

Jockey Club STEAM Education Resources Sharing Scheme

Beauty and the Skin

Laboratory Manual and Worksheets

Name: _____

Class: _____

School: _____

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Background

Introduction

“Beauty the Skin” is one of the core modules in the scheme to enhance students’ interest in learning, STEAM is a project which integrates KLAS from different subjects.

This module consists of four units covering science, technology, engineering, arts and mathematics:

- ◆ Unit 1 – Is the Skin Important to Us?
- ◆ Unit 2 – The origin of Cosmetics
- ◆ Unit 3 – The magic of Cosmetics
- ◆ Unit 4 – Making Your Own Cosmetics and Skincare products

By applying different knowledge and techniques in STEAM, the four units combined form a single project of cosmetics about studying and investigating the biological and chemical knowledge and theories of them.

Learning outcomes

Upon the completion of the module, you should be able to:

- ◆ Identify different structures and parts of the skin
- ◆ Describe the functions of the skin
- ◆ Understand how cosmetics affect the conditions of the skin
- ◆ Explain the effects of cosmetics by applying chemical and biological theories
- ◆ List out the functions of different active ingredients and essential oils used in skincare products
- ◆ Make their own skincare products

Unit 1 – Is the Skin Important to Us?

1. Introduction

Skin is one of the most important organs in the human body. Having surface area about $1.5 - 2 \text{ m}^2$ in adults, it is the largest sensory organ as well in the human body. Consisting of two main layers of different types of cell, skin is the most important organ for protection against external influences such as UV radiation, pathogens and irritants.

Besides a protective layer, skin is also indispensable for body defence, body water and temperature regulation. The unique structural features and cell types of the skin make it possible to work normally under harsh environmental conditions. In order to understand how cosmetics help to maintain the health of human skin, you are expected to have basic knowledge of anatomy of the skin.

In this unit, anatomy and physiology of the human skin will be introduced. This unit will familiarise you with basic knowledge of the human skin which is necessary for students to understand Unit 2.

2. Summary of Unit 1

2.1 The structure of the skin

- ◆ Skin has three major layers including:
 - Epidermis
 - Dermis
 - Subcutaneous fat
- ◆ Different layers of skin have their own properties and functions

Epidermis:

- ◆ It is the outermost layer of the skin
- ◆ It comprises three main layers: The Malpighian layer, the middle layer and the cornified layer
- ◆ The Malpighian layer:
 - Produces new cells by mitosis
 - Produces melanin for UV protection of the skin
 - Produces vitamin D
- ◆ The middle layer:
 - Comprises living cells
 - The content will be replaced by the fibrous protein keratin
 - Their nuclei will disappear and the cells will die
- ◆ The cornified layer:
 - The outermost layer
 - Consists of dead cells
 - Prevents invasion of pathogens, protects from minor injuries
 - Reduces water loss

Dermis:

- ◆ A thicker layer of connective tissue
- ◆ Consists of several important structures:
 - Hair follicles, hair and erector muscles
 - Sebaceous glands
 - Sweat glands
 - Sensory receptors and nerves
 - Blood vessels

Subcutaneous fat:

- ◆ Consists of fat cells and connective tissues
- ◆ For insulation
- ◆ Fat storage
- ◆ Reduce heat loss

2.2 The Importance of the skin

- ◆ The human skin has a lot of vital functions:
 - Body temperature regulation
 - Body defence
 - Sensation (touch, heat and pain)
 - Management of water content in the body

Body temperature regulation:

- ◆ Under hot conditions, heat loss from the skin (body) increases
 - The blood vessels near the skin surface will dilate (vasodilation)
 - Increase in sweating
 - Hairs lie flat
- ◆ Under cold conditions, heat loss from the skin (body) decreases
 - The blood vessels near the skin surface will constrict (vasoconstriction)
 - Reduction in sweating
 - Hairs are erected

Body defence:

- ◆ The skin is a non-specific defence mechanism
- ◆ Protects the body without targeting any specific pathogen
- ◆ Involves both physical and chemical barriers
- ◆ Physical barriers:
 - Protect the body from the entry of pathogens
 - Are provided by the cornified layer which consists of dead cells
- ◆ Chemical barriers:
 - Protect the body by killing or slowing down the growth of pathogens
 - Are provided by the sebum secreted by sebaceous glands

3. References

Gabriella Baki and Kenneth S. Alexander, Introduction to Cosmetic Formulation and Technology, John Wiley & Sons. Inc., 2015

Beauty and the Skin
Unit 1 – Is the Skin Important to Us?

Student Worksheet

1) Which of the following layer does the skin consist of?

- A. Epidermis
- B. Waxy layer
- C. Hairy layer
- D. Chemical layer

2) Which of the following statements about epidermis is correct?

- A. The inner layer of the skin.
- B. The thicker layer of the skin.
- C. Made of fat and connective tissue.
- D. Provide a waterproof barrier.

3) Which of the following statements about dermis are correct?

- (1) Consists of sebaceous glands, sweat glands and blood vessels.
- (2) No hair follicles structure.
- (3) Contains sensory receptors and nerves.
- (4) Is the outermost layer of the skin.

