the treatment is one-step and the result is irreversible. Note - Permanent wave chemistry is not strong enough to break the necessary number of -S-S- bonds to give effective 'relaxing'. Need to break c. 30% - 40% compared to c. 20% from perming chemistry (thiol).

Relaxing products are formulated as very thick creams to hold the hair straight during the treatment.



Conclusions

- ▶ Hair structure is very complex
 - Varies from person to person
- ▶ The hair care market is growing globally
 - Developing countries
- ▶ A number of different products are need to
 - Clean
 - Condition
 - Style
 - Temporary
 - Permanent
 - Bleaches, dyes etc.

innospec 

Touching Everyday Lives

**Thank you for
your attention**

