Science University Of Salahaddin- Erbil

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Development of the Integymentary system

Report Submitted In The Alternative

Embryology Exam

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CONTENTS:

Summary :

The skin is an important part of the integumentary system, which has important functions such as protection against dehydration, injury and infection, as well as present high potential of renewal. Histologically, the skin consists of two functional layers, that are morphologically distinct, the epidermis and dermis. The mammary glands, ungueal capsule and horn are also part of this system. Due the poor data available on literature about the development of skin and other cornea attachments in bovine, the aim of this study was to describe the morphological characteristics of the integumentary system development during the embryonic and fetal periods in bovine. Individuals were allocated in three groups: Group I -embryos from 20 to 26 days (n=4), Group II -embryos from 30 to 47 days (n=6) and Group III -fetuses from 74 to 140 days (n=6). During the development of the skin it was observed different morphological patterns according to the analyzed regions. Especially, a higher level of differentiation was observed during 30-47 days of gestation. The bovine claw and mammary gland develop later between 74 to 140 days of gestation. In summary, these results related to the development of the integumentary system in bovine may help the analysis and understanding of the development of their organs, as well as the pathological disorders associated to the organogenesis.

The integumentary system is the body system which surrounds you, both literally and metaphorically speaking. If you look in the mirror you see it, if you look anywhere on your body you see and if you look around you in the outside world, you see it. It is the system that can instantly tell us whether someone is young or old, someone's ethnicity or race or if he/she has been on holidays recently.

It also protects us a great deal from harm and allows us to sense our surrounding environment. Broadly speaking, the integumentary system is composed of skin and its appendages, subcutaneous tissue, deep fascia, mucocutaneous junctions, and breasts. This article will discuss all of these components in detail together with some clinical notes about them and the integumentary system as a whole.

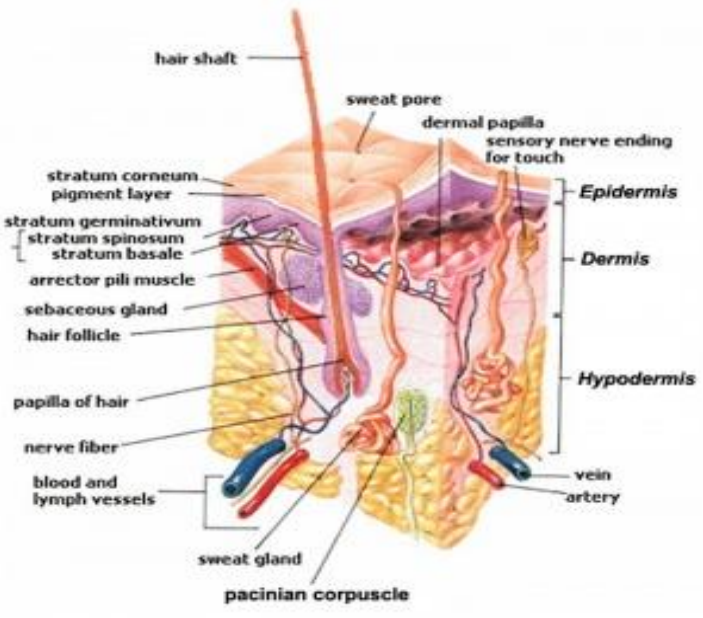
The Integumentarynsystem (skin) is an important part of the integumentary system, which has important functions such as protection against dehydration, injury and infection, as well as present high potential of renewal. Histologically, the skin consists of two functional layers, that are morphologically distinct, the epidermis and dermis. The mammary glands, ungueal capsule and horn are also part of this system. Due the poor data available on literature about the development of skin and other cornea attachments in bovine, the aim of this study was to describe the morphological characteristics of the integumentary system development during the embryonic and fetal periods in bovine. Individuals were allocated in three groups: Group I -embryos from 20 to 26 days (n=4), Group II -embryos from 30 to 47 days (n=6) and Group III -fetuses from 74 to 140 days (n=6). During the development of the skin it was observed different morphological patterns according to the analyzed regions. Especially, a higher level of differentiation was observed during 30-47 days of gestation. The bovine claw and mammary gland develop later between 74 to 140 days of gestation. In summary, these results related to the development of the integumentary system in bovine may help the analysis and understanding of the development of their organs, as well as the pathological disorders associated to the organogenesis.