- A. (1) and (2)
- B. (2) and (3)
- C. (3) and (4)
- D. (1) and (3)

4) Which of the following statements is/are correct?

- (1) The Malpighian layer produces new cells, melanin and vitamin D.
- (2) The cornified layer consists of flattened and dead cells.
- (3) The middle layer comprises dead cells.
- (4) The epidermis layer is made of fat.

- A. (1) only
- B. (2) only
- C. (1) and (2)
- D. (3) and (4)

5) Subcutaneous fat:

- A. Consists of fat cells for insulation.
- B. Is the middle layer of the skin.
- C. Is used to reduce water loss.
- D. Comprises of dead cell.

6) Sweat glands:

- A. Secrete sweat.
- B. Produce sebum.
- C. Can slow down the growth of pathogens.
- D. Are connected to hair follicles.

7) Which of the following statements about sebaceous glands are correct?

- (1) Connected to hair follicles.
- (2) Produce sweat to keep the skin hydrated.
- (3) Produce sebum to keep the skin soft and waterproof.
- (4) Supply nutrients to hair follicles

- A. (1) and (2)
- B. (1) and (3)
- C. (3) and (4)
- D. (1) and (4)

8) The functions of the human skin are:

- A. Body temperature regulation
- B. Body defence
- C. Sensation
- D. All of the above

9) Under hot conditions, how does the skin respond?

- A. Reduce in sweating
- B. Vasodilation
- C. Hairs are erected
- D. Increase in sebum secretion

10) Which of the following statements about vasodilation are correct?

- (1) Increase in the blood flow to the skin surface
- (2) Heat loss from the blood increases
- (3) Increase in sweating
- (4) Hairs lie flat

- A. (1) and (2)
- B. (2) and (3)
- C. (3) and (4)
- D. (1) and (2) and (4)

11) Under cold conditions, how does the skin respond?

- (1) Increase in sweating
- (2) Vasoconstriction
- (3) Hairs are erected
- (4) Reduce in sebum secretion

- A. (1) and (2)
- B. (2) and (3)
- C. (3) and (4)
- D. (1) and (2) and (4)

12) Which of the following statements about body defence of the skin are correct?

- (1) Is a non-specific defence mechanism.
- (2) Involves only physical barriers.
- (3) Involves the cornified layer and the sebaceous glands.
- (4) Sweat produced can kill pathogens.

- A. (1) and (2)
- B. (2) and (3)
- C. (3) and (4)
- D. (1) and (3)

13) The physical barriers of the skin:

- (1) Involve the cornified layer of the epidermis.
- (2) Protect the body from the entry of pathogens.
- (3) Can kill bacteria.
- (4) Can inhibit the growth of bacteria.

- A. (1) and (2)
- B. (2) and (3)
- C. (3) and (4)
- D. (1) and (3)

14) The chemical barriers of the skin:

- (1) Involve sebaceous glands.
- (2) Can kill pathogens.
- (3) Involve the subcutaneous layer of the skin.
- (4) Can inhibit the growth of pathogens.

- A. (1) and (2)
- B. (2) and (3)
- C. (2) and (4)
- D. (1) and (2) and (4)

15) Which of the following statements about the skin are correct?

- (1) Helps to regulate body temperature.
- (2) Helps to protect the body.
- (3) Has three major layers.
- (4) Is a tissue.

- A. (1) and (2)
- B. (1) and (3)
- C. (1) and (2) and (3)
- D. (2) and (3) and (4)

Unit 2 – The Origin of Cosmetics

1. Introduction

Most of the cosmetics are applied directly onto the skin. Products with diverse functions such as moisturization, cleansing, anti-aging, UV protection and others, are widely used to improve or restore the skin conditions. In fact, almost all the cosmetics comprise organic compounds which the chemical structures and presence of functional groups will largely affect the functions and performance of the products. Therefore, in order to facilitate the learning of cosmetics and how they work, one should have a basic knowledge of organic chemistry.

Essential oils, one of the most frequently used active ingredients in skincare products, are a mixture of aromatic and volatile compounds extracted from natural plants. Alcohol, triglycerides, fatty acids and terpenes can be easily found in many cosmetic and skincare products. They contain different functional groups such as hydroxyl group, aldehyde, ketone and ester etc. Due to the difference in functional groups, each type of terpene has a unique combination of useful properties like moisturization and cleansing.

In this unit, you are expected to comprehend the fundamental concepts of organic chemistry such as structures, functional groups and extraction methods. This unit paves the road for finishing Unit 3 and Unit 4.

