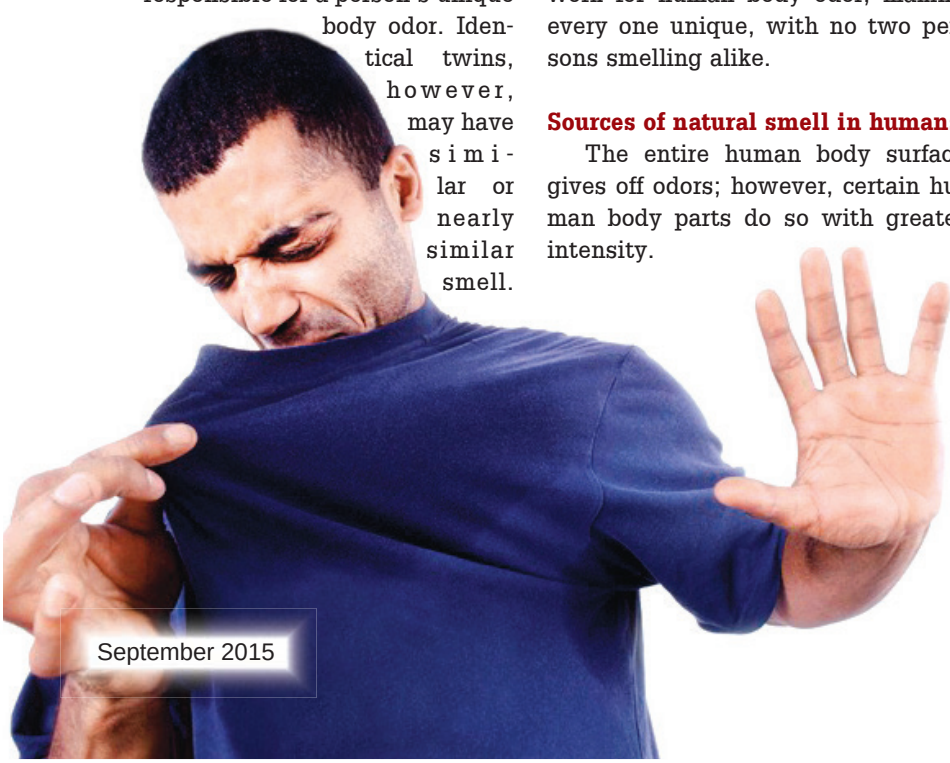
Human body odor – The basis for deodorants and fine fragrances

All humans emit odors that vary with the time of the day. It is a complex mixture of natural and artificial components, depending on human intent, the environment, the living condition, and other factors that are not in direct human control. The sum of the smells given off by the human skin, the hair, the body apertures, and other body constituents determines human body odor. The intensity, character, type, etc., depends on internal and external factors. Seasons, weather condition, race, social and professional groups all contribute to the characteristic odor of an individual.

1. **Human physiological characteristics:** The body or skin odors have close relations to the general skin structure and its physiological characteristics. The state of human health, constitution, body metabolism, etc., all influence human body odor. Fundamental experimentation over the years establishes that genetics is responsible for a person's unique body odor. Identical twins, however, may have similar or nearly similar smell. Similarities may also exist in certain groups belonging to a specific race with similar genetic make-up or coding.
2. **Diet:** Food a person consumes determines body secretions. Body secretions are an outcome of human body metabolism. Foods like meat, fish, cereals, oils & fats, vegetables, spices, beverages and any medication a person eats directly influences human body odor.
3. **Climatic conditions:** Climate or weather, the clothes worn, and the level of skin exposure to the atmosphere are also a critical factor affecting human body odor.
4. **Civilization levels and the way of life:** The standard of hygiene, living conditions, and a general way of life an individual follows is another important factor in contributing to overall human body odor.

All the above general factors typical for most groups form the framework for human body odor, making every one unique, with no two persons smelling alike.



Sources of natural smell in humans

The entire human body surface gives off odors; however, certain human body parts do so with greater intensity.

1. Scalp, palms of the hands, soles of our feet and armpits.
2. Hair and all hairy skin surfaces.
3. Body orifices namely our mouth, anus and urogenital organs.

The odors of the skin, including the hair-covered areas, are of interest to the general fragrance and cosmetic industry. The urogenital organs are of particular interest to the hygiene cosmetic industry.

