

## Pathology Class 5:

### Signals, Surfaces, and Silent Risks (Ages 14-18yo)

1. Which nutrient deficiency is most strongly associated with bleeding gums and poor wound healing?  
**A. Vitamin C**  
B. Vitamin D  
C. Vitamin B12  
D. Zinc
2. The RDA (Recommended Dietary Allowance) is primarily designed to:  
A. Optimize long term health for each individual  
**B. Prevent classic deficiency diseases in most people**  
C. Maximize sports performance  
D. Match genetic needs
3. Which pattern is most associated with niacin (vitamin B3) deficiency?  
A. Night blindness and dry eyes  
B. Bone deformities  
**C. Dermatitis, diarrhea, and dementia**  
D. Easy bleeding
4. Which feature makes a mole more concerning as a warning sign?  
A. It is small and light colored  
B. It appeared in childhood  
C. It is perfectly round  
**D. It changes over time in size, shape, or color**
5. Warts are caused by:  
**A. A virus**  
B. A mineral deficiency  
C. Sun damage  
D. An autoimmune reaction only
6. Athlete's foot is best described as:  
A. A nerve condition  
**B. A fungal skin infection**  
C. A vitamin deficiency  
D. A pressure injury
7. Why can modern diets still produce nutrient deficiencies even with enough calories?  
A. Calories automatically block vitamin absorption  
B. Cooking always destroys all nutrients  
**C. Food is often less nutrient dense and highly processed**  
D. The body stops absorbing minerals after age 30

8. High blood pressure is called a silent condition because it:
- A. Only happens at night
  - B. Makes no sound in arteries
  - C. Only affects older adults
  - D. Can cause damage without obvious symptoms**
9. Which hygiene habit most helps reduce infection spread from hands?
- A. Regular handwashing and short clean nails**
  - B. Using lotion
  - C. Using antibacterial hand gel
  - D. Rinsing with water only
10. The lesson emphasizes that repeated small risks and exposures:
- A. Rarely matter
  - B. Only affect skin
  - C. Always cause immediate symptoms
  - D. Can accumulate into long term damage**

**Home Activity – Answer Key****Activity 1 – Mechanism Map: From Surface Clue to System Failure**

Choose ONE:

- Spoon-shaped nails
- Bowed legs (rickets)
- Bleeding gums (scurvy)
- Muscle cramps
- Changing mole

Create a **6-step causal chain**:

- Nutrient / trigger
- Molecular disruption
  - Cellular dysfunction
  - Tissue-level change
  - Surface signal
  - Long-term systemic risk

This must be mechanistic, not descriptive.

1. Spoon-Shaped Nails (Iron Deficiency)

Low iron intake or poor absorption

- Reduced hemoglobin production
- Decreased oxygen delivery to tissues
- Altered keratin formation in nail matrix
- Spoon-shaped nails (koilonychia)
- Long-term risk: anemia, fatigue, reduced cognitive performance, decreased exercise tolerance

Key concept: Iron deficiency affects rapidly dividing tissues and oxygen-dependent processes.

2. Bowed Legs (Vitamin D Deficiency / Rickets)

Low vitamin D

- Impaired calcium absorption from gut
- Poor bone mineralization
- Soft, weak long bones
- Bowing of weight-bearing bones
- Long-term risk: fractures, skeletal deformity, chronic musculoskeletal pain

Key concept: Vitamin D is required for calcium regulation and bone strength.

3. Bleeding Gums (Vitamin C Deficiency / Scurvy)

Low vitamin C

- Impaired collagen synthesis
- Weak connective tissue and capillary fragility
- Gum tissue breakdown
- Bleeding gums
- Long-term risk: poor wound healing, vascular weakness, systemic connective tissue compromise

Key concept: Vitamin C is required for collagen cross-linking and vessel integrity.

## 4. Muscle Cramps (Electrolyte Imbalance)

Low magnesium / potassium / sodium imbalance

- Disrupted ion gradients across muscle cell membranes
- Abnormal action potentials (nervous system firing)
- Sustained involuntary muscle contraction
- Painful cramping
- Long-term risk: arrhythmias, neuromuscular instability if severe

Key concept: Muscle contraction and relaxation depend on tightly regulated electrolyte balance.

## 5. Changing Mole (Abnormal Cell Growth)

DNA mutation (often UV-related)

- Loss of cell cycle regulation
- Uncontrolled melanocyte proliferation
- Asymmetry, irregular borders, color change
- Visible evolving mole
- Long-term risk: melanoma, metastasis

Key concept: Loss of growth regulation leads to neoplastic transformation.

What you are Looking for in your student answers:

- Clear causal progression
- Movement from molecular → cellular → tissue → visible sign
- Inclusion of long-term consequence
- Mechanism, not just restating the symptom

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**Activity 2 – “Silent Risk” Modeling Project**

Choose one silent condition (from the three options below):

- High blood pressure
- Chronic low vitamin D
- Early gum inflammation

Create a **10-year progression model**:

Year 0–2: Subtle signs

Year 3–5: Tissue adaptation

Year 6–10: Structural damage

Explain:

Why does the body tolerate dysfunction for so long?