2. Summary of Unit 2

2.1 What is organic chemistry?

- ◆ It is the study of organic compounds
- ◆ Organic compounds which compose of carbon element in their structures are essential in our daily lives and they exist everywhere in the world
- ◆ One carbon atom can:
 - Form 4 single covalent bonds
 - Link up to form a chain structure
 - Form single, double or triple covalent bonds

Classification of organic compounds:

- ◆ There are different functional groups among organic compounds:
 - A saturated hydrocarbon
 - Double bond
 - Hydroxyl group
 - Carboxylic acid group
- ◆ Different functional groups have different chemical properties
- ◆ According to the presence of functional groups, organic molecules can be classified into different homologous series:
 - Alkanes
 - Alkenes

- Alkanols
- Alkanoic acid

2.2 Polarity and intermolecular forces

Polarity:

- ◆ Organic compounds can be classified into polar or non-polar compounds
- ◆ Polarity is a relative concept (no absolute standards)
- ◆ Polar compounds: Compounds consisting of elements with big electronegativity difference
- ◆ Non-polar compounds: Compounds consisting of elements with small electronegativity difference
- ◆ **Like-dissolve-like principle:** 1) Polar compounds dissolve polar compounds
2) Non-polar compounds dissolve non-polar compounds
3) Polar compounds cannot dissolve non-polar compounds

Intermolecular forces:

- ◆ Van der Waals' forces: Due to the attraction between temporally partial +ve and –ve charge
- ◆ Higher the Van der Waals' forces, higher the boiling point, melting point and viscosity

2.3 Important organic substances

Detergents:

- ◆ For object-washing: dishes, furniture, cars, window and floor etc.
- ◆ For body-washing: bathing, hand-cleaning, hair-cleaning etc.
- ◆ Types of detergents:
 - Soap
 - Soapless

	Soap	Soapless
Made from	Animal and plant fats	Petroleum
Made of	Fatty acids	Hydrocarbon
How to make	By the reaction of fatty acids with alkali (Saponification)	By a series of chemical reactions

Structures of soap and soapless particles:

- ◆ Soap consists of a hydrophilic head and a hydrophobic tail
- ◆ The hydrophilic head: Carboxylate group
- ◆ The hydrophobic tail: Alkanes
- ◆ Soapless also consists of a hydrophilic head and a hydrophobic tail
- ◆ The hydrophilic head: Sulphate group
- ◆ The hydrophobic tail: hydrocarbon (e.g. alkanes, aromatics)

Emulsification:

- ◆ It is a process to disperse two immiscible liquids (like oil and water) to form a homogeneous mixture

- ◆ Since oil is a non-polar liquid and water is a polar liquid, they are immiscible (like-dissolve-like principle)
- ◆ However, once an emulsifier is added, the immiscible mixture will become miscible and homogeneous
- ◆ The chemical structure of emulsifier can be divided into two regions, hydrophobic (non-polar) region and hydrophilic (polar) region
- ◆ Therefore, detergents comprise two regions

Skin cleansing products:

- ◆ Consist of surfactants to remove any dirt found on the skin
- ◆ Internal and external dirt:
 - Internal: sweat, sebum and dead skin cells
 - External: dust, residues of cosmetics and environmental impurities
 - Surfactants used: sodium lauroyl sarcosinate and sodium cocoyl isethionate
 - Both of them are emulsifiers and mild to the skin

2.4 Separation and purification methods

- ◆ The most commonly used techniques are: Distillation and extraction
- ◆ Many useful organic compounds can be obtained from the nature (e.g. plants, animals, sea and earth)
- ◆ To obtain organic compounds from plants, distillation and extraction are applied

Distillation:

- ◆ Simple distillation
 - By making use of the great difference of two compounds in boiling points (b.p.)
 - Involving vaporizing a liquid and then condensing the vapour
 - Example: separation of pure water from sea water
- ◆ Fractional distillation
 - Can be used to separate miscible liquids with similar boiling points.
 - Using fractionating column with glass beads providing a large surface area
 - Repeated vaporization and condensation of the target mixture occur

Extraction:

- ◆ Used when we need to separate two immiscible liquids
- ◆ By using separating funnel
- ◆ Making use of the differences in polarity and density of two liquids

Obtaining essential oil from plants:

- ◆ Two advanced techniques are used: steam distillation and Soxhlet extraction
- ◆ Steam distillation:
 - By using hot steam to carry the essential oil from the plant to the condensation chamber
- ◆ Soxhlet extraction:
 - Repeated extraction by vaporization and condensation of extraction solvents
 - The extracted essential oil will stay in the distillation flask without vaporization

3. References

Gabriella Baki and Kenneth S. Alexander, Introduction to Cosmetic Formulation and Technology, John Wiley & Sons. Inc., 2015

Beauty and the Skin
Unit 2 – The Origin of Cosmetics

Student Worksheet

1) Which of the following compounds is classified as organic compound?

- A. Carbon monoxide
- B. Carbon dioxide
- C. Sodium carbonate
- D. Fatty acid

2) Which of the following statements about carbon atom are correct?

- (1) Can form 4 single covalent bonds
- (2) Can form 4 double covalent bonds
- (3) Can link up to form a chain structure
- (4) Can form triple covalent bond

- A. (1) and (2)
- B. (2) and (3)
- C. (1) and (3) and (4)
- D. (2) and (3) and (4)

3) The name of homologous series of saturated hydrocarbon is?

- A. Alkanes
- B. Alkenes
- C. Alkanols
- D. Alkanoic acids

4) The name of homologous series of compounds with hydroxyl group is?

- A. Alkanes
- B. Alkenes
- C. Alkanols
- D. Alkanoic acids

5) The name of homologous series of compounds with carboxylic acid group is?

- A. Alkanes
- B. Alkenes
- C. Alkanols
- D. Alkanoic acids

6) Which of the following statements about functional groups are correct?