Skin secretions are the main contributing factor in the odor of an individual and to analyze and classify these elements we have to understand the basic human skin structure and its physiology. A broad understanding of the human skin is indispensable if one has to create a successful consumer product in this category.

Human skin structure

The skin is no ordinary structure in the human body. This 1.7 square-meter protective cover separates the fragile interior of our body from potentially harmful and damaging stimuli present in the environment. The skin regulates body temperature and controls loss of water from the body tissues. Different sensory nerve endings present on our skin protect the human body. Our skin cover, prevents penetration of radiation, protects the human body from any damage, and resists mechanical jerks due to external agencies.

The skin comprises of two main layers, the "Epidermis", and the "Dermis".

Epidermis

The epidermis is the most superficial layer and comprises of stratified

squamous epithelium. From the outside in, the stratified epithelium has five layers.

Stratum Corneum

Stratum Corneum is the most superficially placed keratinised cells without nuclei and with indistinct cell outlines. This layer is thickest on the soles and the palms. It is thin at the lips. Hairs, nails, etc., are outgrowths of this layer.

Stratum Lucidum

Stratum Lucidum is a thin, slightly transparent layer three to five cells deep. It is present below the *Stratum Corneum* and is very similar to it, having indistinct cell outline without nuclei.

Stratum Granulosum

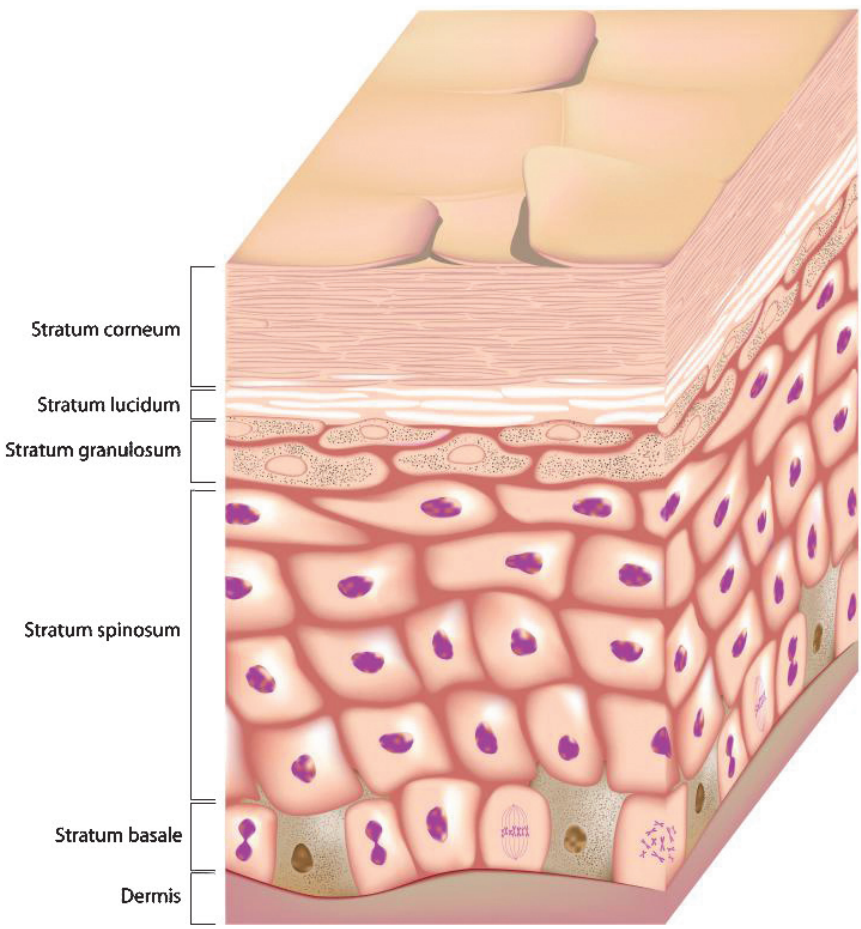
Stratum Granulosum, consisting of three to five layers of flattened polyhedral cells, comes next.

