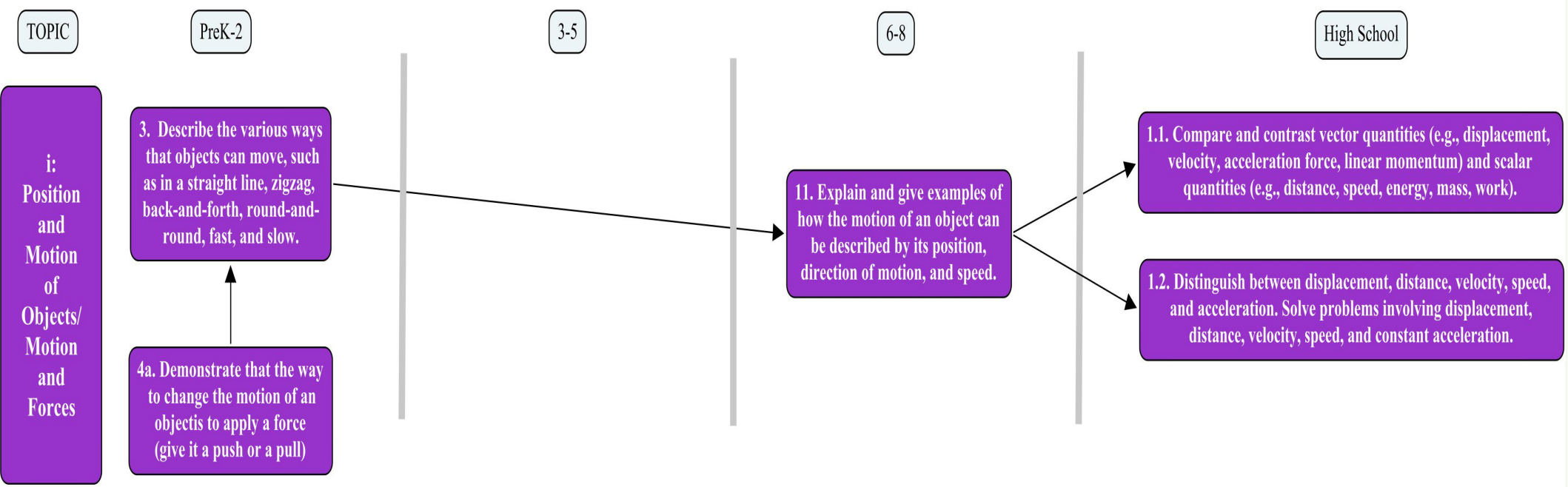
How do strand maps differ from concept maps?

- Quantity of conceptual content
- Meaning of linking arrows
- Linkage to additional digital resources

Portion of Physical Science Strand Map: Force and Motion Progression

Figure 1. Portion of the Physical Science strand map showing several *force and motion* standards (*From Strand Maps of the 2001/2006 Science and Technology/Engineering Standards* http://www.doe.mass.edu/omste/maps/)



Standard = numbered phrase in the MA STE Framework

(color coded to the topic it is currently associated with)

5. Describe the hierarchical organization of multicellular organisms from cells to tissues to organs to systems to organisms.

A standards specifies what students should know and be able to do:

- Demonstrated knowledge *and* skills
- Assessable and/or measurable

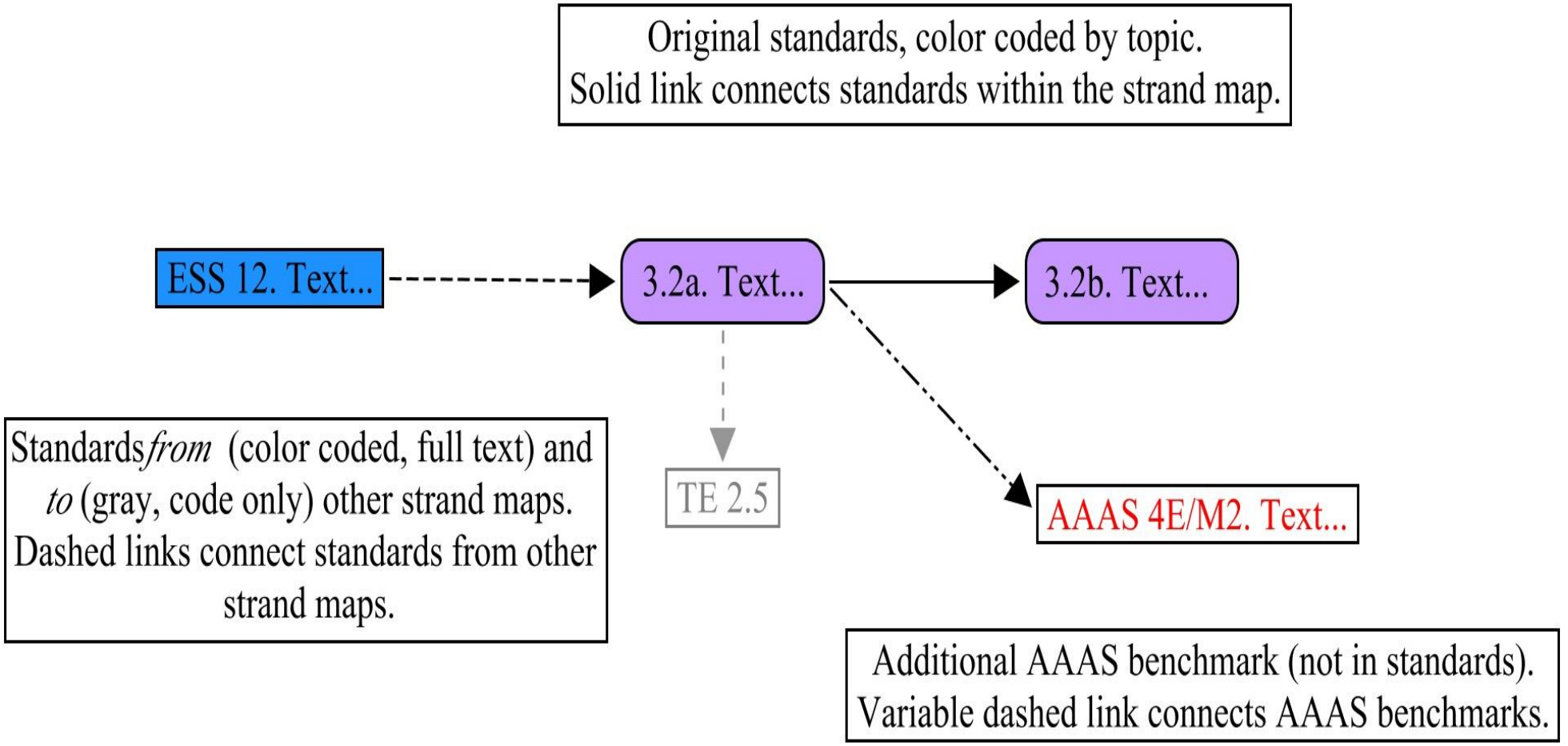
Concept = a conceptual unit of understanding (may be a whole or partial standard)

Some standards were split if they included multiple concepts or skills that stand on their own (but not always).

9a. Recognize plant behaviors, such as the way seedlings' stems grow toward light and their roots grow downward in response to gravity. **(!?)**

9b. Recognize that many plants and animals can survive harsh environments because of seasonal behaviors, e.g., in winter, some trees shed leaves, some animals hibernate, and other animals migrate. **(!?)**

Key to Strand Map



Notation at the end of a standard indicate particular comments found on the corresponding notes pages. Ex: **(?!) (2)**

Assumptions Underlying the Strand Maps

Some assumptions were made in the creation of the maps that will assist in interpreting the meaning of the maps.

Assumption 1

Links show how standards contribute to one another

- Linking arrows = connections that are *necessary* for learning, NOT *possible* connections between concepts (In AAAS Atlas language: “one contributes to achieving the other”).
- An arrow *leaving* a standard implies that the concept contributes to learning the concept of the next/connected standard.
- These links are primarily based upon:
  - Wisdom of practice, professional judgment
  - Logic of the subject matter
  - Cognitive research specific to a particular idea
  - General principles of cognitive development: for ex: concrete before abstract; simple before complex

Assumption 2

The strand maps represent the current STE Framework

- Standards are always kept within the grade span and strand in which they currently are found in the Framework.

- The topic the standard is associated with may shift within the strand.

- Coloring designates the original topic (where the standard currently resides in the Framework).

Assumption 3

Simple is better

- Tried to have as few arrows as was necessary.

