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Research Article

A Novel System Model of Human Body Anatomical Structures: An Engineering-Inspired Theoretical Framework

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Abstract

This paper proposes a novel system model of human anatomical structures, which mainly consists of four parts: hierarchical design method, Skin-Core Dichotomy (SCD) model, full-coverage interface model, and Gender Control Sector (GCS), breaking the traditional paradigm of human anatomy. Key contributions of the paper include:

Engineering-Based Anatomical Design Methodology: Inspired by hierarchical design and I/O logic from integrated circuit architecture, the human body is restructured as a scalable and designable system, freeing human anatomy from morphology.

Proposal of the Skin-Core Dichotomy (SCD) model: Which redefines the human body as a system composed of two major modules: the skin and the denuded core. This model breaks away from traditional anatomical segmentation.

Full-Coverage Interface Architecture: A comprehensive interface logic system is designed to cover all human subsystems, reflecting the polymorphic mixed signal of human body holographic mapping.

Establishment of the Gender Control Sector (GCS): A programmable sub-region that enables sex-specific modular control and plug-in switching.

Designation of Four Transitional Zones: As independent functional blocks, emphasizing the role of four transitional zones in systemic integration.

Cross-Species and Universal Applicability: This system model is applicable not only to humans but also to other organisms and even non-living systems (excluding GCS), enabling a unified framework for modal expression.

Philosophical Foundation: The model embodies the principle of "universal transformation," offering a new methodological and ontological perspective for medical development.

Keywords: Hierarchical design, Skin-core dichotomy (SCD), Interface design, Gender control sector (GCS), Anatomical engineering.

Abbreviation: SCD: Skin-Core Dichotomy; GCS: Gender Control Sector; I/O: Input/Output; SGCS: Skin Gender Control Sector; CGCS: Core Gender Control Sector

Introduction

Since the publication of Belgian physician Andreas Vesalius's *De humani Corporis Fabrica* in 1543*, human anatomy has evolved into a systematic and mature discipline. Human thinking has become confined within established frameworks, with few seeking major breakthroughs from its foundations. Today, human anatomy exhibits the following fundamental weaknesses:

First, whether in regional, systemic, microscopic anatomy, or any other branch, the discipline remains rooted in material morphology and descriptive science [1,2], with its core objective being the description and classification of observable biological structures. While this paradigm has served clinical diagnosis and surgical practice well, it limits our ability to reinterpret the human body as an engineered system-one composed not only of organs and tissues, but of interoperable functional modules capable of signal transmission, external interaction, and systemic adaptation.

Second, traditional anatomy-both regional and systematic-has not established a complete and explicit interface logic between its constituent parts. Systematic anatomy, whether organized into 9 systems (as in the Chinese tradition) or 11 systems (as in the Western tradition), provides detailed descriptions of each system's internal components. However, it does not define formal interfaces *between* systems. How does the arterial system interface with the nervous system along a specific neurovascular bundle? How do the lymphatic vessels couple with the venous system at the thoracic duct? These cross-system connections-the very pathways that make the human body an integrated whole rather than a collection of isolated systems-remain implicit, described anecdotally in regional anatomy but never formalized as a complete interface network. The consequence is profound: without a formally defined, full-coverage interface map of the human body, we lack a complete grasp of how the body works as an integrated system; we cannot fully capture the body's total information architecture; we cannot comprehensively explain disease mechanisms that propagate across system boundaries; and clinical diagnosis remains inherently partial, with treatments targeting isolated symptoms rather than systemic dysfunctions.

Third, regional anatomy is constrained by the five-block model of head, neck, trunk, upper limbs and lower limbs, hindering understanding of skin's autonomy and interface functions as well as the role of transition zones. The boundaries between these blocks-such as the cervico-thoracic junction or the pelvic-hip interface-are precisely where interface logic is most dense and where clinical problems (such as thoracoabdominal combined injuries) most frequently arise. Yet traditional anatomy treats these zones as mere boundaries rather than as functional modules in their own right.

Fourth, gender transition will become increasingly important in both clinical and anatomical contexts, and the lack of a formally designated Gender Control Sector (GCS) is not conducive to the systematic development of gender transition technologies or sex-specific anatomical modeling. Traditional anatomy treats sexual dimorphism either as a post-hoc annotation to a generic (implicitly male) template or as a series of isolated "variations," rather than as a configurable architectural feature of the body plan.

In Order to Solve the Above Four Problems, this Paper Proposes a Novel Human Structural System Model

First, this paper adopts a top-down hierarchical design methodology inspired by integrated circuit architecture [3,4], abandoning traditional morphological replication. A six-layer human body structure architecture is proposed, with the understanding that deeper layers may be elaborated in future work. In this hierarchical framework, every layer and every functional block within each layer is connected through explicitly defined interface logic, ensuring that the entire structure can be represented as a complete, connected graph [5-19].

Second, a full-coverage interface model is introduced on the human body surface to realize holographic mapping of multi-state and mixed signals. Multi-state refers to the four fundamental states of matter-solid, liquid, gas, and plasma-along with other special states; mixed signals encompass sound signals, light signals, and electrical signals. The inclusion of gas as a primary signal modality reflects the established physiological role of gasotransmitters-Nitric Oxide (NO), Carbon Monoxide (CO), and Hydrogen Sulfide (H_2S)-as endogenous signaling molecules that diffuse freely across membranes *[Mustafa et al., 2009; Kolluru et al., 2017]* [20,21]. By defining explicit I/O interfaces at every anatomical boundary-from the skin-environment interface to the deepest neurovascular portals-this model transforms the human body from an implicit assembly of parts into an explicitly connected topological graph. Theoretically, this enables the construction of a form-a complete, hierarchical map of human anatomical connectivity-in which every node (structure/region) and every edge (interface/signal pathway) is formally specified.

Third, this paper proposes a conceptually distinct model: the Skin-Core Dichotomy (SCD) model, which divides the human body into two autonomous yet highly integrated systems-the skin and the denuded core. In this model, the human body is a triple-coupled system of skin, core, and environment; the skin is redefined as a complete, active, dual-surfaced interface system: all external surfaces serve as environment-facing interfaces, while all internal surfaces serve as core-facing interfaces. The SCD model provides a higher-order bipartite view that is independent of the traditional 9-system or 11-system classification, and it falls under the categories of both regional anatomy and systematic anatomy-a dual affiliation that underscores its integrative potential.

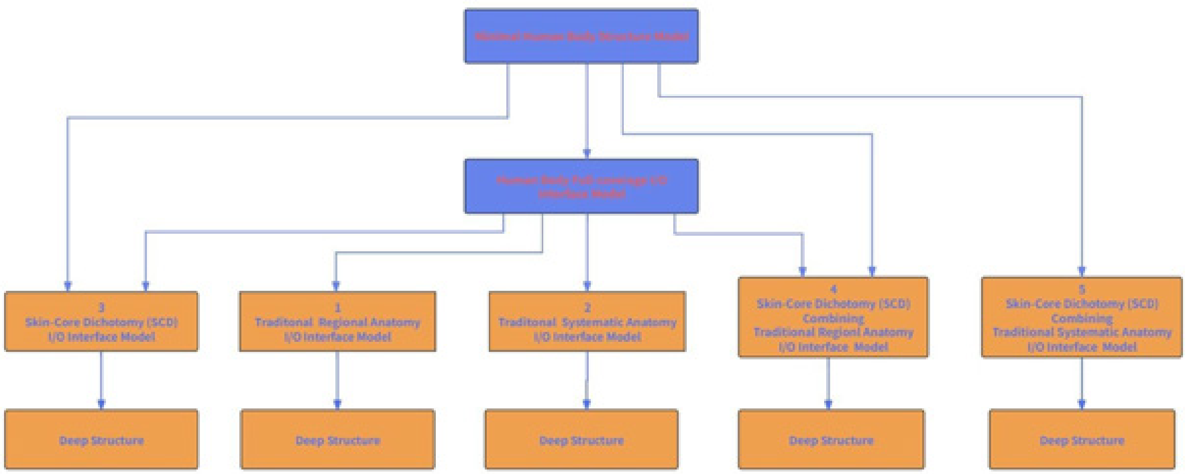
The SCD model serves as the primary model for regional anatomy; the traditional five-block model is downgraded to a secondary model and modified to a nine-block model by adding four transitional functional zones: cranio-cervical junction, cervico-thoracic junction, shoulder-axillary complex, and pelvic-hip interface. These transitional zones represent the anatomical instantiation of the interface concept itself-they are the loci where multiple systems converge, where neurovascular bundles traverse between regions, and where the interface logic is most dense.

Fourth, this paper establishes the Gender Control Sector (GCS), which is embedded within both the skin and core systems. GCS is a programmable sub-region responsible for encoding sex-specific interface logic. By treating gender not as a biological "variation" but as a configurable architectural parameter-operationalized through the variable X in the I/O interface model-the SCD framework integrates sexual dimorphism into the core logic of the body plan rather than appending it as an afterthought. A novel human structural system model is formed with hierarchical design, SCD model, interface logic and GCS architecture as pillars, transforming human anatomy from descriptive morphology to programmable engineering design. It can holographically map multi-state and mixed signals, break through the traditional anatomical structure division, and has gender pluggability. The human body is rendered as a modular, scalable, and designed system-one that can be analyzed, reconfigured, and optimized through engineering languages.

****Foundational Significance for Medicine.** ** The full-coverage interface theory proposed in this paper represents not merely a methodological innovation in anatomical modeling, but a conceptual breakthrough for medical theory as a whole. If the human body cannot be represented as a complete, connected, hierarchical topological graph, then our grasp of human physiological function remains incomplete; our understanding of disease mechanisms that propagate across system boundaries remains fragmented; and clinical diagnosis remains inherently partial-treating isolated symptoms rather than systemic dysfunctions. The interface framework advanced here points toward a direction in which artificial intelligence, by progressively completing deeper and finer levels of the interface graph, can asymptotically approach a complete anatomical connectivity map of the human body. This would pave the way for medicine to transition from localized, symptom-based diagnosis to truly systemic, interface-aware diagnosis-a shift from reading the body as a collection of isolated chapters to understanding it as a single, fully connected narrative. This paradigm lays the theoretical foundation for future programmable biological systems, sex-specific regenerative therapies, medical aesthetics, and hybrid human-nonhuman signal architectures.

Five Types of Hierarchical Design Paths for Human Body Anatomical Structures**

This paper proposes a minimal human body structure model and a full-coverage human body I/O interface model, which are discussed in detail in Section 3. As shown in (Figure 1), the first layer is the Minimal Human Body Structure Model, and the second layer is the Human Body Full-coverage I/O Interface Model (I/O represents Input/Output). The Minimal Human Body Structure Model and Full-Coverage I/O Interface Model, introduced above and detailed in Section 3, provide the abstract system logic within which these partitioning schemas operate. At the level of regional and systematic anatomical segmentation, five alternative schemas can be derived from the foundational models:



***Caption:** From the Minimal Human Body Structure to Human Body Full-coverage I/O Interface Model, there are five further approaches: 1. Traditional regional anatomy I/O interface model. 2. Traditional systematic anatomy I/O interface model. 3. Skin-Core Dichotomy (SCD) I/O interface Model proposed in this paper. 4. SCD combining traditional regional anatomy I/O interface model. 5. SCD combining traditional systematic anatomy I/O interface model.

Figure 1: Five Types of Hierarchical Design Paths for Human Body Anatomical Structures.

i. The traditional regional anatomy I/O interface model-the five-region division of regional anatomy, or the revised nine-region division proposed in this paper (the traditional five regions-head, neck, trunk, upper limbs, and lower limbs-plus four transitional zones: cranio-cervical junction, cervico-thoracic junction, shoulder-axillary complex, and pelvic-hip interface).

ii. The traditional systematic anatomy I/O interface model.

iii. The Skin-Core Dichotomy (SCD) I/O interface Model proposed in this paper, which falls under the categories of both regional anatomy and systematic anatomy.

iv. The Skin-Core Dichotomy (SCD) combined with the traditional regional anatomy I/O interface model, where SCD serves as the primary level of division, while either the traditional five-region or the revised nine-region scheme serves as the secondary level of division.

v. The Skin-Core Dichotomy (SCD) combined with the traditional systematic anatomy I/O interface model, where SCD serves as the primary level of division, while traditional systematic anatomy serves as the secondary level of division.

The present paper focuses exclusively on the fourth schema and part of the third schema. The first, second and fifth schemas are noted here for completeness but will be elaborated in subsequent work.

Hierarchical Design of Human Anatomical Structures: From Organ Assemblies to Interface Systems

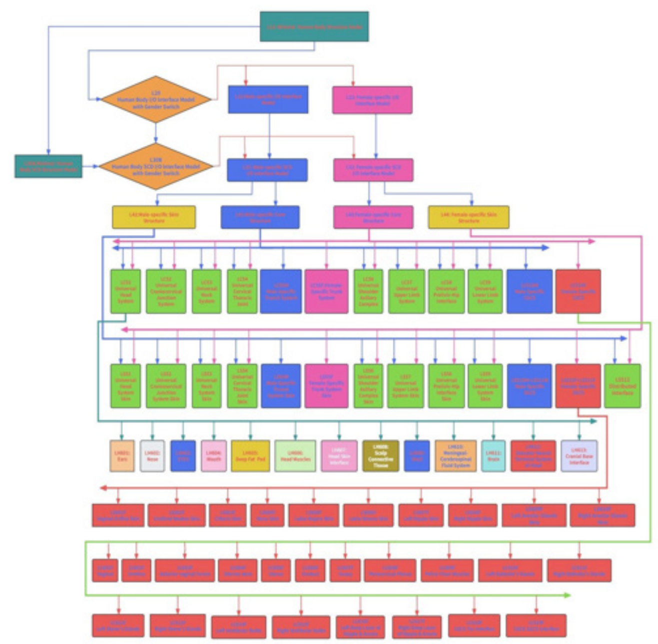
Reconstructing the Cognitive Paradigm of the Human Body

Human anatomy has long been a morphological discipline and conceptualized the human body as an assembly of organs, emphasizing functional segmentation and physiological mechanisms. However, this perspective overlooks the body's latent potential as an information system-a complex network of interfaces capable of input, processing, and output. With the rise of digital modeling and systems engineering, it is imperative to reexamine the organizational logic of human structure, shifting from the notion of an "organ assembly" to that of an interface system. This section introduces a hierarchical design methodology for human body anatomical structure based on interface logic and the SCD model. Centered around (Figure 2): Overall Framework of Hierarchical Design of Human Body Anatomical Structures, it constructs a cognitive framework in which the body is rendered as a programmable, mappable, and schedulable system.