Stratum Spinosum

Stratum Spinosum, also made up of polyhedral cells of variable thickness, follows the *Stratum Granulosum*. The surface of these cells has a cover of minute spines, that interdigitate with similar spines of adjacent cells. These cytoplasmic protrusions are called as the "Prickle Cells". The branches of two cells have no cytoplasmic continuity, but attach themselves to one another by a well-developed cytoplasmic nodes or desmosomes. A network of cytoplasmic fibrils supports these basophilic cells. Star shaped branched cells capable of DNA synthesis, or "cells of Langerhans" is scattered irregularly throughout the skin.

Stratum Germinativum

Stratum Germinativum (*Stratum Malpighi*) is a single layer of columnar epithelium, having transverse, thin, short, cytoplasmic process on its basal lamina. It anchors the epithelium to the lower dermis. These



cells have oblong nuclei, with cuboidal to columnar cell structure, and are perpendicular to the basement membrane, producing newer cells to replace those above by the process of mitosis. At the junction of the epidermis and dermis are present melanocytes or melanin containing branched cells. Melanocytes produce melanin pigment. Malpighain cells and the melanin are present in the deeper cells of the *Stratum Germinativum*. Cytrocrine secretion converts the fully formed melanin granules from melanocytes to the malpighain cells. We find melanin a yellow to a black pigment in the *Stratum Germinativum* on specific cell particles, or the melanosome within the melanocyte. Melanin contributes color to the skin and protects one from the ultra-violet rays of solar radiation.

Dermis

The Dermis or the "true skin" consisting of connective tissue lies below the epidermal layer, which it supports and binds to the underlying tissues. It consists of chiefly collagen and elastic fiber that provides tensile strength. Structurally the superficial part of the dermis is compact and forms the papillary layer resembling innumerable finger-like projections into the prickle cell layer of the epidermis. The inner part of the dermis consists of loose connective tissue with fat. This layer makes up the reticular layer of the dermis, merging into the subcutaneous layer of fat.

Fibroblasts cells from which the fibrous tissue of the dermis develops is present in the dermis. Melanophores containing melanin pigments and cell

belonging to the reticuloendothelial system in protecting the body from invading bacteria are also present in the dermis. Unlike the epidermis, the dermis has a well-organized lymphatic system and a luxuriant capillary blood vessel network supplying blood to the tip of the dermal papillae and plays an important role in regulating temperature. Besides bundles of involuntary muscles and vasomotor nerves, the dermis has sensory nerve endings of different types that keep an individual conversant about the surroundings.

We find pear like shape sebaceous glands in the dermis, which open into the root of the hair follicles. It is present also on the red surface of the lips, in the nostrils, in the papillae, on the anus, and on the foreskin and *labia minora*. In places that are independent of hairs, the duct of the sebaceous glands opens directly to the surface of the skin. Sebaceous glands are not present at the palms of the hands, soles of the feet, fingers, and toes. Large sebaceous glands are present on the face, on the forehead, in the creases of the nose and lips and on the back. It is present in the loins in comparatively larger proportion. A hundred square millimeter skin on the forehead contains five times as many sebaceous glands as equivalent from the thigh and 100 times as much as we find in the calf. The density on the back of our hand is about 50 per square centimeter. Sebaceous glands secrete an oily material or sebum. Sebum forms due to an elimination of broken up or destroyed sebaceous gland cells. Sebum is rich in fatty acids (palmitic acid and stearic acid) and their esters, cholesterol and their esters, triglycerides, wax esters, and other aliphatic components. Sebum mixes with other epidermal fats and other skin secretions on the skin surface. Sebum is generally liquid at 38° C with oil-like consistency, sometimes solidifying on the skin surface.

The cholesterol present in the sebum can absorb about 100% water and keep the surface of the skin moist. Irradiation of sebum creates vitamin D. Sebum behaves as a lubricant to prevent damage to the epidermis during summer and conserves heat during winter. Thus, sebum forms a protective layer on the skin against external effects of the environment and prevents loss of water. Contraction of the hair musculature during adverse environmental cold conditions stimulates sebum secretion from the sebaceous gland, thus bringing about super fattening of human skin.

The amount of sebum the skin secretes depends on the number of sebaceous glands present per unit surface area of the skin. One square centimeter of the forehead skin could contain 0.1 to 0.21 milligram of fat. The quantity of fat is the highest during puberty, slowly diminishing with age. We can safely estimate the total quantity of sebum in a healthy adult at anywhere between 1.6 to 1.8 grams.