Introduction:

The skin provides a barrier between ourselves and our environment (temperature, water, UV), and contains specializations in different regions including hair, nails, teeth, glands and sensory receptors. In other species there are also specializations of beaks, scales and feathers.The two major tissue organizations of epithelial (ectoderm, epidermis) and mesenchyme (mesoderm connective tissue, dermis and hypodermis) are shown within skin. In addition, we have also have extensive populating by melanocytes (neural crest) and sensory nerve endings.

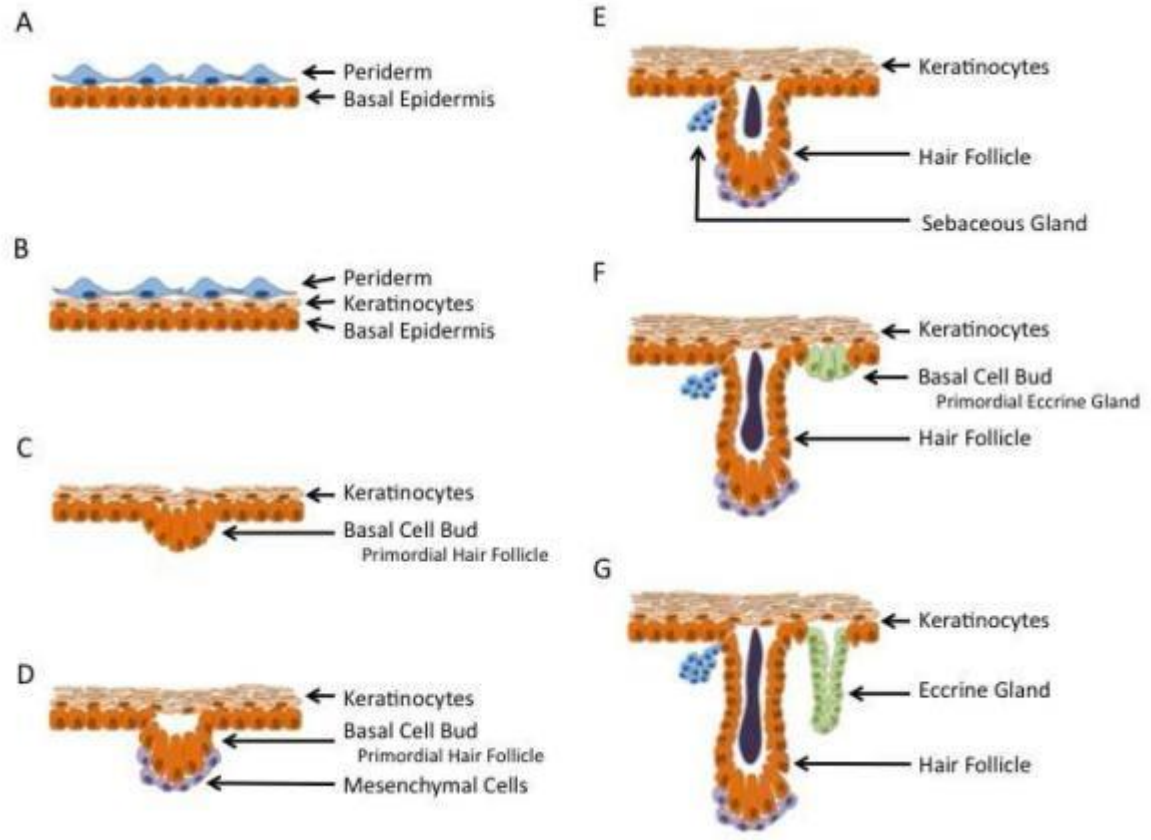
Possibly the first epithelial tissue specialization from which arose other epithelial specializations now located inside the body.
The external skin associated structures have many different roles and functions. This system is also an excellent model for distribution or "pattern" and adult stem cells.The integumentary system covers the surface of the embryo (skin) and its specialized skin structures including hair, nails, sweat glands, mammary glands and teeth. As a system it has contributions from all embryonic layers.
The skin provides a barrier between ourselves and our environment, it also contains specializations in different regions including hair, nails, glands and sensory receptors. In other species, additional specializations such as feathers, horns and shell can be seen.