Framework Overview: Hierarchical Design

Figure 2 presents the overall framework of human body structure design, combining the top-down hierarchical design approach for integrated circuits with the author's proposed full-coverage interface model and Skin-Core Dichotomy (SCD) model. The SCD model divides the human body into two major components: the skin and the denuded core. The human body structure, unfolded and deepened from the skin and core respectively, is designed according to male-specific and female-specific specifications, forming a new non-morphological human body structural atlas.

As shown in (Figure 2), the system begins with L11-Minimal Human Body Structure Model at the top layer, branching into two pathways:



*Caption: Combining the top-down hierarchical design approach for integrated circuits with the author's proposed Skin-Core Dichotomy (SCD) (SCD divides the human body into two parts: skin and denuded core), Figure 2 presents a six-layer human anatomical structure. Table 1 illustrates the layers in Figure 2. The second layer is the full-coverage human body I/O interface. From the fourth layer onwards, male-specific and female-specific skin/core structures are designed.

Figure 2: Overall Framework of Hierarchical Design of Human Body Anatomical Structures.

One leads to L20 at Layer 2: Human Body I/O Interface Model with Gender Switch, conceptualized as an idealized human body I/O interface model.

The other leads to L30A at Layer 3: Minimal Human Body SCD Structure Model.

From L20, two gender-specific branches emerge:

a. **L21:** Male-specific I/O interface

b. **L22:** Female-specific I/O interface

By combining L20 with L30A, we derive L30B: Human Body SCD Model with Gender Switch. By combining L21 with L30B, we derive L31: Male-specific SCD I/O Interface. By combining L22 with L30B, we derive L32: Female-specific SCD I/O Interface.

Both gender-specific SCD models are further subdivided into two dimensions:

Core Structure: ** Includes ten functional blocks-head system, cranio-cervical junction, neck system, cervico-thoracic junction, trunk system, shoulder-axillary complex, upper limb system, pelvic-hip interface, lower limb system, and the Core Gender Control Sector (CGCS). These form the backbone of information processing and physiological scheduling.

Skin Structure: ** Comprises ten skin zones corresponding to the core blocks, plus an integrated distributed external interface and an integrated Skin Gender Control Sector (SGCS) external interface. The SGCS mirrors the CGCS, forming a symmetrical and coupled system. This dichotomy is not merely structural-it represents a logical leap: the skin is no longer a passive wrapper around the core, but an autonomous interface system and structural subject (Table 1).

Table 1: Layered Structure of the Human body.

Layer	Module Code	Module Name & Function	Notes
Layer 1	L11	Minimal Human Body Structure Model	
Layer 2	L20	Human Body I/O Interface Model with Gender Switch	
	L21	Male-specific I/O Interface Model	
	L22	Female-specific I/O Interface Model	
Layer 3	L30A	Minimal Human Body SCD Structure Model	
	L30B	Human Body SCD I/O Interface Model with Gender Switch	
	L31	Male-specific SCD Structure Model	
	L32	Female-specific SCD Structure Model	
Layer 4	L41	Male-specific Core Structure	
	L42	Male-specific Skin Structure	
	L43	Female-specific Core Structure	
	L44	Female-specific Skin Structure	
Layer 5	LC51-LC510M	Male-specific Core Submodules	10 Submodules here
	LC51-LC510F	Female-specific Core Submodules	10 Submodules here
	LS51-LS512M	Male-specific Skin Submodules	11 Submodules here
	LS51-LS512F	Female-specific Skin Submodules	11 Submodules here
Layer 6	LH601-LH613	Core Head System Structure	13 Submodules here
	LS601F-LS610F	Female-specific SGCS Structure	10 Submodules here
	LC601F-LC619F	Female-specific CGCS Structure	19 Submodules here
			Lay6 contains over 100 submodules in total; only representative modules are listed here.

Gender-specific Models: Structural Differentiation and Interface Characteristics

In Figure 2, the human structure is divided into male-specific and female-specific models, each with its own core and skin architecture. This gender differentiation reflects not only physiological differences but also the critical role of interface logic in identity expression and environmental interaction. It should be noted that Figure 2 does not fully present Layer 6. Currently, only the head system structure, female skin GCS structure, and female core GCS structure are shown. Due to graphical capacity limits, the male skin and core GCS structures-though drafted-are not included in the figure. Additionally, Layer 6 contains over a hundred sub-modules, many of which are still in development. The primary distinction between male-specific and female-specific models lies in the structure and logic of the GCS. Nonetheless, both models share a unified design principle: the skin functions as the structural subject of the system. A characteristic of hierarchical design is that the interfaces between successive layers are formally defined and consistent-each layer exposes a well-specified set of functional modules to the adjacent layers. "Seamless" here refers to logical consistency in the design hierarchy and does not imply the absence of anatomical boundaries.

Reconstructing a Polymodal Hybrid Signal Full-Coverage I/O System

In traditional anatomical perspectives, human–environment interaction is simplified as a linkage between sensory organs and neural pathways, lacking the capacity to model the human body as a multi-source signal system. Within the Skin–Core Dichotomy (SCD) framework, this study begins with Layer 1's Minimal Human Body Structure Model (L11)-also referred to as the Universal Human I/O Interface in its abstract signaling capacity-and proposes Layer 2's polymodal hybrid signal full-coverage I/O interface model L20-a human body interface system with a plug-in gender switch. From L20, two gender-specific polymodal interface models are derived: L21 (Male-specific) and L22 (Female-specific). The goal is to construct a human–environment contact system that adheres to engineering standards, supports scalability, and enables closed-loop signal logic-systematically mapping polymodal hybrid signals across human body structure.

Minimal Human Body Structure Model

As shown in (Figure 3), Layer 1 defines the human body as a modular input/output entity. Represented by a unique rectangular unit with a left-side input port I and right-side output port O, the body is abstracted as a black-box system. This simplification marks a conceptual shift from morphology-based anatomical representation to an engineering-centered language for describing human structure.

*Caption: This is Layer 1, the human body is abstracted as a pure input/output black box, represented by the pink rectangular frame. The symbol "I" and blue arrow on the left indicate signals entering the body from the external environment, while the symbol "O" and red arrow on the right represent signals output from the body to the environment.

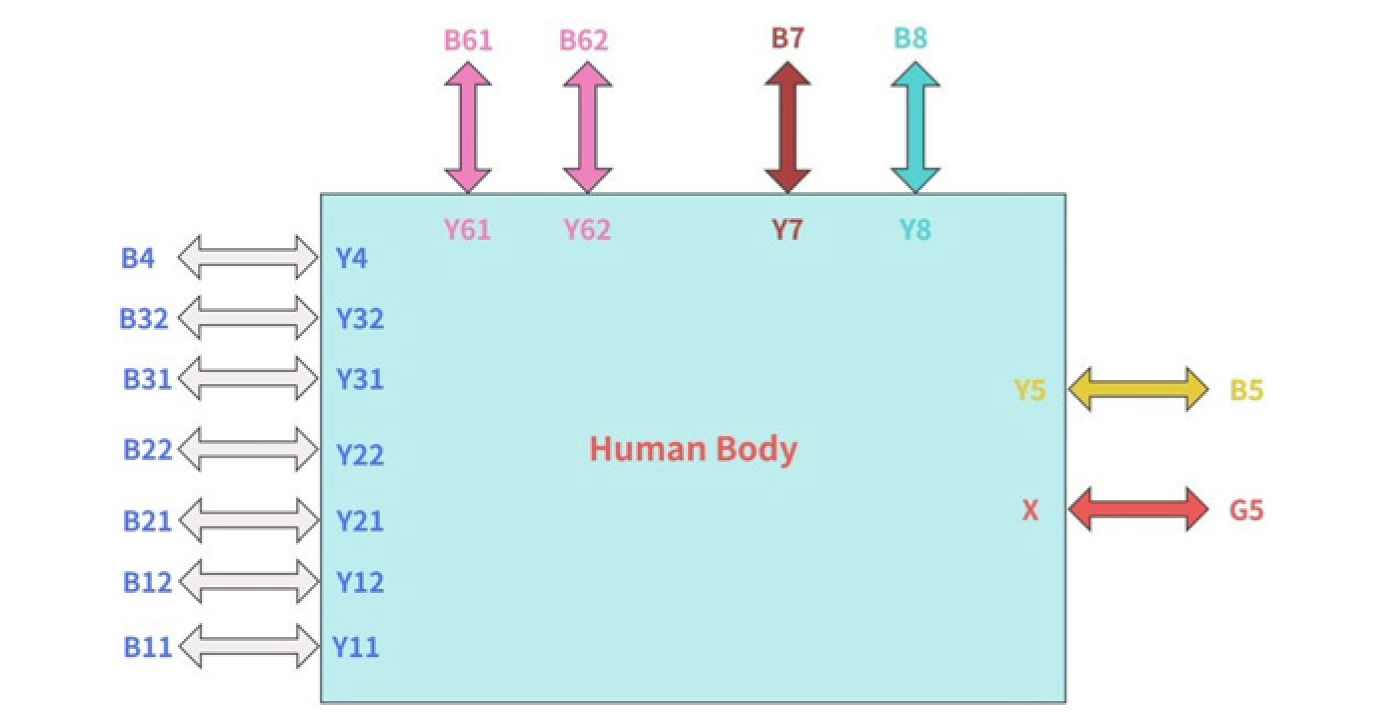
Figure 3: L11—Minimal Human Body Structure Model.

It establishes a logical foundation for treating the human body as a programmable signal processing platform. Moreover, the model holds universal applicability: replacing the label "human" with "animal," "plant," or even "non-living things" retains its validity-laying the groundwork for cross-species extension (Figure 3).

Polymodal Hybrid Signal Interface and Gender Plug-In Concept Model

Comparing L11 (Figure 3) in which input/output signals are generalized and undifferentiated, L20 (Figure 4) introduces signal typology [22]. This paper defines a broad concept of signal: all human body inputs and outputs are considered signals. These signals exhibit polymodal hybrid characteristics:

Polymodal: solid (e.g., mechanical forces and tactile stimuli *[Ingber, 2003]* [23]), liquid (e.g., blood, lymph, and interstitial fluid signaling *[Benias et al., 2018]* [22]), gas (e.g., gasotransmitters including nitric oxide, carbon monoxide, and hydrogen sulfide *[Mustafa et al., 2009]* [20]), plasma, and special states.



*Caption: L20 belongs to Layer 2 and presents a universal, full-coverage human body I/O interface diagram. The 13 interfaces are categorized in Table 2. The symbol "X" represents the gender switch: X=M for male-specific, X=F for female-specific. Each B-code interface corresponds functionally to its Y-code counterpart. G5 denotes the Gender Control Sector (GCS) interface.

Figure 4: L20—Human Body I/O Interface Model with Gender Switch.

Hybrid: combinations of physical and chemical signals such as sound, light, and electrical signals.

This classification extends, rather than replaces, established physiological categories of interoceptive and exteroceptive signaling. Where conventional frameworks distinguish signals by their transduction mechanisms (e.g., chemical, mechanical, thermal, electromagnetic), the polymodal taxonomy proposed here categorizes signals by their material phase and combinatorial complexity. This phase-based schema is intended to align with the interface-logic architecture of the SCD model, in which the skin surface functions as a continuous phase boundary across which matter and energy in multiple states must be transduced.

The polymodal hybrid signal model aims to reflect the holographic state of the human body, offering a more comprehensive representation. L20 serves as the "primary I/O panel" of the signal system, defining all recognizable interfaces between the body and environment-i.e., sources of perception, feedback ports, and interaction nodes.

The inclusion of gas as a primary signal modality reflects the established physiological role of gasotransmitters as endogenous signaling molecules that diffuse freely across membranes and modulate vascular tone, neurotransmission, and immune responses *[Mustafa et al., 2009; Kolluru et al., 2017]* [20,21]. The anatomical instantiation of these polymodal signals is detailed in Section 7.2 (see LC51 interface specifications).

**L20 Model Design Principles: **

Full Interface Coverage: ** All physiological structures are included as I/O nodes, regardless of traditional function.

Signal Aggregation Strategy: ** Complex structures like skin are integrated into composite interfaces (e.g., B5 and G5) to enhance engineering expressiveness.

Gender Plug-In Capability: ** Variable X is the gender plug-in switch, which can switch from M (Male-Specific) to F (Female-Specific), or from F to M, thus changing the contents of G5.

**Spatial Topology of Interfaces: **

Narrow Channel Interfaces: ** Defined geometric boundaries and signal constraints. Small but precise data transmission; ideal for fine control and intentional triggers. These constitute fine control and specialized feedback points, suitable for micro-signal regulation and intention initiation.

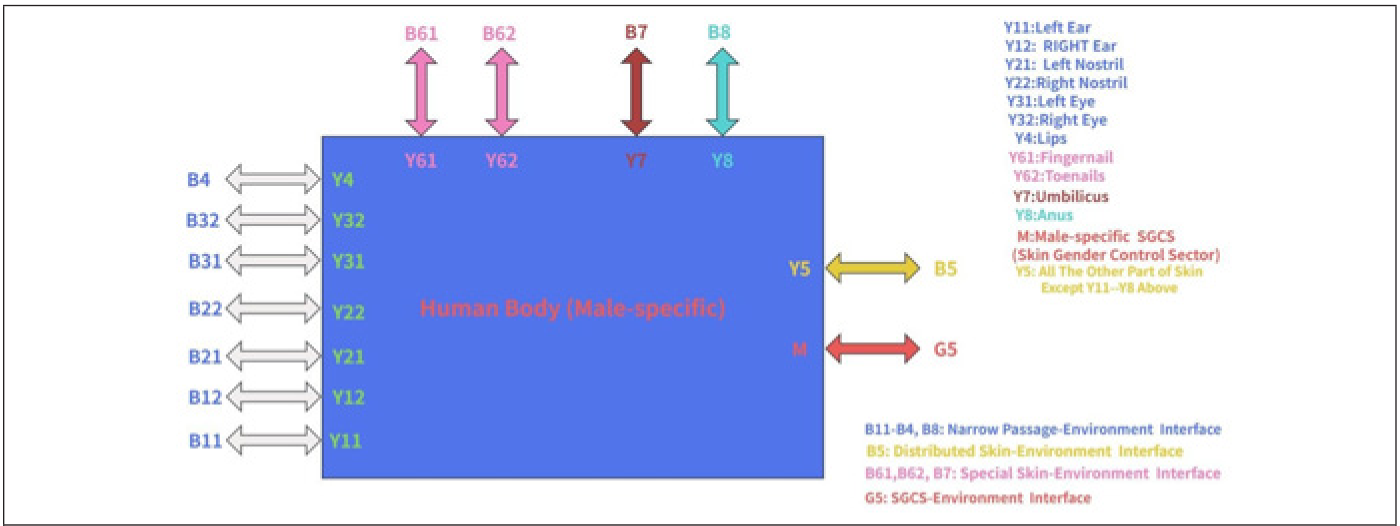
Distributed Interfaces: ** Large surface area, dense signal points. Capable of multimodal signal reception and integration. Forms high-dimensional environmental maps and emotional/tactile spaces. Each B-code interface corresponds to a Y-code interface, reflecting identical functional meaning.