The central nervous system, hormones, and to some extent ambient temperature all affect sebum secretion in humans. Androgen and adrenal cortex hormones increase sebum secretion, while estrogen cut its production. A diet of increasing proportion of oils & fats and carbohydrates affect sebum generation. Racial difference plays an important role with Africans tending to secrete more sebum than Caucasians. The quantity and quality of sebum with respect to its composition in every individual is predetermined with major changes occurring only in case of skin ailment or disease.

A person with illness like seborrhea, fatty seborrhea (seborrhea *oleosa*), secretes sebum that is liquid in nature containing a good amount of bound fatty acids. Similarly, a person with dry seborrhea (seborrhea *sicca*) secretes a yellow color viscous sebum containing many free fatty acids. Seborrhea can lead to other skin ailments like rashes or eczema. People suffering from nervous diseases like Parkinson's secrete sebum in increased quantity. Medicinal drugs that influence the human nervous system also bring about changes in the sebaceous gland secretion and vice-versa.

Pure sebum and its known constituents that have a high molecular weight in comparison to other odorous molecules are mostly odorless or have insignificantly low odor. However, they could provoke responses in sense of human smell and significantly in the case of dogs. Researchers believe that pheromones are present in the sebum or sebum-like secretions of the sex organs and genital regions that can evoke specific reactions in others. Readily and easily perceptible odorous substances arise mainly due to decomposition by skin micro-flora of sebum and sebum constituents. Genetic composition determines sebaceous gland secretion and skin micro-flora peculiarities determine the resulting odor of the individual. Odorous substances originating in foods like garlic metabolites or any metabolic abnormalities in the individual may manifest itself in sebum smell.

Sweat glands

Sweat glands are present throughout most of the skin. There are about 3 million active sweat glands in the body. The lower ends of the sweat glands reach the deep part of the dermis and act as islands or regrowth of epidermis in cases of injury and burns. Modified smooth muscle cells, known as the myoepithelial cells present at the base of the sweat glands surround their ducts in a way that their contraction help in eliminating sweat.

Table 1
Constituents of Eccrine Perspiration

Constituent	Value
Water	99.22 to 99.74 g
Solids	1.174 to 1.587 g
Ash	0.147 to 0.566 g
Creatinine	0.1 to 1.3 mg
Urea	12.0 to 57.0 mg
Lactic acid	285 to 336 mg
Carbolic acid	2.0 to 8.0 mg
Sugar as glucose	1.0 to 3.0 mg
Uric acid	0.07 to 0.25 mg
Dehydroascorbic acid	70.5 µg
Total nitrogen	33.2 mg
Non-protein nitrogen	27.0 to 64.0 mg
Amino acid	1.1 to 10.2 mg
Ammonia nitrogen	5.0 to 9.0 mg
Urea nitrogen	5.0 to 36 mg
Calcium	1.0 to 8.0 mg
Iodine	0.5 to 1.2 µg
Iron	0.022 to 0.045 mg
Chloride	36.0 to 468.0 mg
Sodium ions (Na+)	24.0 to 312.0 mg
Potassium ions (K+)	21.0 to 126 mg
Sulfur	0.7 to 7.4 mg
Copper	0.006 mg
Amino acids (Total)	43.62 mg

Values for 100 ml Sweat

Sweat glands are of two types, Eccrine, and Apocrine.

We find eccrine glands throughout the surface of the body. They are present in large numbers on the palms and soles than on the head or the trunk. In humans, they peak at levels of 200 to 400 per square centimeters of skin surface with a high of 600 per square centimeter on the feet and their discharges alter, primarily due to changes in deep body temperature. Glands present at the palms and soles respond and secrete at times of emotional stress. Eccrine sweat composition depends on the blood constituents and contains sodium chloride, urea, lactates, creatinine, uric acid, ammonia, amino acids, glucose, water-soluble vitamins B and C.

Apocrine glands are larger sweat glands and derived from the hair follicles. The distribution of these glands in humans varies from individual to individual and race to race. We find apocrine glands in special regions such as axillae, the areola of the nipples, *mons pubis*, *labia majora*, etc., that have sexual significance responding to the circulating adrenaline. For every apocrine gland, there is one eccrine gland in the axillae region, whereas the ratio is one apocrine gland to ten eccrine glands in other areas. Thus, the main area where we get body malodor is the axillae region. Apocrine sweat glands become functional only after puberty in a normal healthy individual.