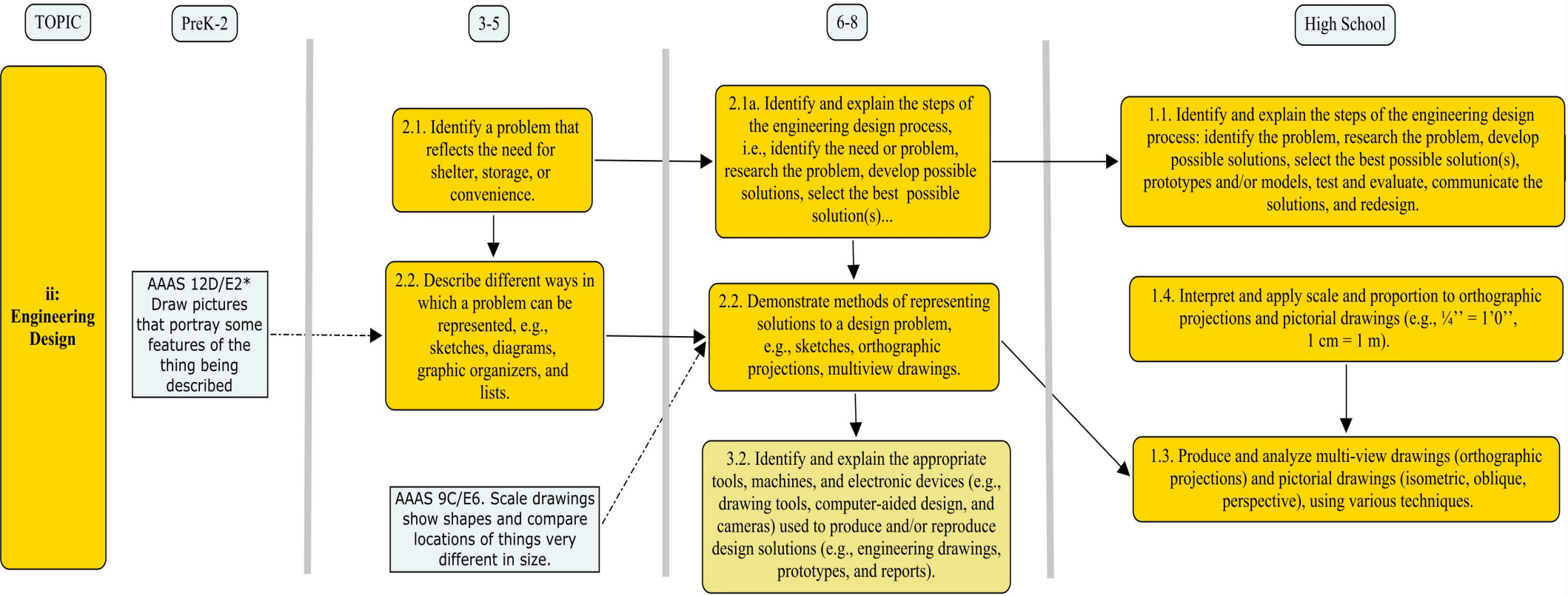
- The placement of standards (or concepts) is first by affiliation to a topic, and then placed to reduce any "spaghetti" effects.

What patterns emerged from the Strand Maps?

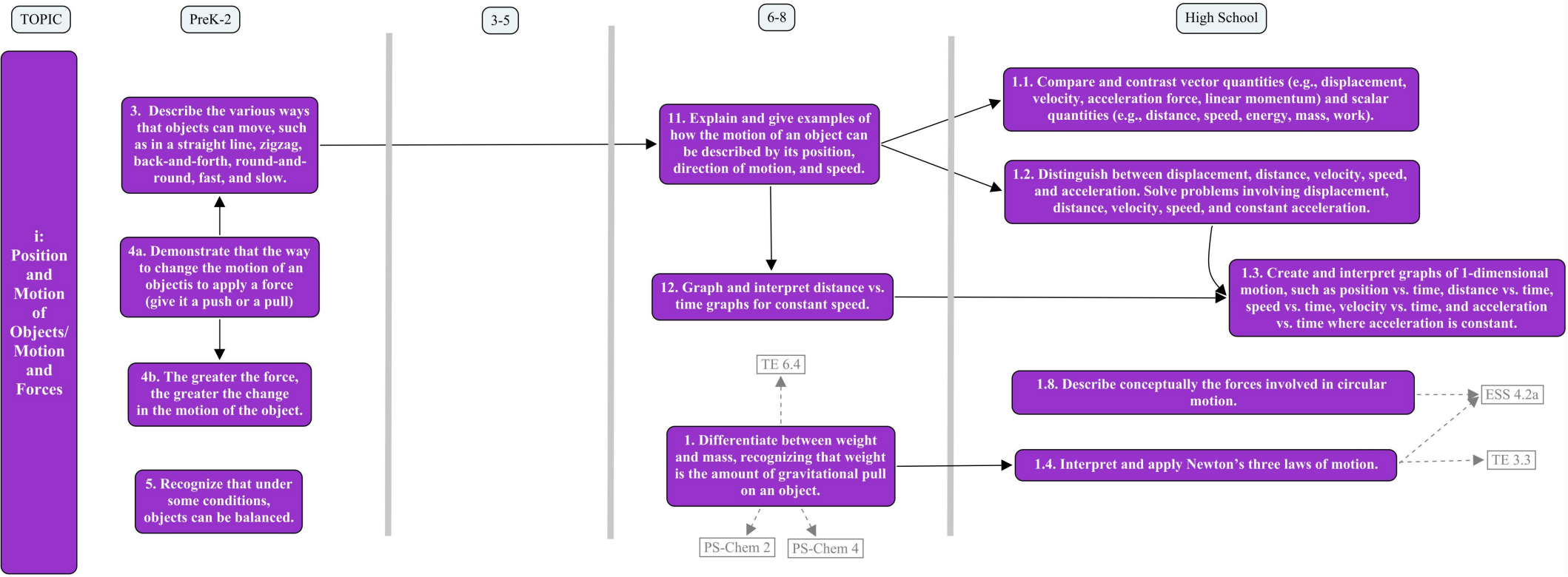
- Patterns that would prove useful to the science curriculum review process: identification of unsupported standards