**Gender Control Sector (GCS) and Plug-In Logic: **

GCS is defined as the genital and breast complex, determining male, female, or third-gender characteristics. G5 is a composite interface whose configuration depends on variable X, the gender plug-in switch:

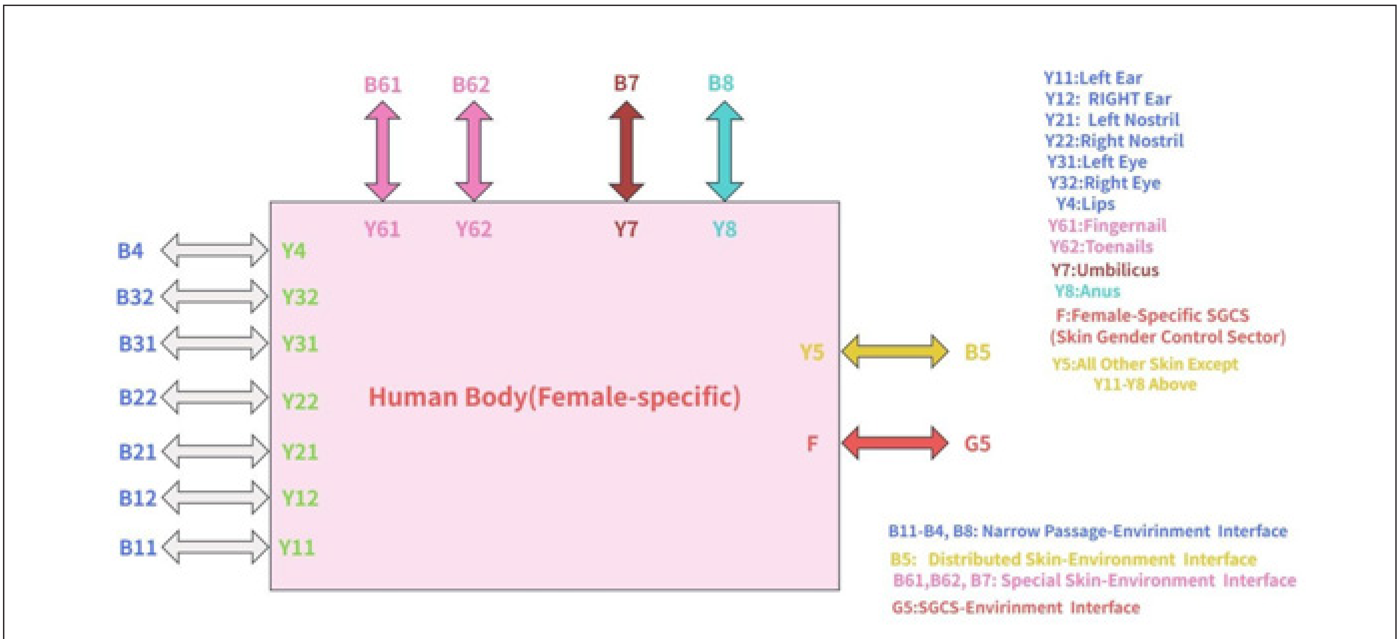
i. If X = M → G5 = Male GCS Interface → L20 becomes L21 (Figure 5)

ii. If X = F → G5 = Female GCS Interface → L20 becomes L22 (Figure 6)



*Caption: Replacing X in Figure 4 (L20) with M, while keeping everything else the same, yields L21. M stands for male, and this is the interface between the Male-Specific Skin Gender Control Sector (SGCS) and the environment. L21 illustrates the full-coverage Male-Specific interface.

Figure 5: L21—Male-Specific I/O Interface.



*Caption: Replacing X in Figure 4 (L20) with F, while keeping everything else the same, yields L22. F stands for female, and this is the interface between the Female-Specific Skin Gender Control Sector (SGCS) and the environment. L22 illustrates the full-coverage Female-Specific interface. F (Female-specific GCS Interface) of L22 (Figure 6) includes 10 sub-interfaces as detailed in the text.

Figure 6: L22—Female-Specific I/O Interface.

B11, B12, B21, B22, B31, B32, B4, B5, B61, B62, B7, B8, G5-a total of 13 interfaces (among which B5, B61, B62, G5 are composite interfaces)-represent the full set of human interfaces. The design of the full human interfaces in human anatomy is unprecedented and has breakthrough significance.

In (Table 2), the B7 interface (umbilicus) has dual cultural and physiological significance due to its connectivity during the embryonic stage; B61 (Fingernails) and B62 (Toenails) represent the micro-perceptive contact points at the extremities of the human body, potentially allowing integration with micro-sensors or behavior analysis modules in the future. Fingernails/Toenails are among the few inherently rigid input-output terminals of the integumentary system (teeth being another notable example, though functionally restricted to the oral cavity), signifying a tool-like extension. Fingernails/Toenails are deeply integrated with the soft skin while possessing unique input-output characteristics. Essentially, they function as semi-autonomous micro-factories and are special interfaces within the skin system (Figure 4) (Table 2).

Table 2: L20 Interface Groups (Total: 13 Interfaces).

Group	Code Range	Functional Description
Narrow Channel Interfaces	B11 (Left Ear), B12 (Right Ear), B21 (Left Nostril), B22 (Right Nostril), B31 (Left Eye), B32 (Right Eye), B4 (Lips), B8 (Anus)	Multimodal I/O channels for sound, smell, light, speech, ingestion, and excretion
Special Interfaces	B61 (Fingernail), B62 (Toenail), B7 (Umbilicus)	Micro-environmental feedback, cultural encoding, and specialized skin zones
Distributed Interface	B5 (All skin zones excluding special and gender zones)	Broad sensory interface, cooling system, social gender expression (e.g., tattoos, cosmetics)
Gender Control Interface	G5 (Perineum and Breast Complex)	Gender recognition and emotional mapping; high signal density and complex feedback mechanisms

Male-Specific/Female-Specific GCS I/O Interface

(Figure 5) M (Male-specific GCS Interface) of L21 (Figure 5) includes 8 sub-interfaces: M1 (Penile Skin), M2 (External Urethral Orifice), M3 (Glans Penis), M4 (Scrotum), M51 (Left Nipple), M52 (Right Nipple), M61 (Left Areolar Gland), M62 (Right Areolar Gland).

F (Female-specific GCS Interface) of L22 (Figure 6) includes 10 sub-interfaces: F1 (Vaginal Orifice), F2 (External Urethral Orifice), F3 (Clitoris), F4 (Mons Pubis), F5 (Labia Majora), F6 (Labia Minora), F7 (Left Nipple), F8 (Right Nipple), F9 (Left Areolar Gland), F10 (Right Areolar Gland) (Figure 6).

F (Female-specific GCS Interface) of L22 (Figure6) includes 10 sub-interfaces:

F1 (Vaginal Orifice), F2 (Urethral Meatus), F3 (Clitoris), F4 (Mons Pubis), F5 (Labia Majora),

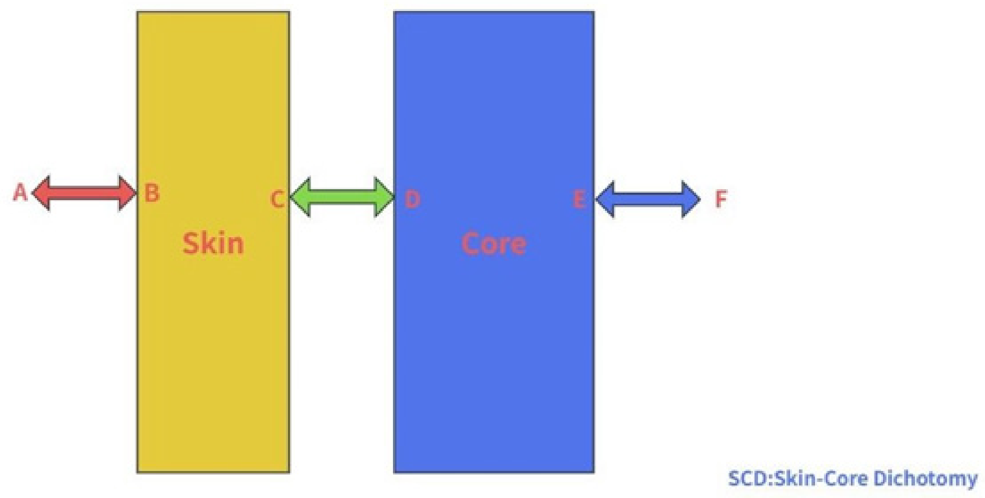
F6 (Labia Minora), F7 (Left Nipple), F8 (Right Nipple), F9 (Left Areolar Gland), F10 (Right Areolar Gland).

The Skin–Core Dichotomy (SCD) Model

Minimal Human Body SCD I/O Interface

L30A (Figure 7) can be viewed as a first-level bifurcation of L11 (Figure 3)-the Minimalist Human Body I/O Interface Model, illustrating the triple coupling of skin, core, and environment. Environmental signals enter the body either through the skin (via A–B) or through the core (via E–F), traverse internal pathways (via C–D), and undergo attenuation, feedback, or unidirectional transmission. Feedback signals may loop multiple times. After processing by both skin and core, the body outputs responsive signals back to the environment via either skin (A–B) or core (E–F) interfaces. At any moment, the body's output is a result of environmental input and the interaction between skin and core.

The E–F pathway (core–environment interface) corresponds anatomically to the narrow-channel interfaces defined in L20-the respiratory and alimentary tract openings, the ocular surface, and the auditory meatus-through which environmental signals gain direct access to core subsystems without prior transduction by the skin. Figure 7 (L30A) resembles two open doors, evoking a sense of symmetrical elegance. It emphasizes the integrity and autonomy of the skin, elevating its importance. The three relational axes-skin–environment, skin–core, and core–environment-become focal points of analysis, as their interactions determine the body's systemic state. Figure 7 (L30A) is not a physical model but a conceptual framework. Within the SCD theoretical system, L30A represents a universal signal structure model-a prototype for signal generation not only in human modeling but also across species, systems, and even planetary domains. In this framework, skin is the membrane of the cosmos. This expansive view, while philosophically resonant, finds its concrete anatomical expression in the specific interfacial specializations of the human integumentary system-the very specializations that the nine-region subsidiary scheme is designed to cartographically organize.

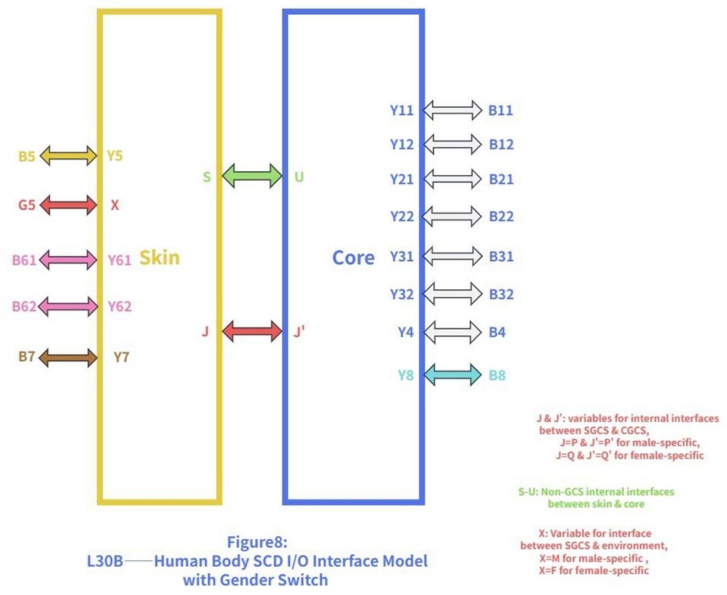


*Caption: L30A is part of Layer 3. On the left is a yellow rectangle labeled "Skin," representing the skin system; on the right is a blue rectangle labeled "Core," representing the denuded core. Three bidirectional arrows span from left to right: Red Arrow A–B represents the external interface between skin and environment; Green arrow C–D represents the internal interface between skin and core; Blue arrow E–F represents the external interface between core and environment. SCD Model reflects the triple coupling of skin, core and environment.

*Note: The labels A, B, C, D, E, F in Figure 7 may differ in meaning from those used in other diagrams throughout this paper. This is a concept model of Skin-Core Dichotomy (SCD).

Figure 7: L30A—Minimal Human Body Structure SCD Model.

Human Body SCD I/O Interface Model with Gender Switch



*Caption: L30B is a Skin-Core Dichotomy (SCD) I/O interface model with gender switch, derived from L30A (Figure 7) and L20 (Figure 4). X is a variable for external interface between SGCS (Skin Gender Control Sector) and environment. X=M for male-specific; X=F for female-specific. J and J' are two variables for internal interface between SGCS and CGCS. S and U represent non-GCS internal interfaces between skin and core. The other symbols in this diagram have the same meanings as their counterparts in L20.

Figure 8: L30B—Human Body SCD I/O Interface with Gender Switch.