- (1) Different functional groups have different chemical properties
- (2) Different functional groups have different polarity
- (3) Different functional groups have different number of carbon atoms
- (4) Different functional groups have different density

- A. (1) and (2)
- B. (1) and (3)
- C. (2) and (3)
- D. (2) and (4)

7) Which of the following statements about polarity are correct?

- (1) Water (H_2O) is more polar than hexane (C_6H_{14})
- (2) Table salt is more polar than vitamin D
- (3) Polar compounds can dissolve non-polar compounds
- (4) Non-polar compounds can dissolve polar compounds

- A. (1) and (2)
- B. (1) and (3)
- C. (2) and (3)
- D. (2) and (4)

8) Which of the following statements about the Van der Waals' forces is correct?

- A. It is a kind of covalent bond
- B. It is due to uneven distribution of electrons
- C. Higher the molecular size, lower the Van der Waals' forces
- D. Higher the Van der Waals' forces, lower the boiling points

9) Soaps:

- A. Are made from petroleum
- B. Consist of fatty acids
- C. Consist of hydrophobic head
- D. Consist of hydrophilic tail

10) Which of the following statements about emulsification are correct?

- (1) The hydrophobic tail of detergent stays in oil phase
- (2) The hydrophilic head of detergent stays in water phase
- (3) The hydrophobic tail of detergent stays in water phase
- (4) The hydrophilic head of detergent stays in oil phase

- A. (1) and (2)
- B. (1) and (3)
- C. (2) and (3)
- D. (2) and (4)

11) Which of the following methods can be used to obtain essential oil from plants?

- (1) Saponification
- (2) Polymerization
- (3) Extraction
- (4) Distillation

- A. (1) and (2)
- B. (1) and (3)
- C. (2) and (3)
- D. (3) and (4)

12) Which of the following statements about distillation is correct?

- A. Used to effectively separate two immiscible liquids
- B. Making use of the difference in melting points
- C. Involves vaporization only
- D. Involves both vaporization and condensation

13) Which of the following statements about extraction is correct?

- A. Used to separate two immiscible liquids by using separating funnel
- B. By making use of the difference in boiling points
- C. By making use of the difference in melting points
- D. Involves condensation

14) Steam distillation:

- (1) Water is vaporized to form hot steam
- (2) Essential oil is obtained by passing through hot steam
- (3) In the reservoir, only essential oil is collected
- (4) The plant is directly immersed into the water bath

- A. (1) and (2)
- B. (1) and (3)
- C. (2) and (3)
- D. (3) and (4)

15) Which of the following statements about Soxhlet extraction is correct:

- A. Separation funnel is used
- B. The plant is directly immersed into the solvent bath
- C. Distillation flask and condenser are used
- D. Heating is not required

Unit 3 – The Magic of Cosmetics

1. Introduction

Since human skin is the largest organ continuously in contact with the environment, the conditions and normal functions of it such as pH, water content and barrier properties are persistently affected. Because of that, there are numerous cosmetic and skincare products such as cleanser, moisturizer, protective and nourishing creams and lotions available in the market to help for maintaining the normal conditions of the skin.

In this unit, the working principle of cosmetic and skincare products will be illustrated. Three important areas will be covered, including skin conditions, how chemicals in cosmetic can affect the skin conditions and common cosmetic ingredients (i.e. essential oils) and their effects. After that, you will be given an opportunity to design and make your own skincare products.

2. Summary of Unit 3

2.1 Normal conditions of the skin

Water content:

- ◆ The normal % of water content is around 80%
- ◆ For the cornified layer, the water content is around 20%
- ◆ Skin with normal water content is smooth, soft and flexible
- ◆ Skin with water content lower than normal could be tight, dry and itchy

- ◆ In order to keep the moisture of the skin, we need to minimize the water loss of the skin from dermis to epidermis (called transepidermal water loss" (TEWL))
- ◆ Keratinized skin cells, natural moisturizing factor (NMF) and intercellular lipids are helpful to reduce the TEWL

pH value:

- ◆ Normally, the pH value of the human skin is between 4 to 6, slightly acidic
- ◆ The acidic environment is useful for body defence
- ◆ If the pH value of skin is higher than 6 or 7, the skin could suffer from:
 - Reduced desquamation
 - Dry
 - Scaly skin
 - Growth of bacteria

2.2 Movement of molecules

- ◆ Generally, there are three kinds of movements of molecules:
 - Diffusion
 - Osmosis
 - Active transport

Diffusion:

- ◆ It is the net movement of molecules
- ◆ From a region of higher concentration to a region of lower concentration
- ◆ Factors affecting the rate of diffusion:

Factors	Rate of diffusion
Concentration difference increases	Increases
Distance between two regions increases	Decreases
Surface area between two regions increases	Increases
Temperature increases	Increases
Size of particles increases	Decreases

- ◆ The ingredients of the skincare products can get into the skin by diffusion
- ◆ Both polar and non-polar substances can get into the skin through the pores of it

2.3 Skincare Products

- ◆ Common skincare products:
 - Skin cleansing
 - Skin moisturizing
 - For aging
 - For acne
 - Sun care

Skin cleansing:

- ◆ Since the skin is always in contact with the environment
- ◆ Removal of dirt, dust, oil and dead skin cells is necessary by using cleansing products
- ◆ There are three basic categories of cleansing ingredient found:
 - Soaps
 - Soapless detergents
 - Solvents
- ◆ Both polar or non-polar solvents can be used for skin cleansing
- ◆ For dry skin, products with mineral oil can be used not only to remove dirt on the skin but also to deposit a thin layer of oil which can reduce TEWL
- ◆ For oily skin, products with alcohol can be used for cleansing and to remove excess oil on the skin surface
- ◆ The cleansing mechanism can be classified into three categories:
 - Abrasion (To remove dirt by applied friction)
 - Emulsifying (Emulsification)
 - Dissolving (Like-dissolve-like principle)

Skin moisturizing:

- ◆ To maintain or restore the water content of the epidermis layer of the skin
- ◆ To replenish the useful molecules which have been washed away after skin cleansing
 - NMF
 - Intercellular lipid
 - Sebum barrier

- ◆ Without NMF, intercellular lipid and sebum barrier, the skin might suffer from:
 - Dryness
 - Microbiological growth
 - Allergy

Common ingredients found in skin moisturizing products:

- ◆ Humectants, emollients, occlusives, skin rejuvenators

Humectants:

- ◆ Usually possess many hydroxyl groups (-OH)
- ◆ The hydroxyl group can be used to form hydrogen bond with water molecule
- ◆ Help to absorb water from the dermis layer to the epidermis layer
- ◆ Used to replenish NMF of the skin after cleansing
- ◆ Such as glycerine, hyaluronic acid, propylene glycol

Emollients:

- ◆ Usually hydrophobic in nature
- ◆ To replenish the lost intercellular lipid after cleansing
- ◆ Used to soften and smoothen the skin
- ◆ By filling the intercellular spaces
- ◆ Such as plant oil, fatty acids, mineral oil

Occlusives:

- ◆ Capable to form a thin hydrophobic layer on the skin surface
- ◆ To replenish the lost sebum layer after cleansing
- ◆ And to reduce TEWL
- ◆ Such as petrolatum, beeswax, silicones

Skin Rejuvenators:

- ◆ Most of the skin rejuvenators are protein
- ◆ To enhance the skin's barrier function
- ◆ By filling the small spaces on the skin surface
- ◆ Such as keratin, collagen, elastin

For aging (anti-aging products):

- ◆ There are two types of skin aging: Intrinsic and extrinsic skin aging
- ◆ Intrinsic skin aging is a slow and irreversible process
- ◆ Including loss of elastin, loss of collagen and decrease in rate of immune cells production
- ◆ While extrinsic skin aging accelerates the speed of intrinsic aging
- ◆ Extrinsic skin aging includes UV damage, smoking, exposing to air pollutants and careless skin damage

Common ingredients found in anti-aging products:

- ◆ Botanical extracts, antioxidants, peptides and proteins, retinoids

Botanical extracts:

- ◆ They are extracted from plants

- ◆ Also known as essential oil
- ◆ Functions: anti-oxidation, tightening and anti-inflammatory effects etc.
- ◆ Such as essential oil of Chamomile and Jasmine

Anti-oxidants:

- ◆ Protect the skin cells from attack of the free radicals
- ◆ By reacting (or reducing) the free radicals
- ◆ Such as vitamin C, E and coenzyme Q10

Peptides and proteins:

- ◆ Reduce wrinkling by increase the synthesis of collagen and elastin
- ◆ Provide smoothing and hydrating effects
- ◆ Such as collagen, elastin, soy proteins

Retinoids:

- ◆ Hydrophobic in nature
- ◆ Stimulate production of collagen and reduce the degradation of it
- ◆ Improve age spots and skin roughness
- ◆ Such as vitamin A and its derivatives

For acne (Treatment of acne):

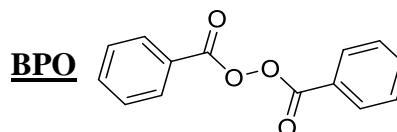
- ◆ Acne vulgaris is a common skin problem especially for teenagers
- ◆ About 85% prevalence in teenagers of ages 12 -24
- ◆ More common in females than in males
- ◆ **Development of acne:**
- ◆ 1st : Increase in secretion of sebum by the sebaceous glands
- ◆ 2nd : Increase in androgen production and activity
- ◆ 3rd : Microbial infection of the sebaceous glands
- ◆ **The story of acne:**
- ◆ Accumulation of sebum and dead cells in the skin pores → Facilitating the growth of bacterial *P. acnes* → The bacteria grow further and lead to inflammation (acne)
- ◆ **Cause of acne:**
- ◆ Problems of hormones, hygiene and microbial infection

Common ingredients used to treat acne:

- ◆ Benzoyl peroxide (BPO), salicylic acid (SA), topical retinoids

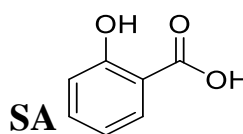
Benzoyl peroxide (BPO):

- ◆ Used to generate reactive radical species to kill bacteria on the skin
- ◆ It is not an antibiotic
- ◆ Other functions: increasing cell turnover rate and anti-inflammatory effect
- ◆ Suitable for mild-to-moderate acne