- Patterns that demonstrated aspects of Ausubelian Learning Theory

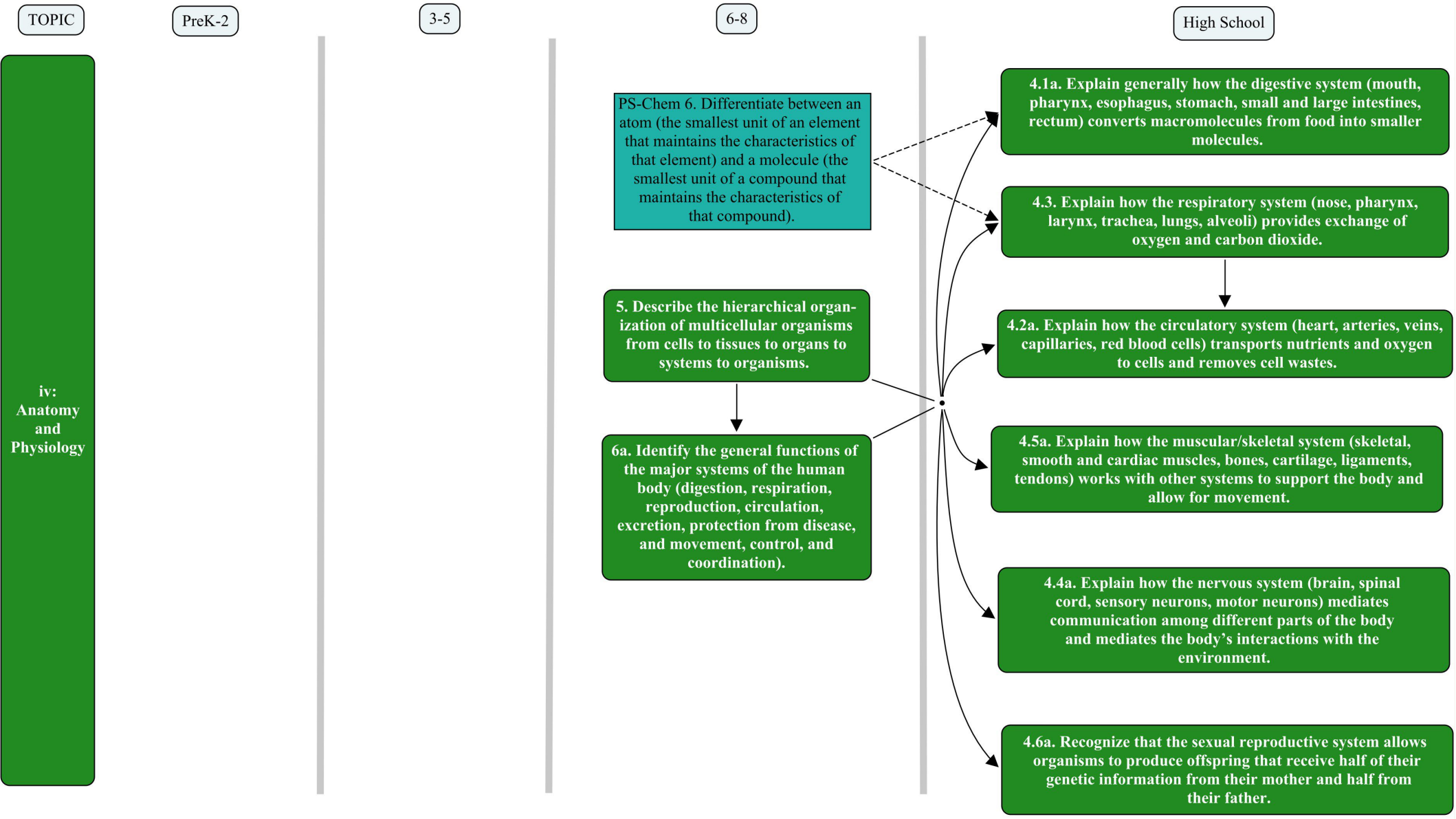
Missing Foundational Standards



Opportunity-to-Learn Gaps & Isolated Concepts



Diverging Standards



Converging & Crosslinking Standards