(Figure 8) (L30B) is a Skin-Core Dichotomy (SCD) I/O model with gender switch, derived from L30A (Figure 7) and L20 (Figure 4). The yellow rectangle on the left represents the skin, and the blue rectangle on the right represents the core. It presents an SCD model of a human body with a plug-in gender switch and multimodal mixed-signal I/O interface. X is a variable for external interface between SGCS (Skin Gender Control Sector) and environment. When X=M, it is male-specific; when X=F, it is female-specific. J and J′ are two variables for internal interface between SGCS and CGCS. S and U represent non-GCS internal interfaces between skin and core.

| Variable | Definition | Values |

|---|---|---|

| X | SGCS–Environment interface gender switch | M (Male), F (Female) |

| J, J′ | SGCS–CGCS internal interface variables | Bidirectional signal pathways |

| S, U | Non-GCS skin–core internal interfaces | General skin-core coupling channels |

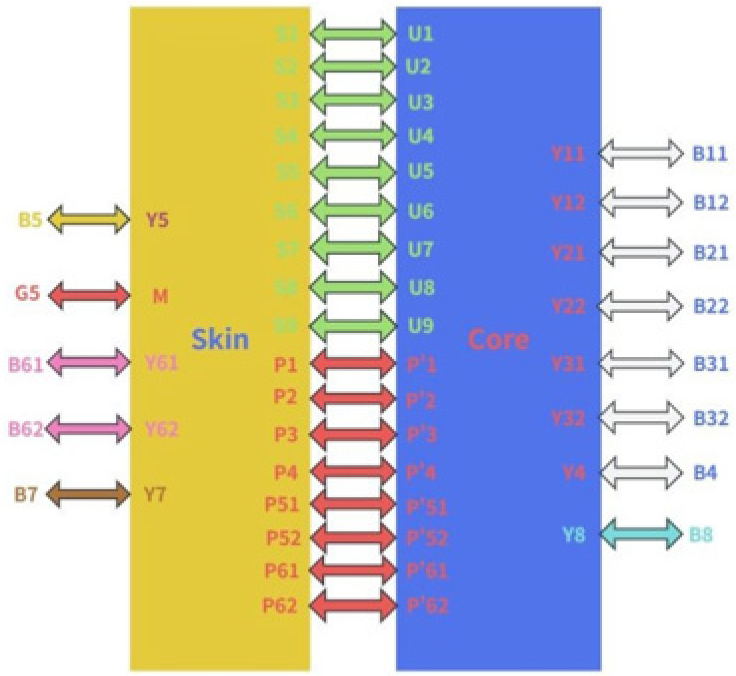
| A–B | Skin–Environment interface | External interface |

| C–D | Skin–Core internal interface | Internal interface |

| E–F | Core–Environment interface | External interface (narrow channels) |

Male-Specific SCD I/O Interface Model

L31 (Figure 9) is derived from the following three factors:



*Caption: L31 is also part of Layer 3, L31 divides the system into two rectangles (yellow for skin, blue for core). External interfaces are assigned as detailed in the text. Internal interfaces between skin and core are grouped into two matrices: S–U Matrix (9 interfaces) representing standard functional blocks, and P–P′ Matrix (8 interfaces) representing male-specific gender control sector interfaces. Table 3 presents the details.

Figure 9: L31—Male-specific SCD I/O Interface Model.

L21 (Figure 5): Male-specific I/O Interface Model

a. L30B (Figure 8): Human Body SCD I/O Interface Model with Gender Switch

b. The relational logic between Skin and Core

S-U and P-P′ matrices are based on a vertical segmentation of the human body into 10 blocks:

a. Head system

b. Cranio-cervical junction

c. Neck system

d. Cervico-thoracic joint

e. Trunk system

f. Shoulder–axillary complex

g. Upper limb system

h. Pelvic–hip interface

i. Lower limb system

j. Gender Control Sector (GCS)

This segmentation builds upon the traditional five-block anatomical model by adding four transitional areas and one Gender-Specific Sector (GCS). The GCS is a composite structure derived from the trunk, isolating the genital and breast areas.

Thus, this paper employs two structural segmentation methods:

**Primary segmentation: ** Skin–Core Dichotomy (SCD)

**Secondary segmentation: ** the traditional five blocks plus four transitional area blocks.

The human body is first divided into skin and core, then each is subdivided into ten corresponding modules (e.g., core head system ↔ skin head system, core trunk ↔ skin trunk, CGCS ↔ SGCS).

Notably, the eight narrow-channel interfaces (B11–B8) belong to the core's external interface, while the distributed interface (B5), GCS interface (G5), and special interfaces (B61, B62, B7) belong to the skin's external interface-significantly increasing the functional weight of the skin. This allocation reflects a fundamental anatomical reality: the narrow-channel interfaces represent points where the core subsystems (respiratory, alimentary, sensory) breach the integumentary barrier to achieve direct environmental contact, whereas the skin interfaces represent the integumentary system's own sensory and secretory apparatus. The SCD model thus formalizes a distinction that traditional regional anatomy implicitly acknowledges but does not systematically articulate.

L31's working mechanism is relatively complex and requires comprehensive analysis based on upper and lower multi-layer structures. I will not discuss it in depth here, but only provide five typical signal paths:

i. **Distributed skin interface B5: ** B5↔Y5↔S (S1, S2……S9) ↔U (U1, U2……U9) ↔Y (Y11, Y12……Y8) ↔B (B11, B12……B8)

i. **SGCS (Skin Gender Control Sector) interface G5: ** G5↔M↔P (P1, P2……P62) ↔P′ (P′1, P′2……P′62) ↔ Y (Y11, Y12……Y8) ↔B (B11, B12……B8)

a) **Fingernail interface B61: ** B61↔Y61 ↔S7↔U7↔Y (Y11, Y12……Y8) ↔B (B11, B12……B8)

b) **Toenail interface B62: ** B62↔Y62↔S9↔U9 ↔Y (Y11, Y12……Y8) ↔B (B11, B12……B8)

c) **Umbilicus B7: ** B7↔Y7↔S5↔U5↔ Y (Y11, Y12……Y8) ↔B (B11, B12……B8)

Of course, the above five signal transmission paths are only a rough description; the actual situation is more complicated (Table 3).

Table 3: Male-specific Skin–Core Internal Interface.

Group	Interface	Description
Non-GCS Group	S1–U1 (Head), S2–U2 (Cranio-Cervical), S3–U3 (Neck), S4–U4 (Cervical-Thoracic), S5–U5 (Trunk), S6–U6 (Shoulder–Axillary), S7–U7 (Upper Limb), S8–U8 (Pelvic–Hip), S9–U9 (Lower Limb)	Reflecting low-frequency lateral signal flow between skin and core
GCS Group	P1–P′1 (Penile Skin), P2–P′2 (Urethral Meatus), P3–P′3 (Glans Penis), P4–P′4 (Scrotum), P51–P′51 (Left Nipple), P52 –P′52(Right Nipple), P61–P′61 (Left Areolar Gland), P62–P′62 (Right Areolar Gland)	Reflecting high-frequency signal flow

***Note:** Core GCS has more functional blocks than skin GCS.

Female-Specific SCD I/O Interface Model

As shown in Figure 10, L32: Female-specific SCD I/O Interface is derived from the following three factors:

a) L22 (Figure 6): Female-specific I/O Interface Model

b) L30B (Figure 8): Human Body SCD I/O Interface Model with Gender Switch

c) The relational logic between skin and core

There are two main differences between L32 and L31:

A. The GCS external interface: M-G5 (L31), F-G5 (L32)

B. The GCS internal interface matrix. The skin–core GCS interfaces in L32 include the following ten connections:

a) Q1–Q′1 (Vaginal Orifice)

b) Q2–Q′2 (External Urethral Orifice)

c) Q3–Q′3 (Clitoris)

d) Q4–Q′4 (Mons Pubis)

e) Q5–Q′5 (Labia Majora)

f) Q6–Q′6 (Labia Minora)

g) Q71–Q′71 (Left Nipple)

h) Q72–Q′72 (Right Nipple)

i) Q81–Q′81 (Left Areolar Gland)

j) Q82–Q′82 (Right Areolar Gland)

Compared to the male-specific GCS model, the female GCS interface group contains two additional sub-interfaces, reflecting the greater surface-area differentiation and multimodal signal capacity of the female external genitalia-a structural elaboration that corresponds to the additional functional dimensions of female reproductive and sexual signaling.

In L32, the signal transmission of GCS interface is as follows:

G5↔F↔Q (Q1, Q2……Q82) ↔Q′ (Q′1, Q′2……Q′82) ↔ Y (Y11, Y12……Y8) ↔B (B11, B12……B8)

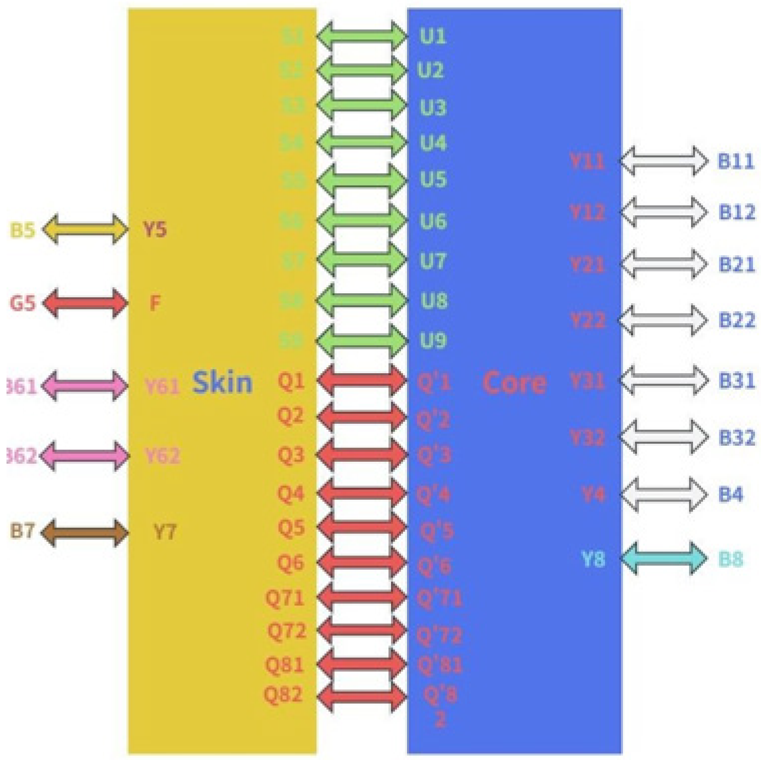
The signal transmission paths for B5, B61, B62 and B7 in L32 are the same as those in L31.

It is instructive to note what does not differ between L31 and L32: the nine universal modules (U1–U9), the narrow-channel interfaces, and the distributed and special interfaces remain structurally invariant across sexes. This invariance underscores a key architectural principle of the SCD framework-namely, that sexual dimorphism is highly localized to the GCS, while the transitional zones and regional modules constitute a shared anatomical vocabulary applicable to both male and female body plans.

Female-Specific SCD Core and Skin Structures

Female-Specific SCD Core Structure

In the hierarchical design of male/female SCD structures, all layers are fully integrated via I/O interfaces. As shown in Figure 11, L43 represents the Female-Specific SCD Core Structure in Layer 4. All I/O interfaces in L43 align with the core interfaces in Layer 3’s L32 (Figure 10), which in turn connects to Layer 2’s L22 (Figure 6).

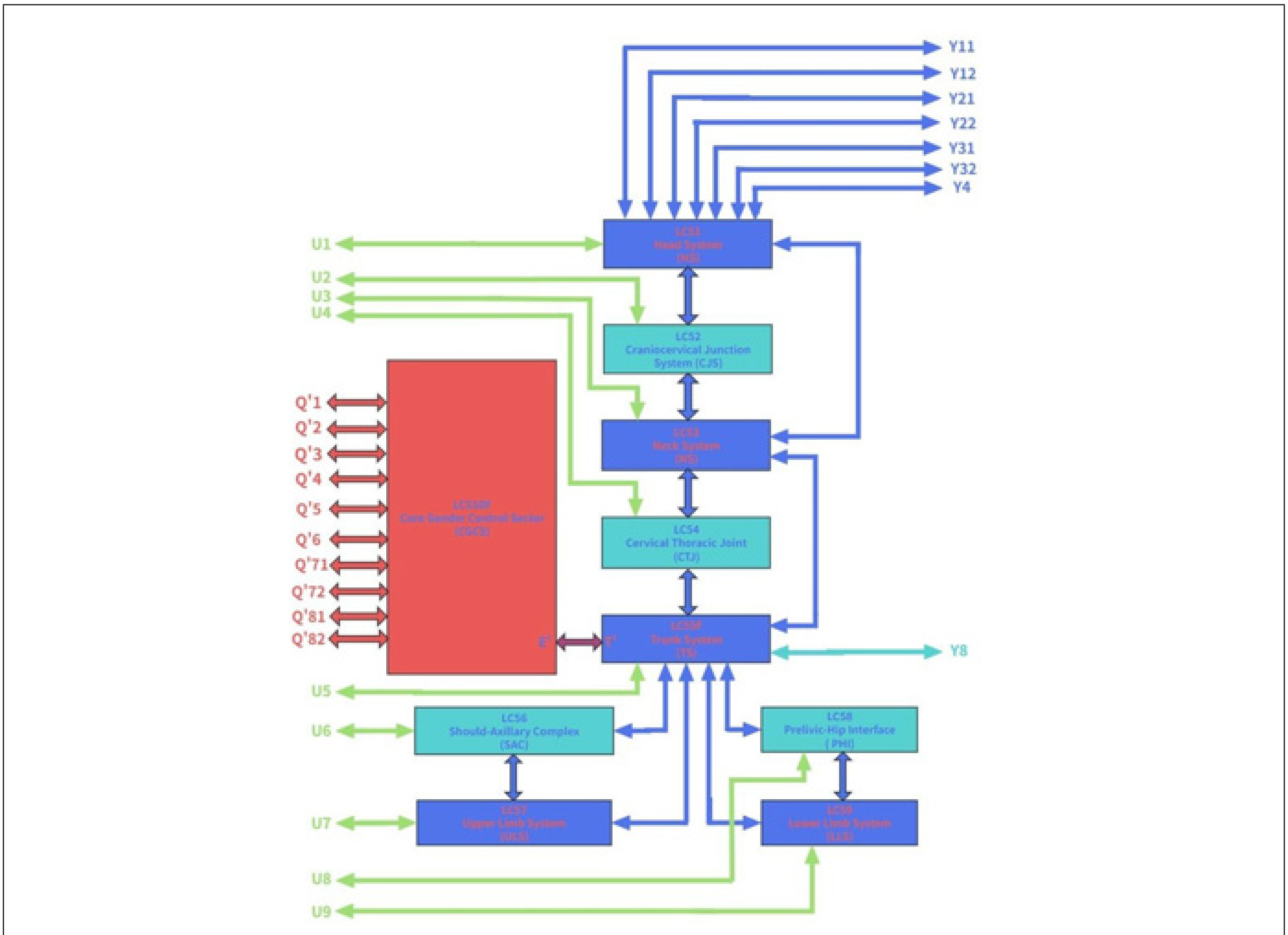


*Caption: L32 also belongs to Layer 3, L32 divides the system into two rectangles (yellow for skin, blue for core). External interfaces are assigned as detailed in the text. Internal interfaces between skin and core are grouped into two matrices: S–U (9 interfaces) representing standard functional blocks, and Q–Q′ (10 interfaces) representing Female-specific gender control interfaces.