The two major tissue organizations of epithelial (ectoderm, epidermis) and mesenchyme (mesoderm connective tissue, dermis and hypodermis) are shown within skin. In addition, we have aslo extensive populating by melanocytes (neural crest) and sensory nerve endings. It remains today as possibly the first epithelial specialization from which other epithelial specializations arose that are now located inside the body.
Ectoderm forms the surface epidermis and the associated glands. Mesoderm, from the somites, forms the underlying connective tissue of dermis and hypodermis. Neural crest cells also migrate into the forming epidermis and the skin is also populated by specialized sensory endings. Fetal skin also has the ability to heal wounds without a scar in contrast to adult skin, this may relate to differences in the fetal extracellular matrix structure. The adult epidermis contains keratinocytes, melanocytes and Langerhans cells.



Skin Development :

The development of the dermal/epidermal layers is a continuous process starting early in pregnancy with discrete patterns related to gestation age, developing from the cranial to caudal pole. At four weeks gestation, fetal skin can be visualized as two distinct layers with a basal cell layer covered by an outer layer, termed the periderm. The periderm is uniquely found in humans without an analog in animal models, such as mice or rats. Keratinization begins at nine weeks gestation, and at thirteen weeks gestation, stratification into different layers becomes apparent. Hair follicles begin to form as epidermal buds along the basal layer at fourteen weeks gestation. In the subsequent two weeks, these epidermal buds are associated with a local proliferation of mesenchymal cells associated with the epidermal bud as hair follicles rapidly develop. This is followed by the continued elongation of the hair follicles. The development of eccrine sweat glands begins as epidermal buds in the basal layer at twenty weeks gestation and continue to develop over the next ten weeks, first by elongating and then by coiling. At 24 weeks gestation, fetal skin continues to heal without scar, as keratinization and stratification into mature morphologic layers continues. After 24 weeks gestation, there is a "transitional period", where skin heals without characteristic scar deposition, but fails to reconstitute the dermal appendages. This transitional period has been found in multiple animal models of fetal wound healing. The scarless wound healing phenotype is lost by third trimester. At 34 weeks gestation, mature keratinocytes characterized by flattened, keratinized morphology is observed in conjunction with adult type dermo-epidermal undulations.



Fetal development of skin. (A) At 4 weeks gestation, skin is composed of two layers, the periderm and basal epidermis. (B) At 9 week gestation, keratinization becomes apparent. (C) At 14 weeks gestation, stratification of the epidermal layer is apparent along with budding of the basal layer as the primordial hair follicle develops. (D) At 16 weeks gestation, mesenchymal cells may be seen associated with the epidermal bud. (E) At 18 weeks, sebaceous glands become apparent, along with hair follicle elongation. (F) At 23 weeks, the hair follicle continues to elongate while the basal layer bud to form primordial eccrine glands. (G) At 30 week gestation, the eccrine glands continue to elongate and coil.

Clinical Review of the Literature: Summary Table of Various Reviews

Author	**Groups Compared**	**Findings**

Stamatas GN, Nikolovski J, Mack MC, et al (2011)[15]	Full term infants (birth to 3 years old) *vs* Adults	• Skin Structure
		  ○ - infants have smaller corneocytes
		  ○ - infants have thinner stratum corneum
		• Skin Function
		  ○ - Barrier function: weaker than adults
		  ○ - Hydration: decreased at birth, but increased later in infancy
		  ○ - TEWL: lower at birth, similar or higher later in infancy (anatomic variance)
		  ○ - pH: infant skin is more alkaline
		  ○ - Cell proliferation: increase turnover

Fluhr JW, Darlenski R, Lachmann N, et al (2012)[26]	Newborns (1-15 days) *vs* Infants (5-6 weeks) *vs* Infants (6 months) *vs* Infants (1-2 years) *vs* Pediatrics (4-5 years) *vs* Adults (20-35 years)	Skin Function • - Hydration: newborns have the lowest hydration and water content Skin hydration increases then remains stable through pediatrics and adults • - TEWL: lowest in the 5-6 weeks following birth, highest at 1-2 years • - pH: newborn infants are more alkaline than all other groups skin becomes more acidic by 5-6 weeks and then remains stable through pediatrics

Author	Groups Compared	Findings
Giusti F, Martella A, Bertoni L and Seidenari S (2001)[2]	Infants (8-24 months) vs Adults (25-35 years)	Skin Function: • - Hydration: infants have higher hydration • - TEWL: no difference between infants and adults • - pH: infant skin is more alkaline at multiple sites
Firooz A, Sadr B, Babakoohi S, et al (2012)[24]	Pediatrics (10-20 years) vs Adults (20-30 years, 30-40 years, 40-50 years)	Skin Function • - Hydration: no between pediatrics and adults • - TEWL: no difference between pediatrics and adults • - Sebum: no difference between pediatrics and adults
Man MQ, Xin SJ, Song SP, et al (2009)[25]	Prepuberty (0-12 years) vs Young group (13-35 years) vs Middle age (36-50 years) vs Old group (51-70 years)	Skin Function: • - Hydration: higher SC hydration in young group males compared to females • - pH: no difference in pH between pediatrics and older groups

In later gestation, the fetal dermis is primarily thickened by a increase in collagen content. This dermis has higher levels of type III collagen, chondroitin sulfate, proteoglycans and hyaluronan compared to adult dermis. Fetal dermis is also notable in its absence of dermal elastin.

Also during the last trimester, the fetus is covered by the vernix caseosa (VC), a protective coat secreted by the sebaceous glands and composed of protein (10%), lipids (10%) and water (80%). The VC is uniquely human, with no counterpart identified in animal models. This coat was initially posited to function as a lubricant in the birthing process. However, as the fetus continues to mature, part of the vernix sloughs from the skin surface into the surrounding amniotic fluid . This physiologic decrease of vernix with advancing gestational age renders this role unlikely. More recent studies of the VC suggest the layer helps to facilitate the transition from an aqueous in utero environment to the dry, extrauterine environment. The vernix helps to protect the fetal epidermis from maceration while immersed in amniotic fluid and permits epidermal cornification and stratum corneum formation. The VC also contains high levels of lysozyme, lactoferrin, linoleic acid, as well as, other anti-infective properties.

Full-term infants at birth have skin that is anatomically mature when examined histologically with all five layers present. These includefrom deep to superficial: stratum basale, stratum spinosum, stratum granulosum, stratum licidum and stratum corneum. As epidermal cells mature, their morphology changes from the columnar stratum basale to the tightly overlapping squamous keratinocytes of the stratum corneum. The time to fully mature, keratinize and form this protective horny layer varies depending on body site. This occurs more rapidly in facial skin than in the trunk and limbs. Neonatal skin has a relatively coarse texture compared to older infants and proceeds to develop a more homogeneous smooth structure during the first 30 days of life. Infants have smaller corneocytes and a significantly thinner stratum corneum until two years of age.

During the next developmental period from infancy to puberty, there is little difference in skin between males and females patients. Both genders demonstrate a steady increase in dermal thickness, with males developing thicker epidermal and dermal layers. At the onset of puberty, there is significant hormonal influence on the skin. After age twelve, females accumulate a thick layer of subcutaneous fat, which is absent in males. On the other hand, males exhibit a gradual thinning of their thick epidermal and dermal layers. These layers remain a constant thickness in females throughout adolescence and adulthood until menopause. Additionally, dermal composition begins to change with advancing age starting at puberty, with both sexes showing similar rates of linear decrease in skin collagen content with age. As females start with baseline lower collagen density, they appear to age earlier than men .

Development Overview :

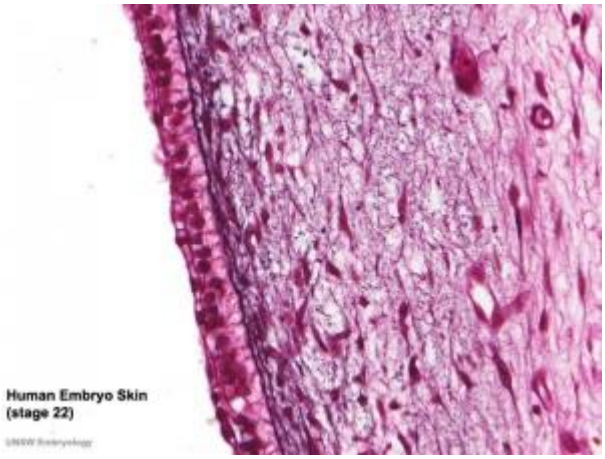
Ectoderm and Mesoderm Origin

4 weeks

- simple ectoderm epithelium over mesenchyme.

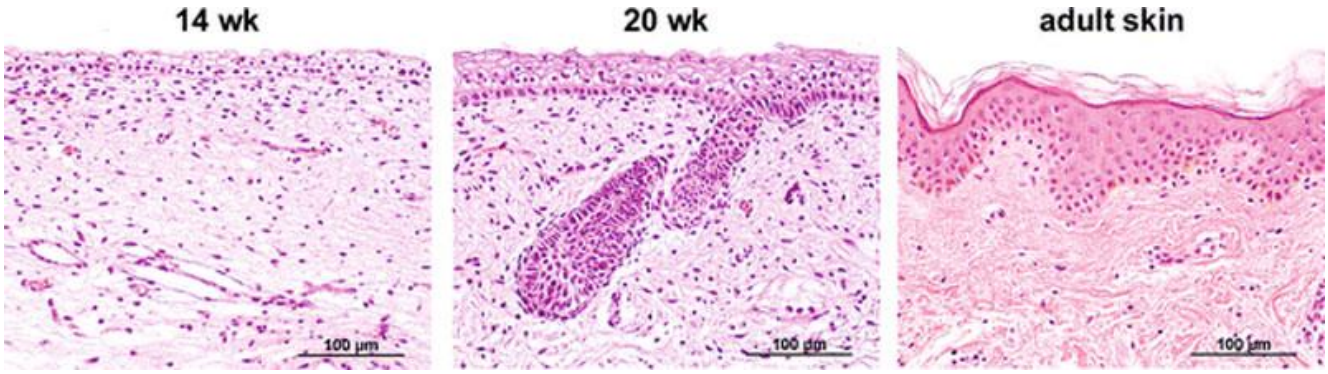
1-3 months

- ectoderm - germinative (basal) cell repeated division of generates stratified epithelium.
- mesoderm - differentiates into connective tissue and blood vessels.
- **week 11** - (**GA** week 13) blood vessels visible in the early fetal skin, small blood vessels in the upper papillary region and larger vessels in the deep reticular dermis.[2]



Integument Human Embryo (Week 8, Stage 22)

4 months



Fetal human integumentary histology[2](Weeks in figure are from LMP)

- Basal cell - proliferation generates folds in basement membrane.
- Neural crest cells - melanoblasts migrate into epithelium. These are the future melanocyte pigment cell of the skin.
- Embryonic connective tissue- differentiates into dermis, a loose ct layer over a dense ct layer. Beneath the dense ct layer is another loose ct layer that will form the subcutaneous layer.
- Ectoderm contributes to nails, hair follictles and glands.

- Nails form as thickening of ectoderm epidermis at the tips of fingers and toes. These form germinative cells of nail field.
- Cords of these cells extend into mesoderm forming epithelial columns. These form hair follicles, sebaceous and sweat glands.

5 months

- Hair growth initiated at base of cord, lateral outgrowths form associated sebaceous glands.
- Other cords elongate and coil to form sweat glands.
- Cords in mammary region branch as they elongate to form mammary glands. These glands will complete development in females at puberty. Functional maturity only occurs in late pregnancy.

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