Salicylic acid (SA):

- ◆ Extracted from white willow (plant)
- ◆ As a precursor of aspirin
- ◆ Has anti-inflammatory effect



- ◆ Suitable for mild-to-moderate acne

Topical retinoids:

- ◆ Vitamin A and its derivatives
- ◆ FDA approved: tretinoin, adapalane and tazarotene
- ◆ Have anti-inflammatory effect, reducing formation of microcomedones
- ◆ Suitable for all cases of acne

Sun care products:

- ◆ Exposing to sunlight for a long duration, skin can suffer from:
- ◆ Redness, irritation, tanning
- ◆ Also possible to cause premature wrinkling and skin cancer
- ◆ But sunlight can induce production of vitamin D in our body

UV radiation from the sun:

- ◆ UV has the highest energy among the spectrum of sunlight reaching the earth's surface
- ◆ There are three kinds of UV: UVA, UVB and UVC
- ◆ UVA: range from 320 nm to 400 nm
- ◆ UVB: range from 280 nm to 320 nm
- ◆ UVC: range from 100 nm to 280 nm
- ◆ However, only 95% of UVA and 5% of UVB can reach us because of the UV absorption ability of the atmosphere
- ◆ **UVB:**
- ◆ It can penetrate the epidermis layer which causes:
 - Redness and thickening of the epidermis
 - Photo aging and tanning
 - Skin cancer
- ◆ But can stimulate the synthesis of vitamin D in the human body
- ◆ **UVA:**
- ◆ It can penetrate the dermis layer which causes:
 - Photo aging, tanning
 - Skin cancer
- ◆ Tanning beds and lamps emit UVA radiation

Tanning and sunburn:

- ◆ Tanning:
- ◆ UV causes the epidermis layer to produce melanin
- ◆ Which make your skin dark in colour
- ◆ Tanning is a sign of skin and DNA damage but not a sign of "healthiness"
- ◆ Sunburn:
- ◆ Is an inflammatory action of the skin after long exposure to UV
- ◆ Signs and symptoms: pain on touch, redness, scaling
- ◆ Increase the risk of having skin cancer

Sun Protection Factor (SPF):

- ◆ Definition: The number of doses of sunlight to redden the skin with sun cream compared to the skin without sun cream

- ◆ Higher SPF, higher protection
- ◆ But it only indicates the protection against UVB
- ◆ Since dose of sunlight received is proportional to the time of UV exposure, people usually treat the number of SPF as time (x10 min)

Common ingredients found in sun care products:

- ◆ UV filters, waterproofing agents

UV filters – physical sunscreens:

- ◆ To scatter and reflect the incoming UVA and UVB
- ◆ And reduce the amount of UV penetrating the skin surface
- ◆ E.g. Titanium dioxide (TiO₂) and Zinc oxide (ZnO)
- ◆ They are insoluble white powders
- ◆ Only stay in the outermost layer of the skin

UV filters – chemical sunscreens:

- ◆ The sunscreens mainly consist of aromatic compounds
- ◆ Which can absorb UV radiation and change it to waves with lower energy
- ◆ E.g. octinoxate, oxybenzone

Waterproofing agents:

- ◆ The agents are hydrophobic compounds with waterproofing properties
- ◆ To reduce loss of UV filters applied on the skin due to any form of water
- ◆ Such as from the swimming pool, sweat and sea etc.
- ◆ E.g. cyclomethicone, dimethicone

3. References

Gabriella Baki and Kenneth S. Alexander, Introduction to Cosmetic Formulation and Technology, John Wiley & Sons. Inc., 2015

Beauty and the Skin
Unit 3 – The Magic of Cosmetics

Student Worksheet

1) The skin with normal conditions:

- (1) Contains around 80% of water content
- (2) Contains around 20% of water content
- (3) pH should be around 5
- (4) Smooth and soft

- A. (1) and (2)
- B. (2) and (3)
- C. (1) and (2) and (3)
- D. (1) and (3) and (4)

2) Which of the following about TEWL are correct?

- (1) Transepidermal water loss
- (2) Transportation water loss
- (3) Due to water evaporation
- (4) From epidermis to dermis

- A. (1) and (2)
- B. (2) and (3)
- C. (1) and (3)
- D. (2) and (3) and (4)

3) What might happen if the pH value of the skin is higher than 7?

- A. Keep hydrated
- B. Inhibition of growth of bacteria
- C. Scaly skin
- D. Become soft and flexible

4) Which of the following statement is true about diffusion?

- A. From a region of lower concentration to a region of higher concentration
- B. Rate of diffusion increases if the temperature decreases
- C. Rate of diffusion decreases if the size of moving particles decreases
- D. None of the above

5) Which can be used for skin cleansing?

- (1) Soaps
- (2) Soapless detergents
- (3) Solvents
- (4) Honey

- A. (1) and (2)
- B. (2) and (3)
- C. (1) and (3)
- D. (1) and (2) and (3)

6) What is the cleansing mechanism of skin cleansing products using soaps or soapless detergents?