Figure 10: L32—Female-Specific SCD I/O Interface Model.

L43 (Figure 11) reveals eight external interfaces between the denuded core and the environment: Y11, Y12, Y21, Y22, Y31, Y32, Y4, Y8. The first seven are concentrated in the head system; only Y8 belongs to the trunk system. The cephalic concentration of narrow-channel interfaces reflects a fundamental architectural principle of the human body plan: the sensory and ingestive portals are clustered at the anterior cephalic pole to minimize neural conduction distances and to coordinate multimodal environmental sampling. The sole non-cephalic narrow-channel interface, Y8 (anus), represents the terminal outlet of the alimentary tract-a necessary caudal aperture dictated by the linear organization of the digestive system. Internal interfaces facing the skin include U1–U9 and Q′1–Q′82.

L43 (Figure 11) comprises ten sub-functional blocks:



*Caption: This is part of Layer 4, L43 includes 10 blocks: 5 regular function blocks (LC51, LC53, LC55F, LC57, LC59); 4 transition zone function blocks (LC52, LC54, LC56, LC58); and 1 special function block (LC510F, Core Gender Control Sector (CGCS)). U1-U9 is a set of internal interfaces of the non-Gender Control Sector, connected to the corresponding internal interfaces S1-S9 of Skin. Q'1-Q'82 is a set of internal interfaces of the Gender Control Sector, connected to the corresponding internal interfaces Q1-Q82 of Skin. There are 8 external interfaces of Core-Environment which are Y11, Y12, Y21, Y22, Y31, Y32, Y4, Y8.

Figure 11: L43—Female-Specific SCD Core Structure.

Five blocks follow traditional anatomical segmentation: head, neck, trunk, upper limb, lower limb

a. **Four transitional zones are emphasized as independent blocks:** cranio-cervical junction, cervico-thoracic junction, shoulder–axillary complex, pelvic–hip interface

b. **One specialized zone:** the Core Gender Control Sector (CGCS)

The elevation of the four transitional zones to the status of independent functional blocks within the core subsystem is not an arbitrary taxonomic gesture. Each of these zones represents an anatomical locus where major neurovascular bundles, lymphatic channels, and musculoskeletal continuities traverse between traditionally defined regions *[Rhoton, 2002; Caplan & van Gijn, 2012]* [24,12]. In the cranio-cervical junction, the brainstem transitions to spinal cord, the carotid and vertebral arteries converge, and the airway and alimentary tracts cross. In the cervico-thoracic junction, the brachial plexus emerges, the subclavian vessels arch, and the thoracic duct terminates. The shoulder-axillary complex houses the principal neurovascular gateway to the upper limb. The pelvic-hip interface contains the bifurcation of the aorta, the lumbosacral plexus, and the convergence of trunk and lower limb mechanics. To treat these zones merely as "boundaries" between regions is to obscure their functional density. The SCD framework, by contrast, recognizes them as anatomically coherent modules in their own right.

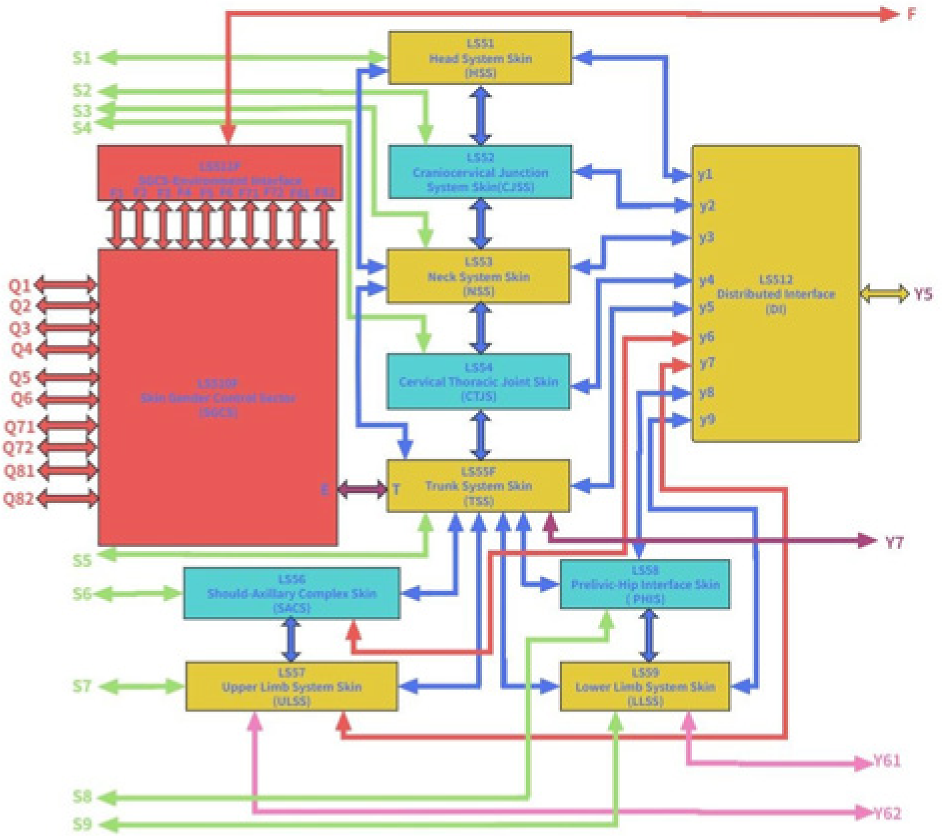
The CGCS is a composite region extracted from the trunk system, integrating the deep breast zones and internal genital structures. It is designed to support future gender transformation technologies. Although CGCS is structurally distinct, it remains connected to the trunk system via the E′–F′ signal channel, through which the neurovascular system exerts influence. CGCS exchanges signals with the Skin Gender Control Sector (SGCS) via the Q′1–Q′82 interface group, affecting SGCS behavior. The neurovascular system is a key factor in this interaction, though it is not classified within

CGCS due to its lack of gender-specific identity.

Conversely, SGCS can influence CGCS through the same Q′ interface group, with signals propagating via E′–F′ to the trunk and neural centers. The coupling between CGCS and SGCS via Q′ signals is a critical mechanism in gender modulation. Having delineated the core subsystem and its ten constituent modules, we now turn to the complementary skin subsystem (L44), which mirrors this modular organization while adding the distributed and specialized external interfaces that constitute the body's primary environmental contact surface (Figure 11).

Female-Specific SCD Skin Structure

As shown in (Figure 12), L44 represents the Female-Specific SCD Skin Structure, symmetrically aligned with the core structure in L43 (Figure 11).



*Caption: This is part of Layer 4, L44 includes 12 blocks: 5 regular function blocks (LS51, LS53, LS55F, LS57, LS59); 4 transition zone function blocks (LS52, LS54, LS56, LS58); 1 special function block (LS510F, Skin Gender Control Sector (SGCS)); and 2 interface blocks (LS511F and LS512). S1-S9 is a set of internal interfaces of the non-Gender Control Sector, connected to the corresponding internal interfaces U1-U9 of Core. Q1-Q82 is a set of internal interfaces of the Gender Control Sector, connected to Q'1-Q'82 of Core. 5 interfaces of Skin-Environment are F, Y5, Y61, Y62 and Y7. F is a set of external interfaces of Skin gender Control sector, Y5 is a set of the distributed interfaces of Skin, Y61 is the fingernail interface, Y62 is the toenail interface, and Y7 is the umbilicus interface.

Figure 12: L44 – Female-Specific SCD Skin Structure.

Internal interfaces are mapped as follows:

- SGCS ↔ CGCS via Q1–Q82 ↔ Q′1–Q′82
- The other nine skin blocks ↔ core blocks via S1–S9 ↔ U1–U9

Additionally, L44 introduces two auxiliary sub-blocks:

Distributed Interface (DI): Generates environmental interface Y5, representing nine sub-interfaces (y1–y9) from the nine skin blocks. The DI exemplifies the abstraction principle central to hierarchical design: while the skin's sensory and secretory capabilities are anatomically distributed across nine distinct regional modules, the DI aggregates these capabilities into a single logical interface (Y5) for higher-level system modeling.

SGCS–Environment Interface: Generates interface F, composed of ten sub-interfaces (F1–F82) from SGCS.

These auxiliary blocks simplify the interface design in Layers 2 and 3, emphasizing conceptual clarity.

Three special skin interfaces are also present:

a. Y61 (Fingernail) from upper limb skin

b. Y62 (Toenail) from lower limb skin

c. Y7 (Umbilicus) from trunk skin

All are external environmental interfaces. L44's interfaces align with the skin interfaces in L32 (Figure 10), while L43 and L44 together constitute the complete interface set of L32.

Signal Transmission: Vertical and Horizontal Logic

Between SGCS and TSS (Trunk Skin System), a lateral signal channel E–T exists. Anatomically, the E–T channel corresponds to the rich network of subcutaneous neurovascular plexuses, lymphatic channels, and fascial continuities that link the integument of the perineal and mammary regions with the broader trunk integument. These horizontal conduits provide the anatomical substrate for the signal integration postulated in the SCD framework. While skin–core signal transmission is considered vertical, intra-skin and intra-core signal flows are horizontal.

Dual Modes of Gender Control: Local vs. Global

The interaction between SGCS and CGCS enables two modes of gender control:

**Local Control: ** Targets specific regions within GCS

a. Example: Modifying only the breast zone to reduce protrusion, eliminating lactation and partial gender traits while preserving reproductive features

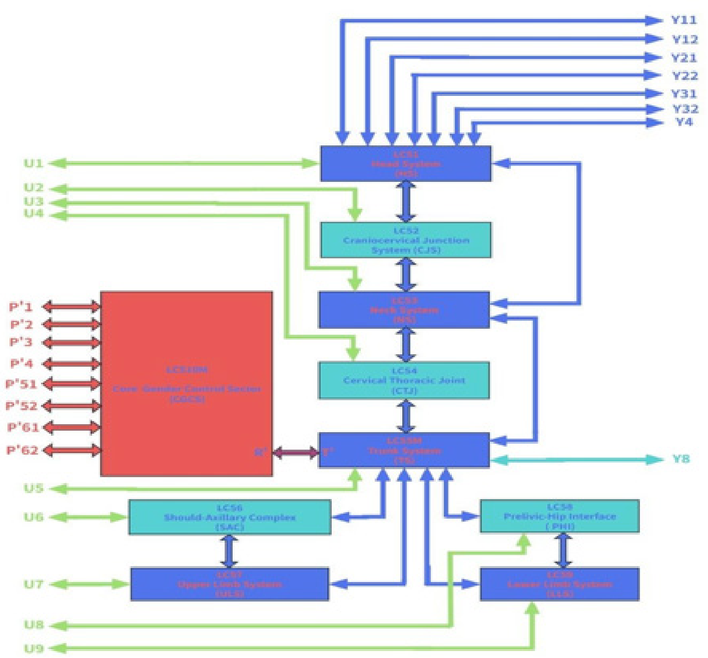
b. Example: Removing SGCS traits while retaining CGCS, resulting in external gender loss but internal retention

c. Example: Surgical removal of the uterus due to disease (e.g., cancer), leading to loss of reproductive ability but no visible change

**Global Control: ** Simultaneous modulation of SGCS and CGCS to achieve full gender transformation

The external manifestation of gender traits resides in SGCS. The SCD framework highlights the role of skin in gender representation and modulation. In clinical contexts, modulation of SGCS components-whether through surgical reconstruction, hormonal influence on integumentary characteristics, or other interventions-can alter the externally perceptible sexual phenotype. The SCD framework provides a formal vocabulary for describing such interventions as targeted reconfigurations of the SGCS interface module, rather than as ad hoc modifications of isolated anatomical structures.

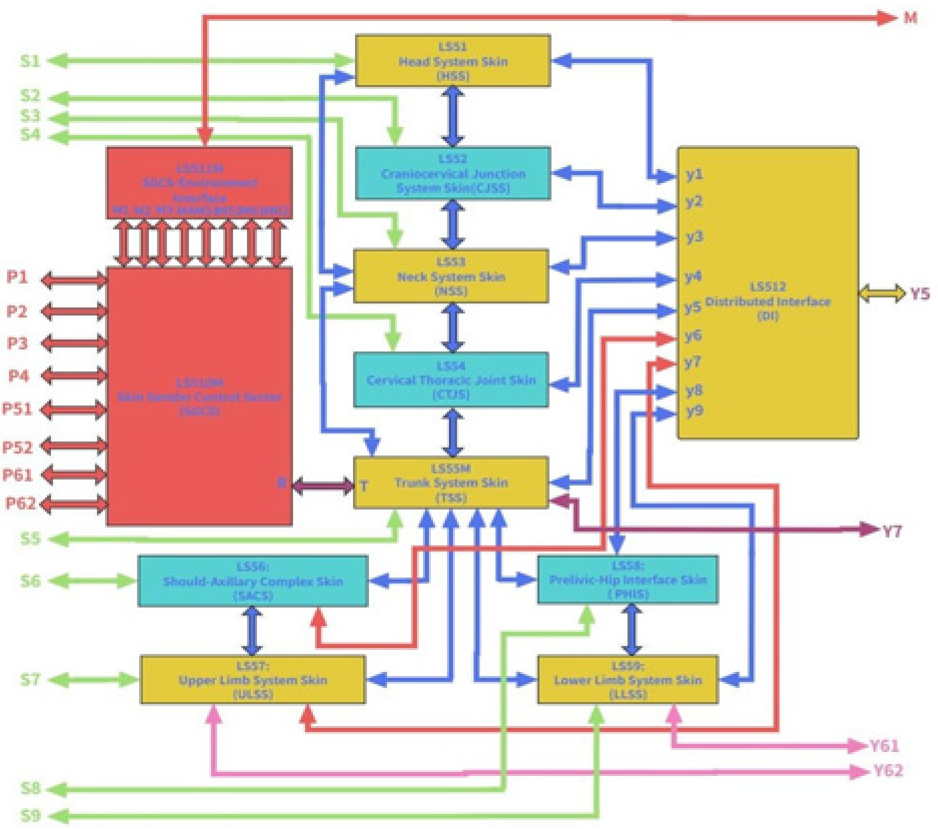
The numerical asymmetry between core modules (10) and skin modules (12) is not an artifact of classification; it reflects a fundamental architectural principle of the SCD model. The two additional modules in the skin subsystem-the Distributed Interface (DI) and the SGCS–Environment Interface-have no core counterparts because they embody functions intrinsic to the skin's role as the body's primary environmental transducer. The core, by contrast, interfaces with the environment only through discrete narrow-channel portals (Figure 13).



*Caption: This is part of Layer 4, L41 includes 10 blocks: 5 regular function blocks (LC51, LC53, LC55M, LC57, LC59); 4 transition zone function blocks (LC52, LC54, LC56, LC58); and 1 special function block (LC510M, Core Gender Control Sector (CGCS)). U1-U9 is a set of internal interfaces of the non-Gender Control Sector, connected to the corresponding internal interfaces S1-S9 of Skin. P'1-P'62 is a set of internal interfaces of the Gender Control Sector, connected to P1-P62 of Skin. There are 8 external interfaces of Core-Environment which are Y11, Y12, Y21, Y22, Y31, Y32, Y4, Y8. Note: In the diagram, module labels are consistent with the formal module codes listed in Table 1.

Figure 13: L41 – Male-Specific SCD Core Structure.

The primary distinction between male and female SCD core/skin structures lies in the architecture of Gender Control Sector, including differences in sub-functional blocks and interface configurations (see Figure 13 and Figure 14).



*Caption: This is part of Layer 4, L42 includes 12 blocks: 5 regular function blocks (LS51, LS53, LS55M, LS57, LS59); 4 transition zone function blocks (LS52, LS54, LS56, LS58); 1 special function block (LS510M, Skin Gender Control Sector (SGCS)); and 2 interface blocks (LS511M and LS512). S1-S9 is a set of internal interfaces of the non-Gender Control Sector, connected to U1-U9 of Core. P1-P62 is a set of internal interfaces of the Gender Control Sector, connected to P'1-P'62 of Core. 5 external interfaces of Skin-Environment are M, Y5, Y61, Y62 and Y7. M is a set of external interfaces of Skin gender Control sector, Y5 is a set of the distributed interfaces of Skin, Y61 is the fingernail interface, Y62 is the toenail interface, and Y7 is the umbilicus interface.

Figure 14: L42—Male-Specific SCD Skin Structure.

Core Head System and GCS Structure Design

Layer 5 Composition

Layer 5 comprises 27 modules (see Figure 2):

a. **Core (12 modules): **

b. 9 universal modules: LC51–LC59

c. 1 Male-Specific trunk system: LC55M

d. 1 Male-Specific Core Gender Control Sector (CGCS): LC510M

e. 1 Female-Specific trunk system: LC55F

f. 1 Female-Specific CGCS: LC510F

g. **Skin (15 modules): **

h. Universal regional modules: LS51–LS59 (head, cranio-cervical, neck, cervico-thoracic, trunk, shoulder-axillary, upper limb, pelvic-hip, lower limb)

i. 1 Male-Specific trunk skin: LS55M

j. 1 Male-Specific Skin Gender Control Sector (SGCS): LS510M

k. 1 Male-Specific SGCS–Environment interface: LS511M

l. 1 Female-Specific trunk skin: LS55F

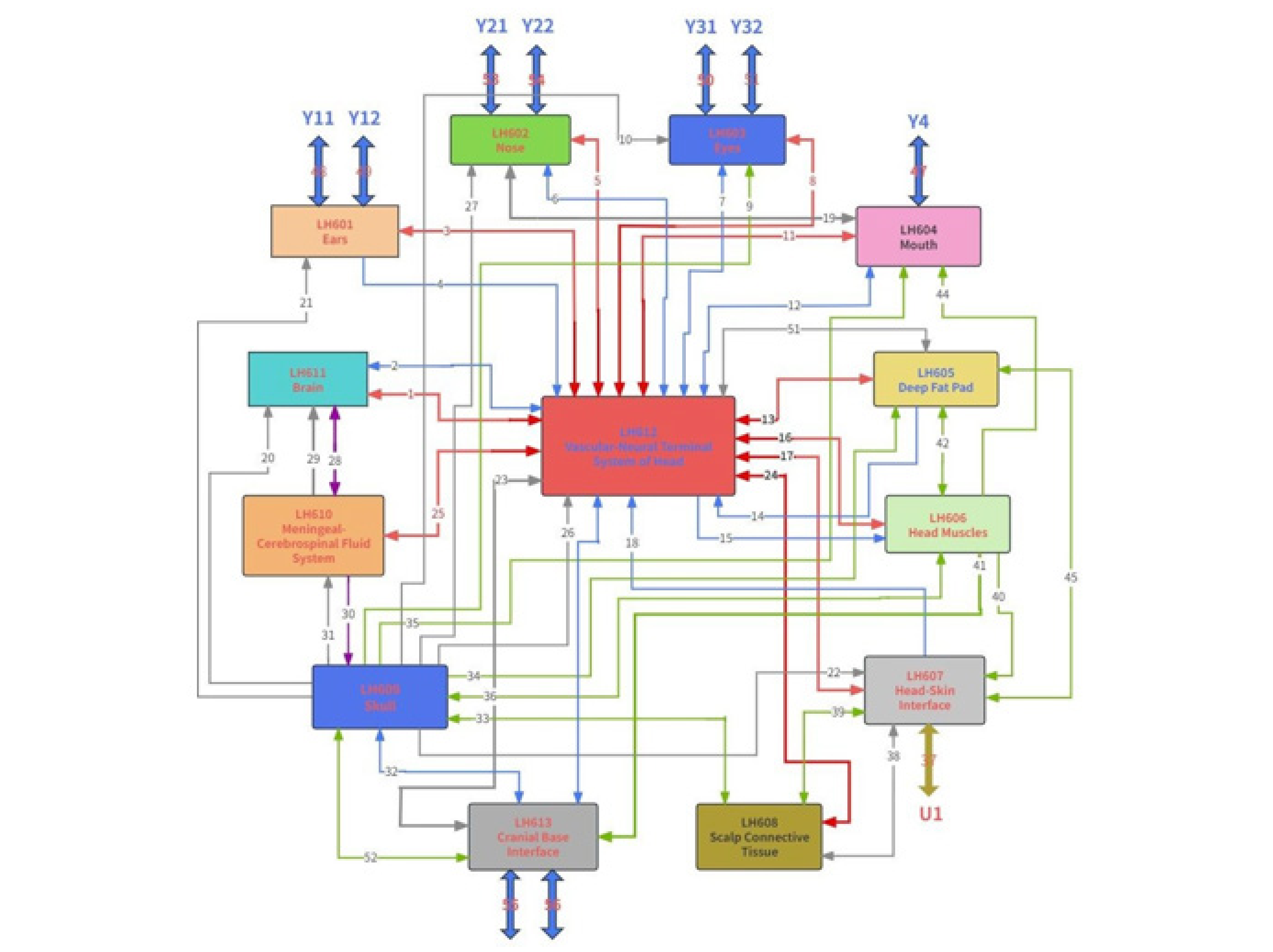
m. 1 Female-Specific SGCS: LS510F

n. 1 Female-Specific SGCS–Environment interface: LS511F

o. Distributed Interface: LS512

Core Head System Structure Design

As shown in (Figure 15), LC51 presents a conceptual framework of internal interconnectivity within the head system. One of its notable layout features is that the Vascular-Neural Terminal System of Head (LH612) is centrally positioned due to its extensive connectivity. In the connectivity graph of LC51, LH612 occupies a topologically central position-it exhibits high betweenness centrality as a hub node connecting multiple subsystems. This topological centrality reflects its functional role as the primary distributor of vascular supply and neural innervation to the specialized interface structures of the head (eyes, ears, nasal and oral cavities, and facial integument). Geometrically, these terminal vessels and nerves arborize toward the periphery; their topological centrality in the model captures their role as obligatory conduits linking core processing centers to peripheral interface nodes.



*Caption: LC51 is a unisex core head system structure, including 13 functional blocks, 7 external interfaces (Y11, Y12, Y21, Y22, Y31, Y32, Y4), and 3 internal interfaces (U1, HC, HN). U1 connects to S1 of Skin. HC connects to Cranio-cervical Junction System, HN connects to Neck System. The U1 interface—the designated coupling point between the core head system (LC51) and the skin head system (LS51)—corresponds anatomically to the calvarial interface: the complex of emissary veins, pericranial nerve branches, and fascial attachments that link the intracranial and extracranial compartments. Different colors of connecting lines reflect different types of signal transmission.

Figure 15: LC51—SCD Core Head System Structure.

LC51 visualizes the dynamic flow of matter, energy, and information among its submodules. Based on defined structures and I/O ports, a clear and dynamic head network is constructed.

The internal connectivity of the head system-and by extension, of all core modules-is modeled according to a unified taxonomy of flows. Traditional anatomy describes vascular supply, neural innervation, CSF circulation, and mechanical support in separate chapters, using distinct descriptive conventions. The SCD framework, by contrast, recognizes these as instances of four fundamental flow categories: material, energy, information, and spatial relations. This unification is not merely terminological; it enables the subsequent application of engineering tools to anatomical systems that have hitherto been treated as irreducibly complex.

**Design Principles for Internal Connectivity: **

a. Anatomical and physiological fidelity: All connections reflect real biological processes (e.g., neural innervation, blood supply, biomechanics, spatial relationships)

b. Defined flow types:

c. Material flow: blood, CSF, interstitial fluid, secretions, metabolic waste

d. Energy flow: mechanical force, heat

e. Information flow: neural signals (sensory input, motor output)

f. Spatial/support relations: containment, support, buffering, protection

g. Directional clarity: Input/output directionality is specified where possible

h. Concise abstraction: Connections are described at a conceptual level; details unfold in lower layers

i. Flow-centric modeling: Emphasis on dynamic exchange processes

**Core Flow Types: **

a. Blood flow (Material/Energy): Oxygenated input / Deoxygenated output / Waste output

b. Neural signal flow (Information): Sensory input / Motor output

c. Biomechanical force (Energy): Muscle contraction / Skeletal support / Cushioning force

d. CSF flow (Material/Cushioning): Circulation and Absorption

e. Spatial/Support relations: Physical Containment / Protection / Separation

**Signal Flow: **

1. Brain

a) IN: From LH612 (Oxygenated blood, nutrients) [12]

b) OUT: To LH612 (Deoxygenated blood, waste, heat)

c) IN: From LH612 (All incoming sensory signals: visual/auditory/olfactory/gustatory/vestibular/somatosensory) *Sonne et al.,* (2025)

d) OUT: To LH612 (All outgoing motor/regulatory signals)

e) IN/OUT: With Meningeal-CSF System (Surrounded/cushioned by CSF; CSF produced by choroid plexus and absorbed via arachnoid granulations) [14]

f) IN: Contained and protected by Skull

g) IN: Wrapped/protected/supported by Meningeal-CSF System

2. Ear

i. IN: From LH612 (Blood supply)

ii. OUT: To LH612 (Waste, heat)

iii. OUT: To LH612 (Auditory signals, Vestibular signals) [15]

iv. IN: Partially embedded in Skull (Petrous part of temporal bone)

3. Nose

i. IN: From LH612 (Blood supply)

ii. OUT: To LH612 (Waste, heat)

iii. OUT: To LH612 (Olfactory signal) [16]

iv. IN: Skeleton formed by Skull (Nasal bones, maxilla, etc.)

v. IN: Shares part of its cavity with Mouth (Choanae open into pharynx)

4. Eye

i. IN: From LH612 (Ophthalmic artery)

ii. OUT: To LH612 (Ophthalmic veins)

iii. OUT: To LH612 (Visual signals) [17]

iv. IN: From LH612 (Motor nerves to extraocular muscles)

v. IN: Attached to Skull (Orbit)

5. Mouth

i. IN: From LH612 (Blood supply)

ii. OUT: To LH612 (Waste, heat)

iii. IN: From LH612 (Gustatory signals, Motor nerves) [18]

iv. OUT: Vocal information originates from Brain via nerves; mouth is resonance/articulation organ

v. IN: Supported by Skull (Maxilla/Mandible)

6. Skull

i. OUT: Contains/protects Brain, Meningeal-CSF System, sensory organs

ii. OUT: Supports Facial Skin, provides attachment for Head Muscles

iii. OUT: Provides passages for LH612 to traverse (carotid canal, optic canal, foramina)

iv. IN: Receives pulling forces from Head Muscles

7. Head Muscles

i. IN: From LH612 (Blood supply, Motor nerve signals) [19]

ii. OUT: To Skull (Movement: masticatory muscles pull mandible)

iii. OUT: To Facial Skin (Facial muscle contractions produce expressions)

8. Deep Fat Pads

i. IN: From LH612 (Blood supply)

ii. OUT: To LH612 (Sensory nerve signals: touch, pressure, temperature, pain)

iii. IN/OUT: Head-Scalp Interface (Supports facial skin, transmits force)

iv. IN/OUT: Head Muscles (Fat pads provide gliding planes, reducing friction)

9. Head-Scalp Interface

i. IN: From LH612 (Blood supply)

ii. OUT: To LH612 (Sensory nerve signals: touch, pressure, temperature, pain)

iii. IN: From Head Muscles (Occipitalis, Frontalis)

iv. IN/OUT: Deep Fat Pads (Force transmission)

10. Meningeal-CSF System

i. IN: From LH612 (Blood plasma for CSF production)

ii. OUT: To LH612 (CSF absorption via venous sinuses) [14]

iii. IN/OUT: Surrounds/cushions Brain, Upper Spinal Cord

11. Scalp Connective Tissue Layer

i. IN: Receives Tissue Fluid (Derived from LH612)

ii. IN/OUT: Cushions shear forces between Scalp and Skull

12. LH612: Cerebrovascular-Neural Terminal System

i. IN/OUT: Pervasive system supplying all cephalic structures [13]

ii. IN: Traverses passages within Cranio-cervical Junction System

iii. IN: Branches penetrate Skull foramina

13. Cranial Base Interface

i. IN: Receives forces from Head Muscles and Neck Muscles

ii. OUT: Transmits movement to Skull

iii. IN: Formed by joints between Skull (Occipital bone) and Cervical Vertebrae [11]

iv. OUT: Connects LH612 to Cranio-Cervical Junction and neck systems

The Cranial Base Interface constitutes the cephalic terminus of the cranio-cervical junction-the first of the four transitional zones identified in the revised nine-region scheme. Its inclusion as a distinct functional block within LC51 reflects the SCD framework's recognition that transitional zones are not mere boundaries but anatomically dense interfaces where multiple subsystems converge and cross.

**Key Highlights of the Internal Connection Diagram: **

a. **LH612 is the Core Circulation and Regulation Network:** Its arterial and neural connection lines radiate to almost all other structures, highlighting its central role as the "lifeline" and "information highway." The designation of LH612 as a distinct functional block represents a departure from traditional anatomical taxonomy, where vasculature and innervation are treated as appendages to the cardiovascular and nervous systems. In network-theoretic terms, LH612 is the head system's power bus and data bus.

b. **Brain is the Information Processing Center:** It receives all sensory input, issues all motor/regulatory commands, and interacts with its environment via blood and CSF.

c. **Clear Mechanical System:** Head Muscles are the primary force generators, acting on the Skull (movement/chewing) and Deep Fat Pads (reaching Facial Skin via the Head-Scalp Interface). Forces from the Neck and Cranio-Cervical Junction system are transmitted through the Cranial Base Interface.

d. **Explicit Protection and Support System:** The Skull and Meningeal-CSF System together form multiple layers of protection for the Brain.

e. **Sensory-Effector Loops:** Environmental stimuli are input through external ports (Eye/Ear/Nose/Skin) to LH612, transmitted to Brain, processed, and then effectors (Muscles) produce responses (movement, expression, speech).

f. **Spatial Relationships Support Function:** Containment, support, and passage provision are systematically represented.

SCD Core Head Structures – Multi-States and Mixed Signals at External I/O Interfaces:

1. Ear

i. Input: Sound (Sound waves), Head Position & Movement Information (Vestibular stimuli)

ii. Output: Cerumen (Earwax), Auditory Signals (to Brain), Vestibular Signals (to Brain)

2. Nose

i. Input: Air (Gas), Odor Molecules (Olfactory stimuli)

ii. Output: Mucus (Nasal secretion), Exhaled Air (partially)

3. Eye

i. Input: Light (Visual stimuli)

ii. Output: Tears, Ocular Secretions, Visual Signals (to Brain)

4. Mouth

i. Input: Solid Food, Liquid, Air (Gas)

ii. Output: Saliva, Speech (Sound), Exhaled Air (Waste gas)

Additionally, the core internal interface "Head-Scalp Interface" connects to the external skin interfaces "Facial Skin" and "Scalp":

a. Input: Physical Contact (Tactile, Pressure), Temperature Stimuli, Chemical Stimuli

b. Output: Sweat, Sebum (Oil), Heat

The interface-specific signal inventories enumerated above constitute the concrete anatomical instantiation of the polymodal hybrid signal taxonomy introduced in Section 4. Where L20 provided an abstract catalog of signal types, LC51 anchors each signal category to its specific anatomical portal and transduction apparatus.

LC51 (Figure 15) presents the flow of polymorphic mixed signals within the SCD core head system-integrating established anatomical knowledge of cranial nerve distribution *[Sonne et al., 2025]*, cervical innervation *[Waxenbaum & Bordoni, 2025]* [11], craniofacial vascular territories *[Caplan & van Gijn, 2012; Tukhtanazarova, 2025]*, [12,13] and gasotransmitter signaling *[Mustafa et al., 2009]* [20] into a unified interface-logic framework.

In summary, the LC51 connectivity diagram reveals several architectural principles of the cephalic core system. First, LH612 functions as a pervasive distribution network-a shared power and data bus that interconnects all specialized cephalic modules. Second, the Brain operates as the central information processor, integrating multimodal sensory inputs and issuing coordinated motor and regulatory outputs. Third, a clearly delineated mechanical chain-from Head Muscles through Skull and Deep Fat Pads to the Head-Scalp Interface-mediates all cephalic force transmission. Fourth, multiple concentric layers of protection safeguard the neural core. Fifth, the diagram explicitly maps sensory-effector loops, tracing environmental stimuli from external ports through neural processing to muscular response. Finally, spatial relations are systematically represented, providing the anatomical substrate for functional interactions. This hierarchical structure not only provides new avenues for research into human structure, disease diagnosis, and treatment but also facilitates the programming (modeling/simulation) of human structures.

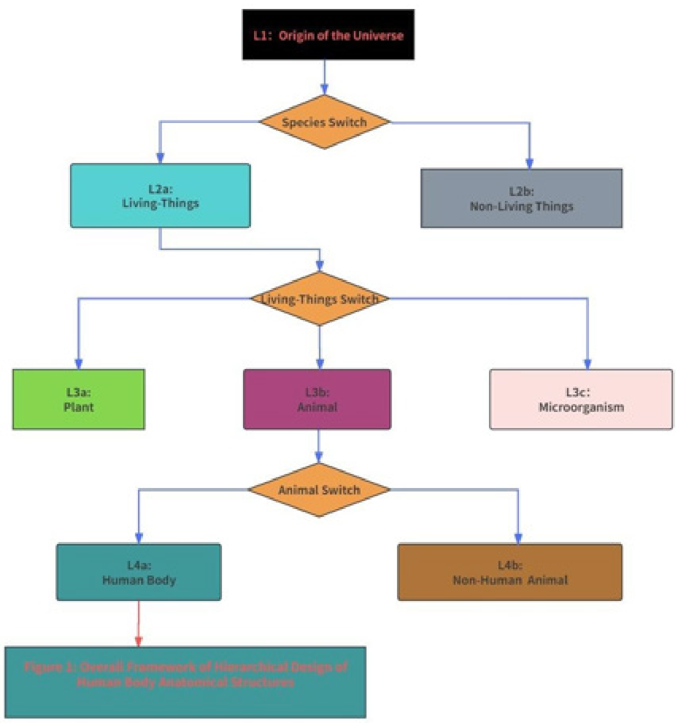
Male-Specific/Female-Specific SCD Core and Skin Gender Control Structures

Conceptual diagrams of Male-Specific and Female-Specific SCD gender control structures have been developed. Due to space constraints, the component lists are provided in (Table 4); detailed signal flow and structural design will be addressed in a forthcoming publication.

Overall Framework of Hierarchical Design of Cosmic Structure

As shown in (Figure 16), the Human Body belongs to the fourth layer of the cosmic structure, with the second layer (L2) and third layer (L3) separating Origin of the Universe from Human Body. Conversion switches exist between different categories within the same layer, reflecting horizontal connections. At the same time, there are vertical pathways for different branches (this diagram does not show all vertical pathways due to their sheer scale). Figure 1 in this article connects Human Body of the fourth layer in this diagram; the vertical pathway from Origin of the Universe to the human Brain goes through nine layers. (Figure 16) illustrates the interconnectedness of all things and the connection between the macro and micro levels.

Figure 16 illustrates the hierarchical design of cosmic structure:



*Caption: Human Body belongs to the fourth layer of the cosmic structure. Conversion switches exist between different categories within the same layer, reflecting horizontal connections. Vertical pathways connect different branches across layers. Figure 1 in this article connects Human Body of the fourth layer in this diagram. This figure illustrates the interconnectedness of all things and connection between macro and micro levels.

Figure 16: Overall Framework of Hierarchical Design of Cosmic Structure.

i. Layer 1: L1: Origin of the Universe

ii. Layer 2: L2a: Living-Things vs. L2b: Non-Living-Things

iii. Layer 3: Living-Things are divided into L3a: Plant, L3b: Animal, and L3c: Microorganism

iv. Layer 4: Animal includes L4a: Human Body and L4b: Non-human Animal

v. Layers 5–9: see Figure 1

Each layer contains a conversion switch between categories, enabling inter-species and inter-domain transformation, and reflecting horizontal connections. The vertical pathway from Origin of the Universe to the human Brain goes through nine layers, reflecting vertical connections.

Examples:

a. Human–Animal conversion: Transplanting animal skin or organs into humans creates hybrid anatomical states

b. Human–Plant conversion: A "vegetative state" reflects a transition from human to plant-like existence

c. Developmental transitions: A newborn, structurally human, undergoes a cognitive shift from animal to human consciousness

d. Death as transformation: The dying process reflects a regression from human to animal, then to plant, and finally to non-living-things.

The cosmic-scale framework presented in this section is offered as a methodological and philosophical context for the SCD model, illustrating the scalability of interface-logic thinking across domains. The anatomical scope of the present paper is restricted to the human body (L4a and its sub-layers, as detailed in Sections 3–7).

Discussion

Comparison of the Two Methods

*Table 4: Composition of Male/Female SCD Core and Skin Gender Control Zones.

Gender Control Zone	Submodules	Description
Male SGCS (Skin)	Penis skin, Urethral opening, Glans penis, Scrotum, Left Nipple, Right nipple, Left areolar gland, Right Areolar gland, SGCS–TSS interface, SGCS–Environment interface	SGCS: Skin Gender Control Sector; TSS: Trunk Skin System
Male CGCS (Core)	Testis, Epididymis, Vas deferens, Ejaculatory duct, Urethra, Prostate, Seminal vesicle, Bulbourethral gland, Bulbocavernosus muscle, Ischiocavernosus, Prostatic plexus, Deep artery/vein of penis, Left/Right deep nipple–areola structures, CGCS–TSS interface, CGCS–SGCS interface	CGCS: Core Gender Control Sector
Female SGCS (Skin)	Vaginal opening, Urethral meatus, Clitoris, Mons pubis, Labia majora, Labia minora, Left Nipple, Right nipple, Left areolar gland, Right areolar gland, SGCS–TSS interface, SGCS–Environment interface	—
Female CGCS (Core)	Vagina, Urethra, Anterior vaginal fornix, Cervix, Uterus, Oviduct, Ovaries, Paracervical plexus, Pelvic floor muscles, Left/Right Bartholin glands, Left/Right vestibular glands, Vestibular bulbs, Left/Right deep nipple–areola structures, CGCS–TSS interface, CGCS–SGCS interface	—

*Note: "Oviduct" replaced with the standard human anatomical term "Uterine tube."

Table 5: Comparison between the method of this paper and traditional human body modeling method.

Dimension	Traditional Modeling	This Paper (IC-Inspired)
Structural Organization	Flat or organ-based segmentation	Top-down hierarchy, I/O interfaces, SCD, GCS
Interface Definition Gender Differentiation Scalability	Implicit or vague Post-hoc adjustment or ignored Fixed structure, hard to iterate	Explicit I/O interface logic Defined in Layer 2 with plug-in GCS Supports modular replacement and system expansion
Interdisciplinary Integration	Biology-centric	Fusion of engineering design and biological structure

Significance of Hierarchical Design

In complex system modeling, hierarchical design is a widely adopted organizational strategy-especially suitable for multidimensional, multifunctional systems like the human body. This paper draws from top-down hierarchical design in Integrated Circuit (IC) architecture, combined with I/O interface logic, to construct a cross-disciplinary framework for human structure.

This method emphasizes starting from overall functionality, refining layer by layer into specific modules. Through clear module boundaries, interface definitions, and formally consistent connections at all layers, it achieves integrity, scalability and reconfigurability. The design philosophy originates in electronic engineering but aligns with biological systems' layered regulatory mechanisms-embodying a fusion of engineering logic and life science.

Hierarchical structural design liberates anatomy from morphology. What does it mean to "liberate anatomy from morphology"? Traditional anatomy is bound to the specific shapes, sizes, and spatial arrangements of structures as they appear in the cadaver or the radiographic image. The hierarchical design methodology abstracts away from morphological particulars to functional and interface logics. The SCD model asks, "What class of signals does this skin region transduce, and to which core modules is it coupled?" This shift from morphological description to functional specification is what enables the subsequent engineering operations-modular substitution, interface standardization, and gender reconfiguration. This paper presents the first set of non-morphological human body structural diagrams-16 figures in total-organized according to the hierarchical design methodology. Additional GCS figures will be published in a forthcoming publication. Subsequent research will continue to complete the fifth and sixth layers of the diagrams.

Hierarchical design facilitates visual teaching of human anatomy. The SCD core head system structure diagram (Figure 15) provides a demonstration, using lines of different colors to represent the transmission of different signal types. Dynamic graphs can be further developed. Hierarchical design breaks down the boundaries between macro-anatomy and micro-anatomy by decomposing functional components from macro to micro.

Theoretical Breakthrough and Engineering Potential of Interface Models

In hierarchical design, there are two types of interfaces: internal and external. Internal interfaces are determined by the divisions of the human body, while external interfaces are determined by the boundary between the human body and the environment. Since most of the human body's surface is skin, skin is the main external interface of the human body. This paper introduces a groundbreaking external interface model for the human body-redefining skin as a comprehensive I/O interface. This transcends the organ-centric view of traditional anatomy and reimagines human–environment interaction through port mapping.

****Revolutionary Contributions:** **

****Full Boundary Coverage:** ** A holographic mapping of life–environment interaction. Interfaces span mechanical, chemical, optical, acoustic, thermal, and social information domains. Skin as a distributed interface fills sensory/exchange blind spots between organs.

****Skin as Primary Interface:** ** Elevated from passive container to Tier-1 environmental interface. Unified triad: Sensory input (touch/temperature/chemical); Secretory and excretory regulation (sweat, sebum, antimicrobial peptides, pheromones); Barrier and immune coordination (e.g., Langerhans cells for antigen recognition [15,16,17,18,19]; pheromone release for behavioral modulation [20,21]).

****Unified Functional Language:** ** All environmental interactions abstracted into I/O protocols.

****Gender as Configurable Parameter:** ** Variable X in L20 (Figure 4) reflects gender plug-in logic-modular slot, signal channel switching. Gender becomes a configurable module, not a fixed attribute.

****Foundation for Gender-Differentiated Modeling:** ** GCS integration via M-G5 and F-G5 enables structural modeling of sex-specific interfaces.

****Application Scenarios (Not Exhaustive):** **

****Clinical Medicine:** ** Medical diagnostics, Urinary incontinence localization, Physiological organ simulation, Transgender medical simulation

****Bioengineering:** ** Bionic robot design, Artificial skin multimodal sensing, Virtual human simulation

****Digital Systems:** ** Digital identity modeling, Gender-emotion interaction systems

****Basic Science:** ** Environmental adaptability research

This design revolutionizes human–environment modeling-shifting from organ mosaics to interface networks, akin to the leap from assembly language to API architecture in computer science.

The Architectural Rationale for the Hybrid Partitioning Strategy

A question that may have lingered since the methodological exposition in Section 2 concerns the choice of the hybrid partitioning strategy-the combination of the Skin-Core Dichotomy as the primary organizational tier with the revised nine-region scheme as the secondary tier (Option 3). Given the conceptual elegance and theoretical power of the pure SCD model (Option 2), why complicate the framework with an additional layer of regional subdivision? Is this not a concession to tradition that undermines the radical aspirations of the SCD paradigm?