Initially, apocrine secretion is viscous, milky, and odorless, but after puberty, their secretion varies in composition, owning a characteristic odor. Presence of indoxyl, volatile fatty acids, hydroxy acids, ammonia and other metabolic excretory products give birth to this odor. Fresh perspiration is odorless. However, bacterial activity in these secretions contributes to the intensity and quality of odor. Sweating is important physiologically as active secretion plays a vital role in keeping the body cool and regulating body temperature. When the ambient temperature is higher than body temperature, sweating is the only means of keeping the body temperature normal.

Table 2
Constituents of Apocrine Perspiration

Constituent
Indoxyl
Volatile fatty acids
Hydroxy acids
Ammonia
Carbohydrates
Steroids

(Exact composition is not yet fully understood)

Table 3
Constituents of Sebum

Constituent
Fatty acids
Stored cholesterol
Cholesterol esters
Triglycerides
Wax esters
Other Aliphatic components

(Exact composition is not yet fully understood)

Please note that NaCl varies from 0.2 to 0.5%. Muscular exercise increases salt concentration in sweat. The sweat secreted by clothed skin has a higher salt concentration than that of naked skin. Profuse sweating eliminates almost 0.5 to 1.0 g of non-protein nitrogen.

Types of sweating in humans

Insensible perspiration occurs, even in cold weather, amounting to about 600 to 800 ml per day.

Psychic sweating occurs chiefly in the palm, sole, axillae, head, and neck in extreme emotional conditions. Muscular exercises, eating spicy foods, sympathetic activity, nausea & vomiting, fainting, hypoglycemia and asphyxia can induce sweating. Sweating reduces during cold due to reduced cu-

taneous circulation. It reduces by dehydration either by reduced fluid intake or by excess sweating. Drinking a glass of icy water dilutes the blood and this can induce sweating profusely.

Thermal sweating occurs in hot environmental temperature. As the environmental temperature increases, sweating rises and can under extreme conditions amount to 11 liters per day. Men start to sweat excessively at temperatures above 28°C and women above 31°C. Apocrine glands activate at an earlier age in women than men. Women also have a larger number of apocrine glands, compared to men. Moreover, the secretion granules of women are larger and so more the odors generated.

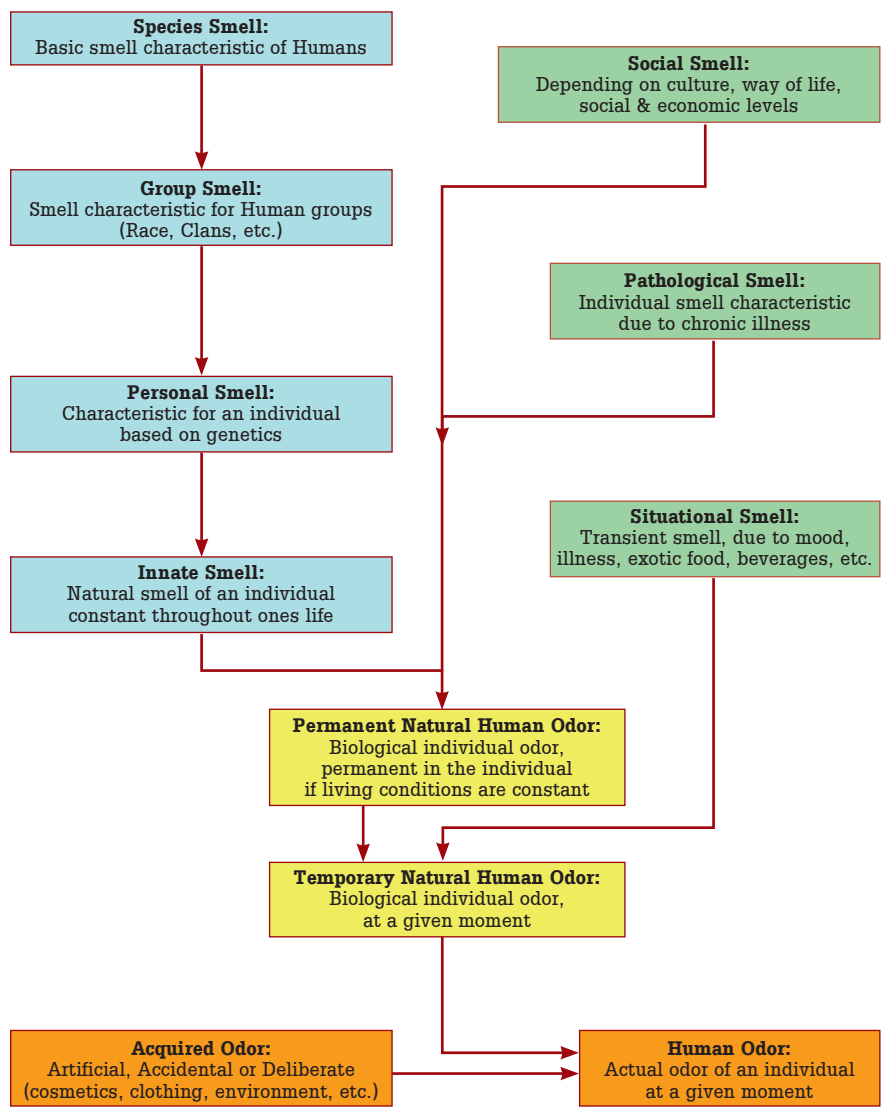
Although the axillae are more of an apocrine organ, the profuse perspiration formed is due to the eccrine glands that secrete copious amounts of sweat in comparison to apocrine glands. Regardless of the fact that eccrine perspiration is only a dilute solution of salts and less important in causing axillary odor compared to apocrine secretion, it does indirectly contribute to the overall promotion of malodor. The smaller amounts of apocrine secretions that are sticky and oily disperse over a wider area by the moisture of the eccrine secretions. Eccrine moisture generated by the eccrine secretions also provides an ideal environment for the rapid growth and proliferation of bacteria responsible for the malodor. Hairs present on the axillae act as an ideal collecting site for the apocrine secretion and increase the surface area available for microbial growth, promoting body malodor. Hair influences smell in humans as body secretions that stay on the large surface area help to foster the actions of the microorganisms, to bring to the fore the intensive odor of the hairy parts.