- A. Abrasion
- B. Dissolving
- C. Emulsification
- D. Saponification

7) What is the cleansing mechanism of skin cleansing products using solvents and small granules?

- (1) Emulsification
- (2) Dissolving
- (3) Abrasion

- A. (1) and (2)
- B. (1) and (3)
- C. (2) and (3)
- D. (1) and (2) and (3)

8) What is the main function of skin moisturizing products?

- A. To replenish the useful substances of the skin
- B. To remove dirt on the skin surface
- C. To dissolve dirt on the skin surface
- D. To remove the sebum on the skin surface

9) What are the main ingredients in skin moisturizing products?

- (1) Humectants
 - (2) Soaps
 - (3) Emollients
 - (4) Small granules
- A. (1) and (3)
 - B. (2) and (3)
 - C. (2) and (4)
 - D. (1) and (2) and (4)

10) Which of the following statements is correct?

- A. Humectants possess many hydroxyl groups while emollients are mainly hydrocarbon
- B. Humectants are mainly hydrocarbon while emollients possess many hydroxyl groups
- C. Humectants are used to fill the intercellular spaces
- D. Emollients are used to absorb water

11) Which of the following statements is correct?

- A. Occlusives are proteins while skin rejuvenators are hydrophobic in nature
- B. Skin rejuvenators can be used to replenish the lost sebum layer
- C. Occlusives can reduce TEWL
- D. Petrolatum can be used as a skin rejuvenator

12) Which of the following would happen during the process of intrinsic skin aging?

- (1) Loss of elastin
 - (2) Loss of collagen
 - (3) Loss of sebum
 - (4) Loss of vitamin D
- A. (1) and (2)
 - B. (2) and (3)
 - C. (2) and (4)
 - D. (1) and (2) and (4)

13) Which of the following mainly cause extrinsic skin aging?

- (1) UV radiation
- (2) Poor diet
- (3) Smoking
- (4) Lack of exercise

- A. (1) and (3)
- B. (2) and (3)
- C. (2) and (4)
- D. (1) and (2) and (4)

14) Which of the following ingredients are used for anti-aging purpose?

- (1) Salicylic acid
- (2) Collagen
- (3) Sodium chloride
- (4) Essential oil

- A. (1) and (2)
- B. (2) and (3)
- C. (1) and (3)
- D. (2) and (4)

15) The factors affecting development of acne are?

- (1) Secretion of sebum
- (2) Water content
- (3) Androgen production
- (4) Level of collagen

- A. (1) and (2)
- B. (2) and (3)
- C. (1) and (3)
- D. (1) and (2) and (4)

16) Which of the following ingredients can be used to treat acne?

- (1) Benzoyl peroxide (BPO)
- (2) Salicylic acid (SA)
- (3) Coenzyme Q10
- (4) Vitamin D

- A. (1) and (2)
- B. (2) and (3)
- C. (1) and (4)
- D. (2) and (3) and (4)

17) Which of the following statement about sun care is true?

- A. Both UVB and UVC from sunlight can reach the earth's surface
- B. Tanning is an inflammatory action while sunburn is caused by melanin
- C. SPF indicates the protection against UVB only
- D. Zinc oxide (ZnO) is a chemical sunscreen while octinoxate is a physical sunscreen

Unit 4 – Making Your Own Cosmetics and Skincare Products

1. Introduction

For the purpose of designing and making cosmetics and skincare products, you should have basic knowledge of organic chemistry and anatomy and physiology of the skin which have been introduced and covered in Units 1, 2 and 3.

You are expected to design and create your own cosmetics. You will have a chance to mix different ingredients which have various properties or colour and to customise their own skincare products. The products will also be examined by IR spectroscopy.

2. Summary of Unit 4

1) Making skin moisturizing products

- ◆ To maintain or restore the water content of the skin
- ◆ Ingredients: Humectants, emollients, occlusive and skin rejuvenators
- ◆ DIY products
 - Floral hand cream
 - Moisture-rich lipstick
 - Multi-functional ointment

2) Infrared spectroscopy

- ◆ Different functional groups absorb IR with different frequency
- ◆ By checking which frequency of IR are absorbed by the molecules, we can tell which functional groups the molecules possess
- ◆ How to interpret the IR spectrum

3. Duration

Two hours for each experiments

4. Objective

You should be able to:

- ◆ Make basic skincare products
- ◆ List out some essential ingredients for making the products
- ◆ Describe how the products can be used to soothe a particular skin problem
- ◆ Use IR spectroscopy for simple compound characterization

5. DIY Floral Hand Cream

Introduction

In this activity, students will try to make their own hand cream by using base oil and floral water they choose (i.e. any taste they like). Important physical process called emulsification will be demonstrated in this experiment.

Duration

About 30 minutes.

Objective

To consolidate learnt knowledge of the relationship between cosmetic and the skin and have a hands-on experience in making a floral hand cream.