The answer lies in the relationship between functional abstraction and anatomical localization-a tension that any system-level description of the body must resolve. The pure SCD model, as articulated in Figure 7 (L30A) and elaborated in the L30B/L31/L32 architectures, provides a universal functional grammar: it specifies that the body comprises two coupled subsystems (skin and core), that their interactions are mediated by defined internal interfaces, and that both subsystems interface with the environment through distinct external ports. This grammar is trans-species in its applicability-the distinction between an enveloping boundary and an enclosed interior is as pertinent to a cell, a fruit, or a planet as it is to a human being.

But a grammar without a vocabulary cannot describe any actual body. The pure SCD model tells us *that* skin and core interact; it does not, by itself, specify *where* particular interactions occur, *how many* regional specializations exist within the skin, or *which* core modules correspond to *which* skin territories. It lacks a coordinate system-a spatial syntax for mapping its abstract logic onto the tangible geography of the human form.

The revised nine-region scheme-operating as the secondary organizational tier-supplies precisely this missing cartography. Its ten constituent modules (the traditional five regions plus the four transitional zones and the Gender Control Sector) provide the anatomically specific vocabulary that renders the SCD framework navigable. Each module in the secondary tier corresponds to a pair of coupled substructures in the primary tier: a skin module (LS51–LS59, LS510) and its core counterpart (LC51–LC59, LC510). The

internal interfaces of the SCD model-the S–U matrix for non-GCS coupling and the P–P′/Q–Q′ matrices for GCS coupling-are thus given precise anatomical addresses. The four transitional zones-cranio-cervical junction, cervico-thoracic junction, shoulder-axillary complex, and pelvic-hip interface-exemplify the indispensability of this secondary tier. In a pure SCD model, these zones would be invisible boundaries, mere lines on a diagram where one module abuts another. But anatomically, they are functionally dense territories in their own right: loci where major neurovascular bundles traverse between regions, where fascial planes converge and diverge, and where the mechanical coupling between skin and core achieves its greatest complexity. The hybrid strategy elevates these zones from invisible boundaries to explicit functional modules, each with its own interface specifications and signal routing logic. This elevation is not a taxonomic quibble; it is the formal recognition that transitional anatomy is anatomy-that the spaces *between* regions are themselves regions.

Moreover, the secondary tier performs a critical bridging function between the SCD framework and clinical practice. Surgeons, radiologists, and physical diagnosticians navigate the body by regional landmarks. The nine-region vocabulary-familiar in its broad outlines, innovative in its emphasis on transitional zones-provides a clinical on-ramp to the more abstract SCD logic. A surgeon planning a cervico-thoracic approach need not master the full SCD interface formalism to benefit from the recognition that this junction is a functionally coherent module with distinct skin-core coupling characteristics. In summary, the hybrid partitioning strategy is neither a redundancy nor a reluctant compromise with anatomical tradition. It is the formal mechanism by which a functional abstraction (the SCD grammar) acquires anatomical specificity (the nine-region vocabulary), and conversely, by which a regional classification scheme acquires systemic coherence. The two tiers are not additive-they are multiplicative, each amplifying the explanatory power of the other.

SCD Model Breakthrough Perspective and Far-Reaching Impact on Medicine

The Skin-Core Dichotomy (SCD) model is conceptually innovative, breaking the traditional division of human anatomy that has existed for centuries. The SCD model states that the human body is a triple coupling of skin, core and environment; it establishes the skin as an independent organ system and highlights the integrity, autonomy, and programmability of the skin. Skin ports are not passive sensors, but active expressors. The SCD model provides a structural basis for future gender-specific aesthetic medicine.

After establishing the basic model of Skin-Core Dichotomy (as shown in Figure 7-L30A), different mapping approaches between skin and core can be developed. By integrating the SCD model with hierarchical design methodology and gender-specific parameters, at the macro level, a layered skin and core model was created in this paper; the coupling signals between skin and core are divided into GCS and non-GCS signals. This model still falls within the realm of regional anatomy. Another approach models the human body as a programmable layered system of “Kernel (biological core) + Skin (functional plugins)”-similar to an operating system, where Biological core = Microkernel (Basic Metabolism), and Skin = Dynamically Loaded Driver Modules. This approach integrates the microscopic and the macroscopic, transcending the confines of regional anatomy, and carries even more revolutionary and disruptive significance. The Kernel+Skin model sketched here represents a promissory note for future work; the present paper focuses on the anatomically grounded ten-module SCD framework developed in Sections 3–7.

1.1.1. SCD Model Breakthrough Perspective

1. Philosophical breakthrough: from structural determination to functional emergence

Traditional anatomy believes that function is the inevitable result of structure (such as heart structure determining pumping function). The SCD model, by contrast, posits that dynamic functions emerge through self-organization within the “skin layer.” For example, immune responses no longer rely on fixed anatomical locations, but rather on molecular signaling networks defined by the skin. This challenges the dogma that “anatomical structures are immutable,” much like the principle in network protocols where “the core doesn’t control routing, the skin determines the path.”

2. Methodological breakthrough: from layered segmentation to dynamic mapping

Traditional anatomy relies on physical dissection (such as organ and tissue sections), with information being static and fragmented. The SCD model provides a universal foundational framework through the core (e.g., extracellular matrix, vascular-neural networks), while the skin dynamically reconfigures functional boundaries through bioinformation flows (e.g., metabolite gradients). For example, the tumor microenvironment can be regarded as "pathological skin," functioning independently of traditional organ classifications.

3. Technological breakthrough: from "limited observation" to "programmable intervention"

Traditional limitations mean anatomy relies on postmortem specimens or live imaging, making real-time manipulation challenging. Application of the SCD model enables core tools (gene editing and organoid culture provide a standardized "core platform") and skin intervention (dynamically reprogramming anatomical functions through synthetic biology, such as designing microbiota-engineered skin).

1.1.2.Far-Reaching Impact on Medicine

1. Revolutionizing the concept of disease:

Traditional: Disease is localized to anatomical structures (e.g., "stomach cancer = gastric tissue pathology") [24]. SCD model: Disease represents "loss of skin layer function" (e.g., cancer is local skin escape from core regulation) [25].

2. Paradigm shift in treatment:

From "Organ Removal/Repair" to "Skin Reprogramming" (e.g., CAR-T therapy: Immune cells are endowed with new "Skin logic") [26,27].

3. Cross-species consistency:

Core conservation (e.g., mitochondrial function is universal across species) permits skin layer differentiation (Octopus skin and human skin share core signaling pathways) [28,29].

Summary

The Skin-Core Dichotomy (SCD) liberates anatomy from the "tyranny of structure." Its essence is a shift from mechanical reductionism to cybernetics-the human body is no longer a "collection of parts," but a super-system of "core hardware" and programmable software. This paradigm may reshape the underlying logic of future precision medicine. It is conceivable that, within the coming decades, the organ-centric organization of anatomy textbooks may be supplemented-if not supplanted-by functional interface classifications derived from the SCD framework [30-35].

The Gender Control Sector: Modularizing Sexual Dimorphism

The Gender Control Sector (GCS), introduced in Layer 2 as the variable X in the I/O interface model and elaborated in Layers 4–6 as a coupled pair of modules (SGCS in the skin subsystem, CGCS in the core subsystem), constitutes one of the four theoretical pillars of the framework presented in this paper. Its significance extends across multiple dimensions-anatomical, clinical, methodological, and conceptual.

Anatomical Significance: Localizing Sexual Dimorphism

Traditional anatomy treats sexual dimorphism as a diffuse property of the body-male and female pelves differ, male and female larynges differ, male and female patterns of subcutaneous fat distribution differ. This diffuse treatment obscures a fundamental architectural fact that the SCD framework renders explicit: sexual dimorphism is highly localized. Of the ten functional modules defined in the revised nine-region scheme, nine-including the four transitional zones-are structurally universal across male and female body plans. Only the tenth module, the GCS, is sex-specific.

This localization is not an artifact of the classification scheme; it reflects a deep biological reality. The cranio-cervical junction of a male and a female are anatomically homologous; the cervico-thoracic junction, the shoulder-axillary complex, and the pelvic-hip interface exhibit no systematic sex-based structural divergence. By isolating the GCS as a dedicated module, the SCD framework provides a precise anatomical address for sexual dimorphism, separating it from the universal architecture that constitutes the remainder of the body plan.

Bipartite Architecture: SGCS and CGCS as Coupled Modules

A defining feature of the GCS within the SCD framework is its bipartite organization. The GCS is not a single module but a coupled pair: the Skin Gender Control Sector (SGCS) and the Core Gender Control Sector (CGCS). This division mirrors the fundamental skin-core dichotomy that organizes the entire framework.

The SGCS comprises the externally accessible, integumentary components of the gender apparatus: the penile skin, scrotum, and nipple-areolar complexes in the male configuration; the labia majora, labia minora, mons pubis, clitoris, and nipple-areolar complexes in the female configuration (Table 4). These structures constitute the visible, palpable surface of sexual dimorphism and are the principal targets of gender-affirming surgical interventions.

The CGCS comprises the internally housed reproductive and deep neurovascular structures. The coupling between SGCS and CGCS-mediated by the P–P′ interface matrix in males and the Q–Q′ interface matrix in females-formalizes the bidirectional signaling that coordinates surface and deep gender characteristics. Hormonal signals from the CGCS modulate the development and maintenance of SGCS structures; conversely, sensory and signaling inputs from the SGCS feed back to central regulatory centers via the CGCS interface.

Clinical Implications: Toward Modular Gender Interventions

The modularization of the GCS within the SCD framework has direct implications for clinical practice, particularly in gender-affirming care. The distinction between SGCS and CGCS provides a principled anatomical basis for differentiating types of intervention:

**SGCS-selective interventions: **Target the externally visible gender apparatus-chest wall reconstruction, genital surface reconfiguration, modulation of hair and soft tissue distribution. These alter the apparent sexual phenotype without necessarily affecting deep reproductive structures.

CGCS-selective interventions: **Target the internal reproductive apparatus-gonadectomy, hysterectomy, oophorectomy-altering reproductive capacity and systemic endocrine status.

**Coupled interventions: **Address both SGCS and CGCS in a coordinated manner, achieving comprehensive gender reconfiguration.

The SCD framework does not prescribe which interventions are appropriate; rather, it provides a clear anatomical and conceptual vocabulary for describing what is being modified and how the modifications relate to the broader body architecture. As gender-affirming techniques continue to evolve-incorporating tissue engineering and regenerative medicine-the modular GCS architecture provides a scaffold for conceptualizing and designing novel interventions.

Methodological Significance: Gender as a Configurable Parameter

At the methodological level, the treatment of gender as a configurable parameter-operationalized through the variable X in Layer 2 and the plug-in GCS architecture in Layers 3–6-represents a departure from traditional anatomical practice. Conventional anatomy either ignores gender entirely (presenting a generic body that is implicitly male) or treats it as a post-hoc overlay.

This shift has downstream consequences for computational modeling, medical device design, and pharmaceutical development. A computational model of cardiovascular physiology built on an SCD framework would, by virtue of the gender switch, automatically instantiate sex-specific parameters where the GCS interfaces with the vascular system. In each case, gender is not an afterthought but a configurable parameter that propagates systematically through the model hierarchy.

Conceptual Significance: Skin as a Gender Interface

Finally, the GCS architecture reinforces a central theme of the SCD framework: the elevation of skin from passive wrapper to active interface. The SGCS is, by definition, a skin module-it is the integumentary component of the gender apparatus. Its inclusion as a first-class module alongside the CGCS underscores that gender is not merely a matter of deep reproductive anatomy but is also a surface phenomenon-expressed, perceived, and culturally encoded at the skin interface.

The SGCS, with its dense innervation, specialized glandular apparatus, and hormonally responsive soft tissue, is a biological substrate for gender identity and expression. By formalizing the SGCS as a distinct module within the GCS, the SCD framework provides an anatomical language for phenomena that have traditionally fallen between the cracks of biological and sociocultural description. In summary, the Gender Control Sector is not merely an additional module appended to the SCD framework; it is an integral component that embodies the framework's core commitments-to modularity, to interface logic, to the primacy of the skin, and to the treatment of biological variation as a configurable architectural feature rather than a deviation from a universal norm.

Cross-Species Adaptability and the Philosophy of Universal Transformation

This paper establishes a novel human structural system model based on four pillars: hierarchical design, Skin-Core Dichotomy (SCD), full coverage interface, and Gender Control Sector (GCS). This model applies not only to humans but also to non-human animals, plants, and non-biological systems (excluding GCS for non-biological systems). For non-biological systems like Earth, the crust serves as the "skin," while the remainder constitutes the "core." The SCD model applies to all systems with an outer layer, where the "skin" can be conceptualized as the "cosmic membrane." SCD represents the most natural division, distinct from anatomical classifications that involve rigid segmentation. SCD embodies the philosophical principle of duality. This paper establishes for the first time a hierarchical model from cosmic interface to human interfaces, with conversion switches at each level, embodying the philosophical principle of "universal transformation."

Conclusion

This paper establishes a novel system model of human body anatomical structures based on four theoretical pillars: hierarchical design, Skin-Core Dichotomy (SCD), full coverage interface, and Gender Control Sector (GCS). It transforms human anatomy from a morphological descriptive science into a programmable engineering design, breaking away from traditional anatomical divisions of the human structure. This achieves a holographic mapping of multi-state and mixed signals and produces the first set of non-morphological human body structural diagrams (16 figures presented herein, with additional GCS figures in preparation), establishing a hierarchical architecture from cosmic origin to human body. This represents not only a paradigm shift in human anatomy but also holds broad application potential across species and systems.

When the scalpel becomes a compiler, we are no longer readers of the body, but authors.

Author Contributions and Personal Information

Zhiren Zhou is the sole author of this paper and independently completed the work of topic selection, research approach, concept formulation and model establishment and analysis, data collection, all drawing and writing, and paper submission. No funding was applied for. Zhiren Zhou is an independent researcher in Toronto, Canada. He was an Associate Professor, Director of the Microelectronics Teaching and Research Section, Deputy Director of Microelectronics Research Institute in Hunan University, Changsha, China. His current interest is in interdisciplinary research between microelectronics, human anatomy and biomedical engineering.

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Conflict of Interest

The author declares no conflict of interest.

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