Skin bacteria decompose the sebaceous secretions giving rise to many odorous substances, producing the natural odor of human skin. Despite the fact that lower fatty acids, steroids and lactones present in the sebaceous secretion have no inherent smell, they help in fixing the odor on to the skin. Body odor profiles being subject to the food ha-bits, race, physical and physiological condition, is specific to every person. Thus, two persons will smell different, depending on personal traits, the environment, social and physiological reasons. The physiological state of the human body determines the emanating odor profiles containing pheromones, to attract the opposite sex. Illness and pathological conditions also have a pronounced influence on the quantity and quality of sweat. Metabolites of food products one eats, and medication, manifest itself in recognizable and distinct sweat smell.

Odorous substances produced on skin

Decomposition of body secretions by the skin micro-flora and likewise decomposition of proteins on the surface of our skin gives rise to many odoriferous substances producing natural human odor. These substan-ces are lower fatty acids (C_4-C_{10}) and macro-cyclic

Classification of Human Odor



systems, steroids, lactones, etc. These substances by itself have little or no smell, but help in fixing the odor on the skin. In addition to these substances, the odor pattern of the skin also has many other distinguishing substances specific to a particular person or group from the combined action of food habits, physical and psychological conditions. A fine example is of a pregnant woman who normally has a characteristic smell of progesterone. Odorous substances appear in skin secretions shortly after meals, like that of garlic, diallyl sulfide, or hot oriental spices (curry/chillies). Vitamin B smell is also relatively easy to distinguish. Likewise, persons consuming only milk or milk products or only cereals are also easy to identify because of their skin odor characteristics. Sometimes, skin secretions may also contain substances that enter an individual either by inhalation or by blood transfusion.

Classification of human body odor

Natural odor refers to all smells originating within the body and it includes all those that arise directly from body secretions or because of natural decomposition or transformation of body secretions. Acquired odor is an odor imposed on the body or clothing from outside, either voluntarily or involuntarily. Smell of menthol or say garlic on the breath of an individual arising out of eating peppermint mouth freshener or a garlic preparation will belong to the group comprising natural smells. Acquired smell is many in number as it can come from various sources and so difficult to classify.

Species smell: It is the common characteristic of humans and is the result of the combination of smells the *homo-sapiens* body exudes due to metabolism. Most mammals have a characteristics smell of fatty acids and protein breakdown products.

Group smell: This belongs to groups or races of people having common physiological characteristics, ecological condition, characteristic diet, etc. A good example could be how Africans have highly developed sweat glands in their under-arms, while Japanese rarely sweat in their under-arm region.

Personal smell: Genetics determines the composition of body secretions. Constituents and its proportion differ in every person and so they smell different.

Innate smell: Superimposition of the above three smells give rise to innate smell. It is constant and independent of individual internal and external conditions. Tests demonstrate that it is easy to identify this smell in an individual except in the case of identical twins.

Social smell: An individual's living condition, food, culture, hygiene, job environment, etc., all contribute to the social smell that arises in the human body. The body smell of people spending most of their time with pet animals falls in this category.

Pathological smell: It is the characteristic odor of chronically sick persons. Typical diseases one can notice a specific odor in sick individuals are leprosy, Parkinson's disease, diabetes, and by use of regular medication.

Situation smell/Instantaneous smell: Generally, these smells are temporary due to body secretions appearing in a specific situation, disappearing once we remove the stimulus that provokes the smell.

Permanent natural human odor: It is the sum of innate and social smells and in some special case also include pathological smell. It is the inherent odor a person carries throughout one's life. Normally the dominant element is the innate smell and in some cases pathological. The social smell is significant only if there are wide differences in living habits and conditions. Experiments show that one can distinguish even twins if they grow up separately under unlike conditions.

Temporary natural human odor: Permanent natural odor and the situation smell combine to result in temporary natural human odor. This odor characterizes a person at a given moment or in a given period of an individual's life. To explain further it is the odor a person gives off under normal conditions; say after a bath with soap and warm water but without using any fragrant substance.

Acquired odor: It is the sum of all the smells due to deliberate or intentional use namely clothing, cosmetics, fragrances, deodorants, cigarette smoke, the environment, etc. Incidentally, human hair takes up external smells most easily in comparison to other parts of the human body.

Actual human odor: It is the total human odor arising from temporary natural odor and acquired odor.

Studying the classification chart of human odor can help one in formulating products to modify, improve, or eliminate human odor.

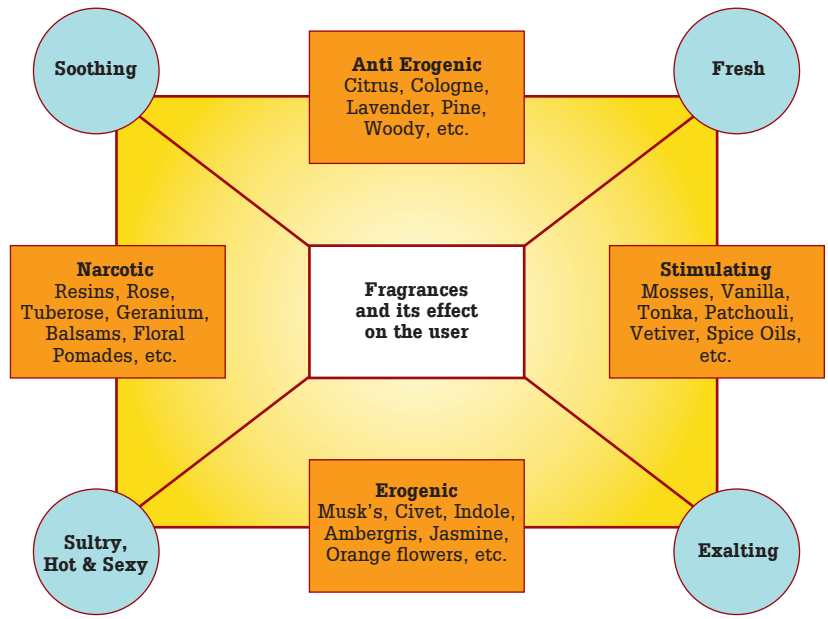
Human odor and social life

Human odor is an important facet of human life. Humans in this respect down the centuries have actively worked to improve the smell of the human body. More than one's own odor, people give more importance to ascertaining the effect of one's smell on others. Pheromones play a significant role in the animal world. The receptors of one animal pick up the pheromones given off by another animal, evoking specific reactions that could range from a voluptuous charm, enticing a prey, or repulsive to attackers. Researchers believe that human emanations could also contain pheromone, having a sexually arousing effect denoting the psychological state of the person. Women

are sensitive to certain smells especially during their menstrual cycle and react more sharply than men to certain chemical substances present in male urine. Pheromones contain steroids, ketones and macrocyclic lactones that a trained person can easily find the odor, helping to decipher the mood and nervous condition of the person.