Equipment

- ◆ 250 mL beaker
- ◆ Stirrer/glass rod

Materials for 5 students

- ◆ 50 mL of base oil (e.g. Sweet almond oil, olive oil, jojoba oil, etc.)
- ◆ 50 mL of floral water (e.g. Rose floral water, chamomile floral water, etc.)
- ◆ 10 mL of emulsifier
- ◆ 5 small containers

Procedures

1. Add 50 mL of base oil and 50 mL of floral water into a 250 mL beaker
2. Stir the mixture by using glass rod
3. Add emulsifier dropwise while stirring the mixture until the mixture becomes homogenous
4. Transfer the cream mixture to small containers

Result and Discussion:

- ◆ Worksheet related to the DIY hand cream activity and emulsification for each student
- ◆ Performance evaluation

6. DIY Moisture-rich lipstick

Introduction

In this activity, students will try to make their own lipstick by using base oil, beeswax and essential oil they choose (i.e. any taste they like). Important function of cosmetic called moisturizing will be introduced in this experiment

Duration

About 45 minutes.

Objective

To consolidate learnt knowledge of moisturizing properties of cosmetic for lips and have a hands-on experience in making a lipstick.

Equipment

- ◆ 250 mL beaker
- ◆ Heating plate
- ◆ Stir bar

Materials for 20 students

- ◆ 20 g of beeswax
- ◆ 20 g of shea butter
- ◆ 27 mL of essential oil (e.g. Lemon, orange, mint etc.)
- ◆ 20 lipstick containers

Procedures

1. Add 20 g of beeswax and 20 g of shea butter into a 250 mL beaker
2. Heat and stir the mixture with a stir bar until completely melted
3. Add the essential oil while stirring the mixture
4. After the mixture becomes clear, carefully transfer the solution to lipstick containers
5. Let it cool

Result and Discussion:

- ◆ Worksheet related to the DIY lipstick activity and moisturizing properties for each student
- ◆ Performance evaluation

7. DIY Sunscreen BB Cream

Introduction

In this activity, students will try to make their own BB cream by using base oil, floral water, pigment and titanium dioxide. The mechanism of physical sunscreen will be introduced during this experiment.

Duration

About 45 minutes.

Objective

To consolidate learnt knowledge of moisturizing properties of cosmetic for skin and have a hands-on experience in making a sunscreen BB cream.

Equipment

- ◆ 50 mL beaker x 2
- ◆ Glass rod
- ◆ Electronic balance
- ◆ Dropper
- ◆ 1 ml Syringe
- ◆ 15 mL centrifuge tube

Materials for 4 students

- ◆ 7 ml of base oil (e.g. Hazelnut oil, olive oil, jojoba oil etc)
- ◆ 20 ml of rose floral water
- ◆ 0.5 g of titanium dioxide
- ◆ 1 g of BB cream pigment
- ◆ 0.1 ml of 2-phenoxyethanol
- ◆ 1 ml of emulsifying polymer (Cold process)
- ◆ 4 small containers

Procedures:

1. Add 1 g of BB cream pigment and 0.5 g of titanium dioxide to a beaker and mix it well.
2. Add 7 ml of base oil to the beaker and mix it with the powder thoroughly
3. On the other hand, add 20 ml of rose floral water and 0.1 ml of 2-phenoxyethanol to another beaker.
4. Add 5 ml of the mixture of floral water each time to the beaker with oil and powder together while adding a few drops of emulsifying polymer.
5. During the addition of floral water, keep stirring.
6. Repeat steps 4 and 5 until all mixture of floral water is transferred.
7. Stir the final mixture thoroughly until a cream-like texture is formed.
8. Transfer the sunscreen BB cream to a small container.

Result and Discussion:

- ◆ Worksheet related to the DIY sunscreen BB cream activity and sunscreen properties for each student
- ◆ Performance evaluation

8. References

Gabriella Baki and Kenneth S. Alexander, Introduction to Cosmetic Formulation and Technology, John Wiley & Sons. Inc., 2015

Beauty and the Skin
Unit 4 – Making Your Own Cosmetics and Skincare Products

Student Worksheet

1. DIY Floral Hand Cream

Observations and explanations:

1. What is the nature of the base oil used (Polar or non-polar) and why?

2. What functional groups does the base oil possess?

3. What is the main function of base oil in the product?

4. What is the nature of the floral water used (Polar or non-polar) and why?

5. What functional groups does the floral water possess?

6. What is the main function of the floral water in the product?

7. Explain why emulsifier is added into the product?

8. According to the IR spectrum, try to identify different regions of wavenumber and the functional group represented:

2. DIY Moisture-rich Lipstick:

Observations and explanations:

1. What is the nature of the beeswax used (Polar or non-polar) and why?

2. What functional groups does the beeswax possess?

3. What is the main function of the beeswax in the product?

4. What is the nature of the shea butter used (Polar or non-polar) and why?

5. What functional groups does the shea butter possess?

6. What is the structure and the main function of the shea butter in the product?

7. According to the IR spectrum, try to identify different regions of wavenumber and the functional group represented:

3. DIY Sunscreen BB Cream:

Observations and explanations:

1. What is the nature of beeswax used (Polar or non-polar) and why?

2. What functional groups does beeswax possess?

3. What is the main function of using beeswax in the product?

4. What is the nature of shea butter used (Polar or non-polar) and why?

5. What functional groups does shea butter possess?

6. What is the main function of carrier oil used in the product?

7. According to the IR spectrum, try to identify different regions of wavenumber and the functional group represented: