Hair, Nails and Glands Lab: NYSSLS Alignment

Teacher guide for the student worksheet at mrsajdak.com/skin-appendages (two pages, 20 questions; Day 1 on the front, Day 2 on the back; a low-write version has the same numbers). Anatomy & Physiology, Hole's Essentials 6.3: Accessory Structures of the Skin. Day 1: Hair and Nails (AP.3.6.4), tabs 1 to 3. Day 2: Glands of the Skin (AP.3.6.5), tabs 4 and 5. © 2026 Ryan Sajdak. Free to use, share and change under CC BY-NC-SA 4.0 (creativecommons.org/licenses/by-nc-sa/4.0): give credit, do not sell it, share your version the same way.

Objectives

The same four statements are printed on the worksheet, two at the top of each day, each with a box to tick. They are the lessons' own statements. Day 1 matches AP.3.6.4: describe the structure and function of hair and nails as skin appendages. Day 2 matches AP.3.6.5: compare sebaceous and sweat glands by structure, secretion, and function. Hair evidence (Q10 to Q12) is the Day 1 extension and sits outside the two statements.

Day	I can	Questions
1	identify the parts of a hair follicle and a nail and explain what each part does.	1, 5, 7
1	use growth rates to explain how long hairs and nails grow.	2 to 4, 6, 8, 9
2	compare eccrine sweat, apocrine sweat and sebaceous glands by where they open, what they make and what they do.	13 to 16
2	plan a fair sweat-print test and use its counts to explain what switches sweat glands on.	17 to 20

Performance expectations: building toward

The lab and worksheet give students evidence for these performance expectations. They are one step on the way, not a full assessment of any one of them.

> **HS-LS1-2**
> *"Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms."* Worksheet link, the main fit: each appendage is a structure built from epidermis that grows down into the dermis, with its own parts and jobs (Q1, Q7, Q13), and each one works with other systems: blood vessels feed the hair bulb and nail bed, a muscle stands hair up (Q5), nerves switch the sweat glands on (Q14, Q20).

> **HS-LS1-3**
> (the plan book's tag) *"Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis."* Worksheet link, partial: students plan a fair sweat-print test, changing one trigger at a time and keeping the rest the same (Q17), and get evidence that the back's sweat glands respond to heat, the response that cools the body when its temperature rises (Q18, Q20). The arrector pili muscle answers cold (Q5). The full temperature feedback loop is not modelled.

> **HS-LS1-1**
> (the plan book's tag) *"Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells."* Touched only: the hair bulb and nail matrix are specialized cells whose product is one protein, keratin (Q1, Q7); a shed club hair has little of the root tissue a nuclear DNA test needs (Q11, Q12). DNA is not modelled.

DCI LS1.A: *"Systems of specialized cells within organisms help them perform the essential functions of life." "Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level." "Feedback mechanisms maintain a living system's internal conditions within certain limits."*

Part by part

Part	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts	What students do
Day 1 · 1. Build a hair Q1 to 6	SEP 2 Developing and using models SEP 5 Using mathematics and computational thinking	LS1.A structure and function; specialized cells	Structure and Function; Stability and Change	Name seven parts of a follicle (shaft, root, follicle, bulb, papilla, sebaceous gland, arrector pili). Grow a scalp hair (1 cm a month, 36-month growing phase, 36 cm) and an eyebrow hair (0.5 cm a month, 2-

	SEP 6 Constructing explanations			month growing phase, 1 cm) through growing, stopping and resting phases; cut the hair and see the rate unchanged; switch on goose bumps.
Day 1 · 2. Grow a nail Q7 to 9	SEP 4 Analyzing and interpreting data SEP 5 Using mathematics and computational thinking	LS1.A structure and function	Scale, Proportion, and Quantity; Structure and Function	Name six nail parts. Grow a line out on a fingernail (3.5 mm a month, 4 months to the free edge) and a big toenail (1.6 mm a month, 10 months), then date a groove left by a fever: 7.0 mm and 3.2 mm both give 2 months.
Day 1 · 3. Hair evidence Q10 to 12	SEP 3 Planning and carrying out investigations SEP 4 Analyzing and interpreting data SEP 7 Engaging in argument from evidence	LS1.A structure and function	Structure and Function; Patterns	Measure hair and medulla width with movable lines, compute the medullary index (human under about 1/3, animal over 1/2), read the cuticle and the root end, and judge a hair from a broken window. The verdict is "consistent with Person A"; the guide on screen says why a microscope cannot prove identity and why a shed club root is poor for DNA.
Day 2 · 4. Three glands Q13 to 16	SEP 2 Developing and using models SEP 3 Planning and carrying out investigations	LS1.A structure and function; feedback	Structure and Function; Stability and Change; Cause and Effect	Identify eccrine (merocrine) sweat glands, apocrine sweat glands and sebaceous glands in skin from the armpit, forehead and palm; see where each opens (skin surface or hair follicle) and what it makes; switch between cool and calm, exercise in a warm room and stress, and between age 10 and 16. Apocrine glands switch on at puberty and answer stress; sebaceous output rises at puberty; the palm has no follicles, so no sebaceous or apocrine glands.
Day 2 · 5. Sweat-print test Q17 to 20	SEP 3 Planning and carrying out investigations SEP 4 Analyzing and interpreting data SEP 5 Using mathematics and computational thinking SEP 6, SEP 7	LS1.A feedback	Patterns; Cause and Effect	Plan the runs that answer "is palm sweat for cooling or for grip?", run an iodine-starch test, count active pores in a 0.05 cm^2 window and multiply by 20. Palm: 320 per cm^2 in exercise, 460 under stress; back: 100 in exercise, 0 under stress. With every gland switched on (pilocarpine) the palm has about 520 per cm^2 and the thigh about 60.

Using it with the lessons

- **Day 1 (Hair and Nails):** tab 1 is the Explore; tab 2 is the Elaborate. Tab 3 is the extension and early-finisher work, and a full make-up. Front of the worksheet.
- **Day 2 (Glands of the Skin):** tab 4 is the Explore; tab 5 is the Elaborate. Back of the worksheet. The Skin Lab's runner already covered how sweat cools; this lab keeps that brief and spends its time on which gland, where it opens, and what switches it on.
- **Not here on purpose:** skin color and melanin (the next lesson). The drawings show hair color only as brown or light.

Also in play

- **Explore, then explain, then apply:** each part starts with data questions (Q1 to 5, Q13 and 14, Q17 to 19). A READ FIRST line on the sheet then sends students to the **Learn It** box in the lab, which opens once they have the data, before the questions that use the ideas (Q6, Q15 and 16, Q20). The slideshow has a matching Learn It slide at each of those points for whole-class teaching. Taught there: hair is made only in the bulb and the shaft is dead; the growing, stopping and resting phases, and that the growing phase sets a hair's length (Part 1); where each gland's duct empties, that thick skin has no hair follicles,

that puberty switches on apocrine glands and enlarges sebaceous glands, and that nerves switch sweat glands on while oil flows steadily (Part 4); evaporative cooling, fight-or-flight sweating on palms and soles, moisture and grip, and that the trigger tells the job (Part 5). Parts 2 and 3 have no Learn It box: their questions are measurements and calculations, and the lab's part cards, case card and verdict note already teach what Q7, Q9, Q11 and Q12 ask.

- **Key terms:** hair follicle, hair shaft, hair root, hair bulb, hair papilla, arrector pili muscle, keratin, growing (anagen), stopping (catagen) and resting (telogen) phases, nail plate, nail bed, nail matrix, lunula, cuticle, free edge, cuticle (hair), cortex, medulla, medullary index, eccrine (merocrine) sweat gland, apocrine sweat gland, sebaceous gland, sebum, pore.
- **Real numbers, rounded:** scalp hair about 0.35 mm a day (about 1 cm a month), growing phase 2 to 7 years, stopping phase 2 to 3 weeks, resting phase about 3 months; eyebrow growing phase a few months. Fingernails 3.47 and toenails 1.62 mm a month (Yaemsiri, Hou, Slade and Glueck 2010). Medullary index: human usually under 1/3, most animals over 1/2 (FBI forensic hair guides). Eccrine glands per cm^2 (Taylor and Machado-Moreira 2013, averages): palm 518, sole 497, head 186, forearm 104, back 103, thigh 69. Sebaceous glands are densest on the face and scalp and absent from the palms and soles.
- **Simplified on purpose:** drawings not to scale; one growing-phase length per hair type; the nail line starts at the cuticle; hair widths are typical values; which glands switch on, and how many of a site's pores print under each condition, are model values that keep the real pattern (palms and soles answer stress; the back answers heat). The page says so.

Standards text quoted from the New York State P-12 Science Learning Standards, High School Life Science (NYSED). The answer key is a separate file, kept off the public site.