A dog attacks only a frightened person, the animal reaction resulting from the "smell of fear". In an experiment, a group of men after seeing a pornographic film shows a distinct change in the composition and odor of their urine and sweat unlike a group of female subjects who show no such change. Polynesian medicine men claim to have the skills to diagnose illness, anxiety, depravity, excitement, etc., by human odor alone. Without a doubt, human odor can show a psychological state, mood, sympathy, antipathy, etc. Perceiving this by others, even subconsciously will inevitably have a larger social significance. We all know how feelings unite and divide people, without any rationality and are an enigma to an external observer. We can attribute it to "life stream" and the realms of parapsychology or even associate it to a person's natural odor or pheromone. Researchers believe that sexual problems between people relate largely to the partners natural body odor.

The actual odor is the total of a person's natural body odor and acquired body odor. Two people will smell different even if they dress, wash, and perfume themselves identically. Body odor like the fingerprint or the characteristic sound of the human voice is thus a unique personal property. Although humans and instruments are not so sensitive enough to distinguish this difference, a dog's sense of smell is enough to identify the difference. People pick up smells from others and of the environment, evoking a psychological reaction. Odor perception, even though



Dr. Jelinek's Odor Classification

at the subconscious level, is clear with most nations and races using incenses and fragrances during religious and traditional functions or events.

Human body odor and conscious control actions

Freshly washed healthy body is not unpleasant. Similarly, fresh perspiration is odorless. However, the bacterial activities in human body secretions contribute to the intensity and quality of odor disagreeable in a social circle. Although many slogans and sayings make a positive link between sweat, work, and achievement, human attitudes demand that one should eliminate body malodor that generates from sweat due hard work at the earliest. This attitude of cleanliness was largely accountable for using various methods to control body malodor from time immemorial. The earliest form of controlling body odor is bathing, and until today does not have any substitute. Regular bathing eliminates sebaceous secretions and odorous end products of perspiration along with skin bacteria, equally responsible for body malodor.

Urbanization of the population, continuous media coverage, influence of advertising, rising education, standard of living and higher disposable income have all contributed in increasing the wish to smell fresh, pleasant and be accepted by the social circle. The concept of masking body malodor is age-old, but the development of diverse personal hygiene requirements, to the present degree, leading to the growth of specialized products is of recent origin. This growth especially to fight malodor in the axillae region, has been remarkable for the last 100 odd years. In earlier days, masking unpleasant body odor with a pleasant smell was popular, but today, preventing any development of malodor first and thereby eliminating body odor is necessary.

Maintaining body hygiene is the key in keeping body odor agreeable to other people in our social circle and cosmetics only aids to influence this need. Our understanding of the physiology of sweating says that we just have to reduce or control axillary odor by any one of the following.

1. Remove the secretion or perspiration from the sweat gland at the earliest possible time and in the

most practical way – cleansing agents, bathing.
2. Reduce or suppress apocrine sweating in the axillae – antiperspirants.
3. Prevent or inhibit growth and proliferation of bacterial flora – deodorants.
4. Mask or improve body odor – body cologne, fragrances, cosmetics, detergents and fabric conditioners through clothes washed in them.

We know that fragrances and cosmetics improve body odor, and this involves pheromones to some extent. Fragrance compositions use substances like animal attractant imitating pheromones. The smell of musks, for example, is supposedly erotic, stimulating and enticing. Fragrances also make use of vegetable plant ingredients like sandal, myrrh, etc., which stimulates and are narcotic. Similar is the significance of other chemical constituents in a fragrance. Dr. P. Jellinek's odor classification by the effect they produce on the user makes this understanding easy.

Critical differences exist in natural human odor characteristics among every individual. Choosing the correct fragrance to mask or enhance this human body odor is of final importance. In this respect, the fragrance a person uses should also be individualistic and no two individuals can use the same product interchangeably. Tradition and promotions of cosmetics and fragrances by marketers today decide and help us choose products, by associating the fragrance to skin type, skin color, hair color or personality type. Scientific understanding of one's human odor alone can help choose fragrance and fragrance products, tailor-made for our use and there are not any two ways about it. Do you agree?

Additional Reading

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