NOTESKARTS

COSMETIC SCIENCE

B.Pharmacy 8th Semester

UNIT 1 — Detailed Study Notes

As per AKTU / PCI Syllabus

Unit: 1

Classification of cosmetic and cosmeceutical products.

- Definition of cosmetics as per Indian and EU regulations, Evolution of cosmeceuticals from
  cosmetics, cosmetics as quasi and OTC drugs.
- Cosmetic excipients: Surfactants, rheology modifiers, humectants, emollients, preservatives.
- Classification and application
  - **Skin:** Basic structure and function of skin.
  - **Hair:** Basic structure of hair. Hair growth cycle.
  - **Oral Cavity:** Common problem associated with teeth and gums.

INTRODUCTION TO COSMETIC SCIENCE

Cosmetic Science is a multidisciplinary field integrating chemistry, biology, dermatology, pharmacology, and materials science to develop safe and effective cosmetic products. It covers formulation, testing, regulatory compliance, and consumer safety.

What is a Cosmetic?

The word 'Cosmetics' is derived from the Greek 'Kosmetikos' meaning 'skilled in decorating or adorning'. Cosmetics are products applied to the human body for beautification, cleansing, protecting, or changing appearance WITHOUT altering the body's physiology.

SIMPLE DEFINITION TO REMEMBER:

Cosmetics = Products that make you look good / feel clean WITHOUT treating any disease

They act on the surface of the body — do NOT penetrate deeper layers

No pharmacological claim = No medicinal claim

CLASSIFICATION OF COSMETIC PRODUCTS

Classification Based on Area of Application

Area	Body Parts	Products
Skin	Face, hands, body	Moisturizers, sunscreens, body lotion
Hair	Scalp, hair shaft	Shampoos, conditioners, hair oils, hair dyes
Nails	Nail plate, cuticle	Nail polish, nail hardener, cuticle oil
Lips	Lip area	Lipstick, lip gloss, lip balm, lip liner
Eyes	Eye area	Mascara, eyeliner, eye shadow, kajal
Oral	Teeth, gums	Toothpaste, mouthwash, teeth whitening strips
Axilla/Body	Underarms, body	Deodorants, antiperspirants, talcum powder

Classification Based on Dosage Form

- Solutions: Perfumes, colognes, toners, micellar water
- Emulsions (O/W and W/O): Creams, lotions, moisturizers
- Gels: Hair gels, face masks, after-shave gels
- Powders: Face powder, compact powder, talcum powder
- Aerosols: Hair sprays, dry shampoos, deodorant sprays
- Sticks: Lipstick, deodorant stick, balms
- Dispersions: Scrubs, exfoliants, toothpaste

Classification Based on Function

Function	Subcategory	Examples
Cleansing	Facial, body, hair	Facial wash, shampoo, cleansing milk
Moisturizing	Skin, hair, lips	Day cream, body lotion, hair conditioner
Color Cosmetics	Face, eye, lips, nails	Foundation, eyeshadow, lipstick, nail polish
Sun Protection	Skin protection	Sunscreen, SPF moisturizer, after-sun lotion
Anti-aging	Skin care	Retinol serum, peptide cream, vitamin C serum
Deodorizing	Odor control	Antiperspirant, deodorant, foot spray
Oral Hygiene	Teeth, gums	Toothpaste, mouthwash, whitening strips

DEFINITION OF COSMETICS — INDIAN & EU REGULATIONS

Definition as Per Indian Regulations

Governing Law: Drugs and Cosmetics Act, 1940 (amended) and Drugs and Cosmetics Rules, 1945

Definition (Section 3(aaa), Drugs and Cosmetics Act 1940):

> "Cosmetic means any article intended to be rubbed, poured, sprinkled or sprayed on, or introduced into, or otherwise applied to, the human body or any part thereof for cleansing, beautifying, promoting attractiveness, or altering the appearance, and includes any article intended for use as a component of a cosmetic."

Features of Indian Cosmetics Definition:

- **Mode:** Applied externally — rubbed, poured, sprinkled, sprayed or introduced
- **Sites:** Human body or any part thereof
- **Purpose:** Cleansing, beautifying, promoting attractiveness, altering appearance
- **Exclusion:** No therapeutic or medicinal claims allowed
- **Authority:** CDSCO (Central Drugs Standard Control Organization)
- **License required:** Manufacturing license under Form 31 & 32

Definition as Per EU Regulations

Governing Law: Regulation (EC) No. 1223/2009 of the European Parliament — effective January 2013

Definition (Article 2, Regulation 1223/2009):

> "Cosmetic product means any substance or mixture intended to be placed in contact with the external parts of the human body (epidermis, hair system, nails, lips, and external genital organs) or with the teeth and the mucous membranes of the oral cavity with a view exclusively or mainly to cleaning them, perfuming them, changing their appearance, protecting them, keeping them in good condition or correcting body odours."

Features of EU Cosmetics Definition:

- **Sites:** Epidermis, hair system, nails, lips, external genital organs, teeth, oral mucous membranes
- **Actions:** Cleaning, perfuming, changing appearance, protecting, conditioning, correcting body odours
- **Claims:** Therapeutic claims strictly NOT permitted
- **CPSR:** Cosmetic Product Safety Report — mandatory before market placement
- **CPNP:** Cosmetic Products Notification Portal — all products must be notified
- **INCI naming:** International Nomenclature of Cosmetic Ingredients — mandatory labeling
- **Annex II:** List of ~1300 prohibited substances

Comparison: Indian vs EU Definition

Parameter	India (D&C Act 1940)	EU (Regulation 1223/2009)
Legal Basis	D&C Act 1940	EC Regulation 1223/2009
Application Sites	Human body or any part	Epidermis, hair, nails, lips, genital organs, teeth, oral mucosa
Purpose	Cleansing, beautifying, attractiveness, appearance	Cleaning, perfuming, protecting, conditioning, odor correction
Medicinal Claims	Not permitted	Not permitted (strict)
Safety Requirement	BIS standards	Mandatory CPSR
Labeling	CDSCO guidelines	INCI nomenclature mandatory
Notification	CDSCO registration	CPNP mandatory
Banned List	Schedule Q	Annex II (~1300 substances)

EVOLUTION OF COSMECEUTICALS

Definition and Concept

Term coined by: Dr. Albert Kligman (dermatologist) in 1984 — Cosmetics + Pharmaceuticals

> "Cosmeceuticals are cosmetic products containing biologically active ingredients claiming medical or drug-like benefits. They bridge the gap between cosmetics and pharmaceuticals."

Characteristics:

- **Appearance:** Sold like a cosmetic — no prescription needed
- **Activity:** Contains biologically active ingredients with proven skin benefits
- **Penetration:** Active ingredients penetrate into the epidermis
- **Legal Status:** NOT a recognized legal category in India or EU — products are classified as cosmetics OR drugs
- **Claims:** Claims health benefits (anti-aging, whitening) but CANNOT claim to treat disease

Evolution Timeline

Period	Milestone	Key Development
Ancient Times	Traditional cosmetics begin	Egyptians used kohl, henna, aloe vera; Ayurveda used herbal pastes
1900s-1950s	Modern cosmetics emerge	Cold creams, face powders; FDA cosmetic regulation (USA, 1938)
1960s-1970s	Active ingredients introduced	Retinoic acid (tretinoin) approved; early vitamin C use
1984	Term 'cosmeceutical' coined	Dr. Albert Kligman coins the term
1980s-90s	Rapid expansion	AHAs, vitamin E, antioxidants; peptide research begins
2000s	Cosmeceutical era	Growth factors, stem cells, nanoparticles, hyaluronic acid serums
2010s-Present	Science-backed products	Personalized cosmeceuticals, microbiome-based products, AI formulation

Common Bioactive Ingredients in Cosmeceuticals

Ingredient	Mechanism	Application
Retinoids (Vitamin A)	Stimulate collagen synthesis, cell turnover	Anti-aging, acne
Vitamin C (Ascorbic Acid)	Antioxidant, inhibits melanin synthesis	Brightening, anti-aging
Alpha Hydroxy Acids (AHA)	Chemical exfoliants, desquamation	Texture improvement, hyperpigmentation
Peptides	Signal proteins for collagen/elastin production	Anti-wrinkle, firming

Hyaluronic Acid	Binds 1000x its weight in water	Deep hydration, plumping
Niacinamide (Vit B3)	Reduces sebum, inhibits melanin transfer	Brightening, pore minimizing
Kojic Acid	Tyrosinase enzyme inhibitor	Skin lightening
Coenzyme Q10	Antioxidant, cellular energy	Anti-aging, photoprotection

Cosmetics vs Cosmeceuticals vs Pharmaceuticals

Feature	Cosmetics	Cosmeceuticals	Drugs
Primary Use	Beautify, cleanse	Beauty + biological effect	Treat/prevent disease
Active Ingredient	Minimal/none	Biologically active	Drug substance
Penetration	Surface only	Epidermis level	Deep tissues
Claims	Appearance only	Functional (limited)	Full therapeutic
Prescription	Not needed	Not needed	May be needed
Examples	Lipstick, shampoo	Retinol cream, Vit C serum	Tretinoin 0.1%

COSMETICS AS QUASI-DRUGS AND OTC DRUGS

Quasi-Drugs

> Quasi-drugs are products intermediate between cosmetics and drugs — applied externally and making limited therapeutic claims without being classified as full pharmaceutical drugs.

- **Mode:** Applied topically like cosmetics but may affect physiological functions mildly
- **Claims:** Limited health claims: 'reduces dandruff', 'prevents tooth decay', 'controls body odor'
- **Regulation:** Drug manufacturing license + safety data required

Examples of Quasi-drugs:

Product Category	Active Ingredient	Claim Made
Anti-dandruff shampoos	Ketoconazole, Zinc pyrithione	Controls dandruff
Fluoride toothpastes	Sodium fluoride	Prevents dental caries

Medicated face washes	Salicylic acid, Benzoyl peroxide	Reduces acne
Depigmenting creams	Kojic acid, Arbutin	Reduces pigmentation
Medicated lip balm	Acyclovir	Treats cold sores

OTC (Over-The-Counter) Drugs

> OTC drugs are pharmaceutical preparations sold directly to consumers without prescription because they are safe for self-medication.

Parameter	OTC Drug	Rx (Prescription) Drug
Prescription	Not needed	Mandatory
Safety Margin	Wide therapeutic index	Narrow therapeutic index
Self-diagnosis	Possible by consumer	Doctor required
Examples	Paracetamol, antacids, sunscreens	Antibiotics, antifungals, opioids

OTC-Cosmetic Overlap Products:

- **Sunscreens:** USA FDA = OTC drug; India = cosmetic for sun protection
- **Anti-dandruff shampoos:** Cosmetic (cleansing) + Drug claim (treats scalp)
- **Fluoride toothpaste:** Cosmetic (cleans teeth) + OTC Drug (prevents caries in USA)
- **Antiperspirants:** USA FDA = OTC drug (blocks sweat glands); India = cosmetic

★ EXAM IMPORTANT POINTS

Q: What is the key difference between cosmetics and cosmeceuticals? → Cosmeceuticals have biologically active ingredients; cosmetics only work superficially

Q: Is 'cosmeceutical' a legally recognized term in India? → NO! Not a recognized legal category

Q: Who coined the term 'cosmeceutical'? → Dr. Albert Kligman, 1984

Q: Sunscreens in USA are classified as? → OTC drugs (not cosmetics)

Q: Under which act are cosmetics regulated in India? → Drugs and Cosmetics Act, 1940

COSMETIC EXCIPIENTS

> Cosmetic Excipients are inactive ingredients combined with active ingredients to produce finished cosmetic products. They include vehicles, carriers, solvents, emulsifiers, stabilizers, thickeners, preservatives, and sensory modifiers.

SURFACTANTS (Surface Active Agents)

Surfactants are amphiphilic (both hydrophilic and hydrophobic) molecules. They are the most important class of cosmetic excipients — critical for cleansing, emulsification, and foaming.

Structural Chemistry:

- **Hydrophilic head:** Polar group — carboxylate, sulfate, quaternary ammonium
- **Hydrophobic tail:** Non-polar hydrocarbon chain (C8-C18 fatty acid derived)
- **CMC (Critical Micelle Concentration):** Minimum concentration for micelle formation; below CMC — individual molecules; above CMC — micelles form

Mechanism of Cleansing:

Step 1: Surfactant adsorbs at oil-water interface → Step 2: Hydrophobic tail dissolves into oil/dirt → Step 3: Micelle forms trapping oil → Step 4: Rinsing removes micelle + dirt

A. Anionic Surfactants

Surfactant	Conc.	Properties & Applications
Sodium Lauryl Sulfate (SLS)	5-15%	Primary cleanser; excellent foaming; may irritate sensitive skin
Sodium Laureth Sulfate (SLES)	5-15%	Gentler (ethoxylated); body wash, shampoos
Sodium Stearate	5-20%	Main component of bar soaps; saponification product
Sodium Dodecyl Sulfate (SDS)	0.5-2%	Foaming agent in toothpaste; wets enamel surface

Properties: Negatively charged; excellent detergency; best foaming; cost-effective; may cause irritation at high conc

B. Cationic Surfactants

Surfactant	Conc.	Properties & Applications
Cetylpyridinium Chloride (CPC)	0.05-0.1%	Antimicrobial; mouthwash, throat lozenges
Benzalkonium Chloride (BAK)	0.01-0.1%	Broad-spectrum antimicrobial; preservative in eye care
Cetyltrimethylammonium Bromide (CTAB)	0.5-1%	Hair conditioning agent; smooth, silky feel

Stearalkonium Chloride	0.1-0.3%	Hair detangler; conditions damaged hair

Properties: Positively charged (quaternary ammonium); poor cleansers; excellent conditioners; antimicrobial; NOT compatible with anionic

C. Nonionic Surfactants

Surfactant	Conc.	Properties & Applications
Polysorbate 20 (Tween 20)	1-5%	O/W emulsifier; solubilizer for fragrances and oils
Polysorbate 80 (Tween 80)	1-5%	Emulsifier and solubilizer; stable in wide pH range
Sorbitan Monostearate (Span 60)	2-10%	W/O emulsifier; creams, ointments
Cetyl Alcohol	2-8%	Emulsifier + thickener; conditioner in hair products

Properties: No ionic charge; stable across wide pH and temperature; compatible with all surfactants; mild; widely used in sensitive and baby products

D. Amphoteric (Zwitterionic) Surfactants

Surfactant	Conc.	Properties & Applications
Cocamidopropyl Betaine (CAPB)	3-10%	Co-surfactant; reduces irritation of SLS; baby shampoos
Sodium Cocoamphoacetate	2-5%	Very gentle; sensitive skin, baby products
Disodium Cocoyl Glutamate	5-15%	Amino-acid derived; biodegradable; natural cosmetics

Properties: Cationic at acidic pH, anionic at alkaline pH; mildest surfactants; excellent compatibility; used to reduce irritation

Functions of Surfactants in Cosmetics:

Function	Mechanism	Product Examples
Cleansing	Micelle formation, emulsification of dirt	Shampoos, facial cleansers, body wash
Foaming	Stabilize air-water interface	Shaving foam, bubble bath
Emulsification	Reduce surface tension at oil-water interface	Creams, lotions, conditioners

Conditioning	Adsorb to hair/skin, reduce friction	Hair conditioners, skin conditioners
Solubilization	Incorporate water-insoluble ingredients	Perfume solutions, micellar water
Wetting	Increase spreadability on surfaces	Sunscreens, leave-in conditioners

RHEOLOGY MODIFIERS

Rheology: The science of flow and deformation of matter. Rheology modifiers control viscosity and texture.

A. Hydrophilic Thickeners (Water-Based Systems)

Thickener	Type	Conc.	Applications
Carbomer (Carbopol)	Synthetic	0.1-1%	Clear gels; pH 6-8; serums, gel formulations
Xanthan Gum	Microbial	0.1-0.5%	Biopolymer; natural cosmetics; suspending agent
Sodium Alginate	Natural	0.5-2%	Seaweed-derived; face masks, gels
Guar Gum	Natural	0.3-1%	Plant-derived; shampoos, lotions; conditioning
HPMC (Hydroxypropyl Methylcellulose)	Semisynthetic	0.5-2%	Cellulose derivative; stable thickener
Sodium CMC	Semisynthetic	0.5-2%	Toothpaste, lotions

B. Lipophilic Thickeners (Oil-Based Systems)

Thickener	Conc.	Applications
Beeswax	5-20%	Natural wax; lip balms, creams, salves, mascara
Carnauba Wax	1-10%	Hardest natural wax; lipsticks, lip glosses, hair wax
Cetyl Alcohol	2-8%	Fatty alcohol; thickens emulsions; also emollient
Stearic Acid	2-8%	Fatty acid; thickens, stabilizes O/W emulsions

C. Emulsifiers — HLB System

Emulsifier	HLB Value	Type	Applications
Glyceryl Monostearate (GMS)	3-4	W/O	Moisturizing creams, massage products
Lecithin (Phospholipid)	2-12	Both	Natural emulsifier; liposomes, skin creams
Polysorbate 60	14.9	O/W	Fragrance solubilizer, creams

HLB System: Hydrophilic-Lipophilic Balance — HLB 1-6 = W/O emulsifiers; HLB 8-16 = O/W emulsifiers

6.3 HUMECTANTS

> Humectants are hygroscopic substances that absorb moisture from the environment and bind water within the skin, preventing dehydration. Key ingredients in moisturizing formulations.

Mechanism of Action:

- **Atmospheric Water Absorption:** In high humidity (>70% RH), draws moisture from air into skin
- **TEWL Prevention:** Form hydrogen bonds with water molecules — reduce Transepidermal Water Loss

Humectant	Conc.	Source	Key Properties
Glycerin (Glycerol)	2-20%	Vegetable oils	Most used; inexpensive; excellent moisture retention
Propylene Glycol	2-10%	Synthetic	Co-solvent + humectant; penetration enhancer
Butylene Glycol	1-8%	Synthetic	Gentler than PG; conditioning, penetration enhancer
Sorbitol	5-20%	Glucose reduction	Sugar alcohol; toothpaste, hair care
Hyaluronic Acid	0.01-2%	Microbial fermentation	Binds 1000x its weight in water; multi-MW forms
Sodium PCA (NaPCA)	0.5-2%	Amino acid derivative	Natural humectant factor (NMF); highly effective
Urea	2-10%	Synthetic	Low conc: humectant; high conc (>20%): keratolytic
Panthenol (Pro-Vitamin B5)	0.5-3%	Dexpanthenol	Humectant + wound healing; hair conditioning

Aloe Vera Gel	1-50%	Plant	Natural humectant; soothing, anti-inflammatory

Natural Moisturizing Factor (NMF):

NMF = Natural humectants found in stratum corneum maintaining skin hydration:

- Amino acids and derivatives — 40%
- PCA (Pyrrolidone Carboxylic Acid) — 12%
- Lactate — 12%
- Urea — 7%
- Inorganic ions (Na+, K+, Ca2+, Mg2+) — 18%

EMOLLIENTS

> Emollients are lipophilic substances that soften skin by filling spaces between skin cells, forming a semi-occlusive film reducing TEWL and repairing the skin barrier.

Mechanism of Action:

- **Occlusion:** Physical barrier on skin surface to prevent water evaporation
- **Barrier Repair:** Replace intercellular lipids in stratum corneum (ceramides, fatty acids, cholesterol)
- **Lubrication:** Reduce friction between skin cells

Classification of Emollients:

Category	Conc.	Examples & Key Properties
Natural Oils	1-20%	Coconut oil (lauric acid, occlusive), Jojoba (liquid wax ester, non-comedogenic), Argan (oleic acid, Vit E), Rosehip (linoleic acid)
Butters	2-20%	Shea butter (stearic + oleic acid, deeply moisturizing), Cocoa butter (rich in palmitic acid)
Mineral Oils	1-30%	Mineral oil (highly occlusive, cheap), Petrolatum/Vaseline (most occlusive emollient)
Silicones	0.5-20%	Dimethicone (non-greasy, conditioning), Cyclopentasiloxane (volatile, evaporates), Amodimethicone (hair conditioning)
Fatty Alcohols	2-8%	Cetyl alcohol C16, Stearyl alcohol C18 — emollient + emulsifier
Fatty Esters	2-10%	Isopropyl Myristate (low viscosity, penetration enhancer), Cetyl Palmitate
Waxes	5-30%	Beeswax (protective barrier), Carnauba wax (hardest natural wax), Paraffin wax

PRESERVATIVES

> Cosmetic preservatives prevent microbial growth (bacteria, fungi, yeast, mold), chemical oxidation, and degradation — ensuring product safety and shelf life.

Why Preservatives are Critical:

- Most cosmetics contain water — ideal growth medium for microbes
- Products used repeatedly, introducing contamination
- Contaminated products can cause conjunctivitis, skin infections, pseudomonas infections

Criteria for Ideal Preservative:

- Effective at low concentrations — broad spectrum (bacteria, fungi, yeast)
- Stable over product shelf life — non-irritating, non-sensitizing
- Chemically compatible with other ingredients — acceptable organoleptic properties

A. Parabens

Paraben Type	Conc.	Solubility	Key Notes
Methylparaben (MP)	0.15-0.3%	Moderate	Most water-soluble; antifungal; often combined
Ethylparaben (EP)	0.05-0.3%	Moderate	Good antifungal; combined with MP
Propylparaben (PP)	0.01-0.1%	Low	More lipophilic; antibacterial
Butylparaben (BP)	0.01-0.05%	Low	Most lipophilic; restricted in EU

Mechanism: Inhibit microbial enzyme systems and disrupt cell membranes. Effective at pH 4-8.

Controversy: Estrogenic activity (endocrine disruption) — growing trend toward paraben-free formulations.

B. Non-Paraben Chemical Preservatives

Preservative	Conc.	Key Properties & Applications
Phenoxyethanol	0.5-1%	Broad spectrum; most popular paraben alternative; effective against bacteria and fungi
Sodium Benzoate	0.1-0.5%	Active at acidic pH (<5.5); antifungal; combined with potassium sorbate
Potassium Sorbate	0.1-0.3%	Antifungal; active at pH <6.5; synergistic with sodium benzoate
Benzyl Alcohol	0.5-1%	Antibacterial; pleasant odor; used in fragranced products
Chlorphenesin	0.1-0.3%	Selective antibacterial; combined with other preservatives

DMDM Hydantoin	0.1-0.5%	Formaldehyde releaser; broad spectrum; controversial

C. Natural Preservatives

Natural Preservative	Conc.	Activity & Notes
Tea Tree Oil	0.5-1%	Terpinen-4-ol; broad spectrum antimicrobial; strong odor
Rosemary Extract	0.05-0.5%	Antioxidant preservative; prevents rancidity of oils
Vitamin E (Tocopherol)	0.05-0.5%	Lipid antioxidant — prevents oxidation of oils; NOT antimicrobial
Vitamin C (Ascorbic Acid)	0.01-0.5%	Water-soluble antioxidant; prevents oxidative degradation

D. Ancillary Preservation

- **Chelating Agents:** EDTA (0.01-0.05%), citric acid — chelate metal ions that catalyze oxidation
- **pH Control:** Maintaining pH 4.0-5.5 (skin-like) inhibits microbial growth
- **Antioxidants:** BHA, BHT, sodium metabisulfite — prevent oxidative rancidity

★ EXAM IMPORTANT POINTS

Q: Name 4 surfactant types with examples → Anionic (SLS), Cationic (BAK), Nonionic (Tween 80), Amphoteric (CAPB)

Q: What is CMC? → Critical Micelle Concentration — minimum conc. for micelle formation

Q: Which humectant binds 1000x its weight in water? → Hyaluronic Acid

Q: Difference between humectant and emollient? → Humectant attracts water; Emollient seals/smooths skin

Q: Paraben controversy? → Estrogenic (endocrine disruptive) activity

Q: What is HLB? → Hydrophilic-Lipophilic Balance; HLB 1-6 = W/O; HLB 8-16 = O/W

SKIN — BASIC STRUCTURE AND FUNCTION

The skin (Cutis) is the largest organ (~1.5-2 m², 3-4 kg body weight, 16% of total body weight).

Layers of Skin — Overview

Layer	Thickness	Key Components
Epidermis	0.05-1.5 mm	Keratinocytes, melanocytes, Langerhans cells, Merkel cells
Dermis	1-4 mm	Collagen, elastin, blood vessels, nerves, hair follicles, sweat glands

Hypodermis	Variable	Adipocytes, connective tissue, blood vessels

EPIDERMIS — Detailed Structure

Outermost, avascular layer composed of 5 sub-layers from outside to inside:

Sub-Layer	Cell Type	Key Characteristics
Stratum Corneum (SC)	Corneocytes (dead)	10-20 layers of dead anucleate cells; brick-and-mortar structure; main barrier; TEWL control; 2-4 weeks turnover
Stratum Lucidum (SL)	Eleidin-filled cells	Thin, clear layer; ONLY in thick skin (palms, soles); absent on face
Stratum Granulosum (SG)	Granular cells	Keratohyalin granules; lamellar bodies release lipids; transition zone — cells begin dying
Stratum Spinosum (SS)	Keratinocytes	Connected by desmosomes; contains melanin from melanocytes; Langerhans cells present
Stratum Basale (SB)	Stem cells, melanocytes	Single layer of cuboidal cells; continuous mitosis; gives rise to all other layers; melanocytes produce melanin

Special Cells of Epidermis:

Cell Type	Location	Function
Keratinocytes	All layers	Produce keratin; undergo cornification; 90% of epidermal cells
Melanocytes	Stratum Basale	Produce melanin (skin color); 1 per 36 keratinocytes; UV protection
Langerhans Cells	Stratum Spinosum	Dendritic immune cells; present antigens; defense against pathogens
Merkel Cells	Stratum Basale	Sensory mechanoreceptors; detect light touch

Brick and Mortar Concept of Stratum Corneum:

- **Bricks = Corneocytes:** Flat, dead, protein-packed keratinocytes
- **Mortar = Intercellular lipids:** Ceramides (50%), Fatty acids (10-20%), Cholesterol (25%), Cholesterol sulfate (5%)
- **Function:** Barrier preventing water loss and environmental insults

DERMIS — Detailed Structure

A. Papillary Dermis (Upper Dermis):

- Loose connective tissue with fine collagen and elastin fibers
- Contains capillaries, lymphatics, sensory nerve endings
- Dermal papillae project upward into epidermis — forms fingerprints

B. Reticular Dermis (Deep Dermis):

- Dense collagen bundles (Type I collagen 70-80%) — tensile strength
- Elastin fibers — provide elasticity (return after stretching)
- Contains blood vessels, nerves, lymphatics, hair follicles, sweat glands

Key Components of Dermis:

Component	Type	Function
Collagen	Type I (80%), Type III	Tensile strength; decreases with aging
Elastin	Protein fiber	Elasticity; reduced in aged skin
Hyaluronic Acid	GAG	Hydration; fills extracellular space
Fibroblasts	Cells	Synthesize collagen, elastin, HA
Eccrine sweat glands	Skin appendage	Thermoregulation; aqueous sweat
Apocrine sweat glands	Skin appendage	Axilla/groin; protein-rich sweat; body odor source
Sebaceous glands	Skin appendage	Produce sebum; lubricate skin and hair

Functions of Skin

Function	Mechanism	Cosmetic Relevance
Barrier Protection	SC prevents entry of microbes, chemicals, UV	Moisturizers reinforce barrier; SPF blocks UV
Water Regulation	Prevents TEWL	Humectants and emollients reduce TEWL
Thermoregulation	Sweating cools; vasoconstriction retains heat	Antiperspirants; cooling sprays
Sensation	Mechanoreceptors, thermoreceptors, nociceptors	Fragrance, texture create pleasant sensations
Vitamin D Synthesis	UVB converts 7-dehydrocholesterol to Vit D3	Sunscreens may reduce Vit D synthesis
Immune Function	Langerhans cells, keratinocyte cytokines	Products may affect immune response; patch testing

HAIR — BASIC STRUCTURE AND GROWTH CYCLE

Hair (Pilus) is a keratinous appendage of the skin. Humans have ~100,000 scalp hairs, losing 50-100 per day normally.

Hair Shaft Layers

Layer	Position	Detailed Description
CUTICLE	Outermost	6-10 overlapping scale-like cells pointing toward tip; hard keratin; flat = shiny; lifted = frizzy; damaged by alkaline pH, heat, bleaching
CORTEX	Middle (main body)	80-90% of hair mass; long keratin chains; melanin granules (eumelanin = brown/black; pheomelanin = red/yellow); disulfide bonds (S-S) give strength
MEDULLA	Innermost (core)	Present in thick/coarse hair; absent in fine hair; contains air pockets

Hair Follicle Structure

Structure	Function & Details
Dermal Papilla	Connective tissue at base; blood vessels nourish matrix cells; controls hair growth
Hair Bulb	Onion-shaped base; matrix cells divide rapidly; melanin injected here into cortex
Inner Root Sheath (IRS)	Huxley's + Henle's layer; guides hair through follicle
Outer Root Sheath (ORS)	Continuation of epidermis; stem cell niche
Sebaceous Gland	Opens into follicle; secretes sebum; lubricates hair and skin
Arrector Pili Muscle	Smooth muscle; contraction = goosebumps; makes hair stand erect
Bulge Region	Reservoir of stem cells; critical for hair regeneration after each cycle

Hair Pigmentation

- **Eumelanin:** Brown to black pigment; large, oval granules
- **Pheomelanin:** Yellow to red pigment; smaller, spherical granules
- **Graying (Canities):** Progressive loss of melanocyte activity; melanin replaced by air vacuoles; begins at age 30-40 in most individuals

Hair Growth Cycle — Detailed

Phase	Duration	% Scalp Hairs	Key Events
ANAGEN (Growth)	2-6 years (scalp)	85-90%	Active matrix cell division; 0.3-0.4 mm/day growth; melanin production active
CATAGEN (Transition)	2-3 weeks	2-3%	Cell division stops; follicle shortens; dermal papilla moves up; club hair forms
TELOGEN (Resting)	2-3 months	10-15%	No growth; club hair retained; new anagen begins pushing old hair out
EXOGEN (Shedding)	Active shedding	—	Club hair detaches; 50-100 hairs/day normally shed

Factors Affecting Hair Growth:

Factor	Effect on Hair
Androgens (DHT)	Miniaturize follicles → androgenetic alopecia (male pattern baldness)
Estrogen	Prolongs anagen; thick hair during pregnancy
Thyroid Hormones	Hypothyroidism → diffuse hair loss
Nutrition Deficiency	Iron, zinc, biotin, protein deficiency → hair loss
Stress	Telogen effluvium — stress pushes hairs prematurely into telogen
Drugs	Chemotherapy → anagen effluvium; anticoagulants → telogen effluvium

★ EXAM IMPORTANT POINTS

Q: Which layer of hair shaft contains melanin? → Cortex

Q: Name pigments responsible for hair color → Eumelanin (brown/black) and Pheomelanin (red/yellow)

Q: Longest phase of hair growth? → Anagen (2-6 years for scalp)

Q: What causes male pattern baldness? → DHT (Dihydrotestosterone)

Q: Percentage of scalp hairs in anagen? → 85-90%

Q: What is telogen effluvium? → Diffuse hair loss from stress pushing hairs into telogen

ORAL CAVITY — STRUCTURE & COMMON PROBLEMS

Structure of Oral Cavity

Structure	Location	Function
Lips	Oral opening	Seal oral cavity; speech; food intake; sensory
Teeth (32 adult)	Upper + lower jaw	Mastication (chewing), speech, aesthetics
Gingiva (Gums)	Around teeth bases	Support and protect teeth roots
Tongue	Floor of mouth	Taste, speech, mastication, swallowing
Salivary Glands	Under jaw, tongue	Produce saliva for digestion, antimicrobial, lubrication

Detailed Structure of TEETH

Layers of Teeth:

Tissue	Hardness	Detailed Properties
Enamel	Hardest (96% mineral)	Covers crown; made of hydroxyapatite [Ca10(PO4)6(OH)2]; translucent white; cannot regenerate; 2-3 mm thick; fluoride forms acid-resistant fluorapatite
Dentin	Less than enamel	Bulk of tooth; yellowish; tubular structure (dentinal tubules); sensitive when exposed; can form secondary dentin
Cementum	Bone-like	Covers root surface; connects with periodontal ligament
Pulp	Soft tissue	Contains nerves (pain), blood vessels (nutrition); inflammation = toothache

Types of Teeth:

Type	Count	Location	Function
Incisors	8	Front teeth	Cutting food; chisel-shaped
Canines	4	Corners	Tearing food; pointed, single root
Premolars	8	Behind canines	Grinding and crushing; bicuspid
Molars	12 (incl. wisdom)	Back	Heavy grinding; multiple cusps and roots

Structure of GUMS (Gingiva)

- **Free Gingiva:** Margin not attached to tooth; forms gingival sulcus (0.5-3 mm deep = normal)
- **Attached Gingiva:** Firmly attached to alveolar bone; pink, stippled (orange peel texture)
- **Interdental Papilla:** Fills space between teeth; prone to bleeding in gingivitis
- **Periodontal Ligament (PDL):** Fibrous tissue connecting cementum to alveolar bone; acts as shock absorber; destroyed in periodontitis

Common Problems of Teeth and Gums — Detailed

A. DENTAL CARIES (Tooth Decay)

Aspect	Details
Definition	Demineralization of enamel and dentin by acids from bacterial fermentation of carbohydrates
Primary Organism	Streptococcus mutans (main), Lactobacillus acidophilus (secondary)
Mechanism	Bacteria ferment sucrose → lactic acid → dissolves hydroxyapatite → enamel lesion → dentin → pulp
Stages	1: White spot (reversible); 2: Enamel cavity; 3: Dentin caries; 4: Pulp involvement; 5: Abscess
Prevention	Fluoride toothpaste (1000-1500 ppm); brushing 2x/day; flossing; reduced sugar; xylitol gum
Role of Fluoride	Converts hydroxyapatite → fluorapatite (acid-resistant); inhibits bacterial enzymes

B. GINGIVITIS (Gum Inflammation)

Aspect	Details
Definition	REVERSIBLE inflammation of gingiva due to plaque; does NOT involve bone or PDL
Cause	Plaque (bacterial biofilm) accumulation; systemic: pregnancy, diabetes, medications
Organisms	Porphyromonas gingivalis, Fusobacterium nucleatum, Treponema denticola
Symptoms	Redness, swelling, bleeding on brushing; bad breath; soft, spongy texture
Prevention	Brushing 2x/day; flossing; professional scaling; antimicrobial mouthwash
Treatment	Scaling and polishing; chlorhexidine gluconate mouthwash (0.2%)

C. PERIODONTITIS (Advanced Gum Disease)

Aspect	Details
Definition	IRREVERSIBLE — destruction of periodontal ligament, alveolar bone, cementum
Cause	Untreated gingivitis; dysbiotic plaque; host immune inflammatory response
Symptoms	Pocket formation (>3 mm); bone loss on X-ray; tooth mobility; gingival recession; pus
Stages	I: 1-2 mm bone loss; II: 3-4 mm; III: 5+ mm; IV: tooth loss
Systemic Links	Associated with diabetes, cardiovascular disease, adverse pregnancy outcomes
Treatment	Non-surgical: Scaling and Root Planing (SRP); Surgical: flap surgery

D. TOOTH SENSITIVITY (Dentin Hypersensitivity)

Aspect	Details
Definition	Sharp, short-lived pain to stimuli from exposed dentin
Mechanism	Brannstrom's Hydrodynamic Theory: Stimuli cause fluid movement in dentinal tubules → activates pulpal nerve fibers
Causes	Gingival recession; enamel erosion; bruxism; aggressive brushing
Triggers	Cold, hot, sweet, acidic foods; air blast; touch
Management	Potassium nitrate toothpaste (desensitizes nerves); fluoride varnish (plugs tubules)

E. HALITOSIS (Bad Breath)

- **Cause:** Volatile Sulfur Compounds (VSCs): H2S, methyl mercaptan from bacterial putrefaction
- **90% Origin:** Oral cavity — tongue dorsum (posterior), periodontal pockets
- **Control:** Tongue cleaning; mouthwashes (chlorhexidine, cetylpyridinium chloride, zinc); treating periodontal disease

★ EXAM IMPORTANT POINTS

Q: What is the hardest substance in the human body? → Enamel (96% hydroxyapatite)

Q: Primary bacteria causing caries? → Streptococcus mutans

Q: Mechanism of dentin hypersensitivity? → Hydrodynamic theory by Brannstrom

Q: How does fluoride prevent caries? → Forms fluorapatite (acid-resistant); inhibits bacterial enzymes

Q: Gingivitis vs Periodontitis? → Gingivitis: reversible, gum only; Periodontitis: irreversible, bone involved

Q: What are VSCs? → Volatile Sulfur Compounds — cause of halitosis