**Option 1 – High Blood Pressure**

Year 0–2: Subtle Phase

- Slightly elevated blood pressure
- No symptoms
- Mild endothelial (cells that line the arteries) stress

## Year 3–5: Adaptation Phase

- Arterial walls thicken (vascular remodeling)
- Reduced vessel elasticity
- Left ventricle of heart begins to work harder

## Year 6–10: Structural Damage Phase

- Chronic endothelial damage
- Increased atherosclerosis (hardening/narrowing of the arteries) risk
- Left ventricular hypertrophy (the heart muscle gets bigger)
- Possible kidney damage

## Why does the body tolerate this?

The cardiovascular system compensates by strengthening heart muscle and thickening vessels. These adaptations maintain function for years before symptoms appear.

Key concept: Compensation masks pathology.

## Option 2 – Chronic Low Vitamin D

## Year 0–2: Subtle Phase

- Mild fatigue
- Slight decrease in calcium absorption
- Minor immune changes

## Year 3–5: Adaptation Phase

- Increased parathyroid hormone (PTH)
- Bone mineral resorption begins
- Subtle bone density loss

## Year 6–10: Structural Damage Phase

- Increased fracture risk
- Chronic musculoskeletal pain
- Potential immune dysregulation

## Why does the body tolerate this?

Hormonal compensation (PTH increase) maintains blood calcium levels, but at the expense of bone integrity.

Key concept: Blood levels may appear normal while tissue depletion progresses.

## Option 3 – Early Gum Inflammation (Chronic Gingivitis)

*Year 0–2: Subtle Phase*

- Occasional bleeding with brushing
- Mild localized inflammation

*Year 3–5: Adaptation Phase*

- Chronic inflammatory signaling
- Bacterial biofilm deepens
- Early connective tissue breakdown

*Year 6–10: Structural Damage Phase*

- Periodontal ligament damage
- Bone loss
- Increased systemic inflammatory burden

Why does the body tolerate this?

Inflammation is localized and initially mild. Because pain is minimal, behavioral change often does not occur.

Key concept: Low-grade chronic inflammation can persist without triggering acute alarm signals.

#### What Students Should Demonstrate

- Clear time progression
- Recognition of compensation mechanisms
- Distinction between symptom absence and disease absence
- Understanding that early pathology is often silent
- Awareness that adaptation ≠ health

#### Core Principle Reinforced

The body prioritizes short-term stability and survival. It will compensate for dysfunction for years before overt failure occurs. **Silent risk conditions are dangerous precisely because compensation hides them.**

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### Activity 3 – Viral Persistence Case Study (HPV / Warts)

#### Case Study Box

Barrier Failure → Viral Entry → Immune Clearance

As a child, one student frequently had “skinned knees” from playing outside. Instead of stopping to fully clean the scrapes, the blood was wiped off and play continued. Years later (around ages 13–17), a cluster of plantar-type warts developed on one knee where the skin had repeatedly healed from abrasions. The warts were frozen off several times, but each time they returned and the patch became larger. Then, within about six months of starting college, the warts suddenly disappeared on their own and never returned.

#### *What likely happened?*

Warts are caused by a virus (HPV) that can enter through small breaks in the skin. Repeated abrasions may have allowed the virus to enter before the skin fully healed. The freezing treatments removed surface tissue, but if virus-infected cells remained deeper in the skin, the wart could regrow. Years later, the immune system likely mounted a stronger, more targeted response and cleared the infected cells. Once the immune system recognizes the virus effectively, warts can disappear without further treatment.

#### *Discussion Questions:*

1. **What failure mode allowed the virus to enter?**

Barrier failure. The repeated abrasions (skinned knees) created small breaks in the skin, which allowed the virus to enter before the tissue fully healed.

2. **Why might freezing remove the wart but not the virus completely?**  
Freezing destroys the visible surface tissue, but if virus-infected cells remain in deeper layers of the skin, the virus can continue multiplying and the wart can grow back.
3. **Why can the immune system sometimes clear warts years later?**  
Over time, the immune system may better recognize the virus and activate a stronger targeted response. Once immune cells identify and attack the infected skin cells effectively, the wart can disappear.
4. **What does this case teach us about hygiene and barrier protection?**  
It shows that cleaning and protecting skin injuries helps prevent viruses from entering. Intact skin is an important barrier, and proper wound care reduces infection risk.
5. **Why does HPV infect epithelial tissue specifically?**  
HPV targets epithelial cells because it enters through micro-abrasions and replicates in the basal layer of the skin, using the normal process of skin cell maturation to reproduce and spread.
6. **What allows viruses to evade immune detection?**  
Viruses like HPV can limit antigen presentation, remain in superficial tissues with low inflammation, and replicate without causing immediate cell death, which delays strong immune activation.
7. **Why might tissue destruction (freezing) sometimes worsen spread?**  
If freezing does not eliminate all infected cells, tissue damage can create additional inflammation and micro-injuries, potentially exposing nearby cells to viral particles and allowing regrowth.
8. **What likely changed immunologically when the warts resolved?**  
The adaptive immune system likely developed a stronger, targeted T-cell response against HPV-infected cells, allowing effective recognition and clearance of the virus.

*Key Principle:*

The body gives signals, but it also has the capacity to correct problems when the immune system becomes strong enough to respond effectively.