Summary of Key Changes to Kansas Science Standards adopted by the Kansas State Board of Education on November 8, 2005

(changes are shown in ***bold italics***)

1. Adds to the mission statement the idea that science education should aid not only reasoned decision making, but decision making that is both "***informed and*** reasoned."[1] Consistent with this concept, the remainder of the changes seek to more adequately inform students about the state of scientific knowledge, particularly in the controversial area that concerns origins.

2. Defines "Science" as: "***a systematic method of continuing investigation that uses observations, hypothesis testing, measurement, experimentation, logical argument and theory building, to lead to more adequate explanations of natural phenomena."*** This definition, together with the balance of its context, does not allow for supernatural or natural preconceptions to drive explanation since the definition requires rigorous empirical testing of explanations.[2] Revisions to the description of "scientific knowledge" in high school Standard 7 also reject the preconception that scientific knowledge is limited to explanations of the "physical world in terms of matter, energy and the forces." Instead the revision simply states more broadly that scientific knowledge explains the "natural world," and is most effective when it is open ended and not driven by preconceptions.[3] (Introduction – Nature of Science and Indicator 1, Benchmark 2, Standard 7)

3. Expressly ***excludes*** intelligent design from the standards while making it clear that the exclusion is not intended to prohibit discussion of that scientific disagreement with a core claim of evolution.[4]

4. Adds a qualifier to a discussion that implies that *accumulated changes* do in fact account for all natural phenomena: "*..**the actual causes of many changes are currently unknown (e.g. the origin of the universe, the origin of fundamental laws, the origin of life and the genetic code, and the origin of major body plans during the Cambrian explosion).**"* (See *Introduction – Patterns of Cumulative Change)*

5. Informs students that biological evolution is a theory that "***postulates"*** or **"seeks to explain,"** rather than a theory that does in fact explain certain phenomena. [See Introduction – *Patterns of Cumulative Change:* Teachers Notes to Benchmark 5, Standard 3, Grade 5-7; and AS 1.a, BM 3, St. 3, G 8-12)]

6. Makes clear that students should be informed of ***any*** bias or preconception that may affect a scientific conclusion, not just personal biases or preconceptions. (AS 4.c., BM 1, St 1, G 8-12).

7. Adds an indicator that will inform students about "***methods for testing hypotheses about the cause of a remote past event (historical hypothesis) that cannot be confirmed by experiment and/or direct observation***." (Ind. 6, BM 1, St 1, G 8-12)[5]

8. Adds an indicator that will inform students that "***the sequence of the nucleotide bases within genes is not dictated by any known chemical or physical law***." (AS. 1(c), BM 2, St 3, G 8-12)

9. Increases student understanding about biological evolution by informing them of the following:

   a. The theory "***postulates an unguided natural process that has no discernable direction or goal.***" (AS 1.a., BM 3, St 3, G 8-12)

   b. "***The view that living things in all the major kingdoms are modified descendants of a common ancestor (described in the pattern of a branching tree) has been challenged in recent years by (i) discrepancies in the molecular evidence, (ii) a fossil record that is not consistent with gradual increases in complexity, and (iii) studies that show that animals follow different rather than identical early stages of embryological development.*** (AS 1.f. BM 3, St 3, G 8-12)

   c. "***New heritable traits may result from new combinations of genes and from random mutations or changes in the reproductive cells. Except in very rare cases, mutations that may be inherited are neutral, deleterious or fatal.***" (AS 2.a., BM 3, St 3, G 8-12)

   d. "***Whether microevolution (change within a species) can be extrapolated to explain macroevolutionary changes (such as new complex organs or body plans and new biochemical systems which appear irreducibly complex) is controversial.***"[6]

e Both evolutionary theory and other concepts such as "***reverse engineering and end-directed thinking are used to understand the function of bio-systems and bio-information***."[7]

10. Given the fact that textbooks uniformly cover the origin of life, an indicator has been added to inform students of both the "***scientific explanations of the origin of life as well as scientific criticisms of those explanations***."[8]

11. With respect to historical perspectives, students are to be informed that:

a. "***Science has led to significant improvements in physical health and economic growth; however, modern science can sometimes be abused by scientists and policymakers, leading to significant negative consequences for society and violations of human dignity (e.g., the eugenics movement in America and Germany; the Tuskegee syphilis experiments; and scientific justifications of eugenics and racism).***" (AS 1.a., BM 3, St 7, G 8-12)

b. Science "***progresses by critical analysis of: 1) properly collected data; and 2) existing theories and hypotheses, which can lead to major new scientific advances (e.g., relativity, plate tectonics, quantum theory, biological evolution)***." (AS 1.b., BM 3, St 7, G 8-12)

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[1] **"Mission Statement.** Kansas science education contributes to the preparation of **all** students as lifelong learners who can use science to make *informed and* reasoned decisions that contribute to their local, state, national and international communities." (Introduction)

[2] A part of the text that accompanies the definition states: "Scientific explanations must meet certain criteria. Scientific explanations are consistent with experimental and/or observational data and testable by scientists through additional experimentation and/or observation. Scientific explanation must meet criteria that govern the repeatability of observations and experiments. The effect of these criteria is to insure that scientific explanations about the world are open to criticism and that they will be modified or abandoned in favor of new explanations if empirical evidence so warrants."

[3] "***understands scientific knowledge describes and explains the natural world." (Rather than "the physical world in terms of matter, energy and the forces.") and "Science that is truly open-ended, and that allows evidence rather than preconceptions to guide explanation is the strongest and allows for constant refining and improvement of its explanations.***" (I. 1, BM 2, St 7, 8-12).

[4] "***We also emphasize that the Science Curriculum Standards do not include Intelligent Design, the scientific disagreement with the claim of many evolutionary biologists that the apparent design of living systems is an illusion. While the testimony presented at the science hearings included many advocates of Intelligent Design, these standards neither mandate nor prohibit teaching about this scientific disagreement***." (Introduction)

[5] "***6. understands methods used to test hypotheses about the cause of a remote past event (historical hypothesis) that cannot be confirmed by experiment and/or direct observation by formulating competing hypotheses and then collecting the kinds of data (evidence) that would support one and refute the other." Additional specificity: "a. Formulates multiple hypotheses about a singular historical event and develops a "best current explanation" of what caused the event, such as the cause of a fire or death. b. Predicts the kinds of circumstantial evidence that one would observe under each hypothesis. c. Collects evidence and draws an inference as to the best explanation and whether the evidence fits either hypothesis. Explains why either explanation can not be entirely validated by a laboratory experiment."***

[6] "***d. Whether microevolution (change within a species) can be extrapolated to explain macroevolutionary changes (such as new complex organs or body plans and new biochemical systems which appear irreducibly complex) is controversial. These kinds of macroevolutionary explanations generally are not based on direct observations and often reflect historical narratives based on inferences from indirect or circumstantial evidence."*** (AS 3.d. BM 3, St 3, G 8-12).

[7] "c. Natural selection, genetic drift, genomes, and the mechanisms of genetic change provide a context in which to ask research questions and help explain observed changes in populations. ***However, reverse engineering and end-directed thinking are used to understand the function of bio-systems and information***." (AS 6.(c), BM3, St. 3, G 8-12)

[8] "7. ***explains proposed scientific explanations of the origin of life as well as scientific criticisms of those explanations." Additional Specificity: "7. Some of the scientific criticisms include: a A lack of empirical evidence for a "primordial soup" or a chemically hospitable pre-biotic atmosphere; b. The lack of adequate natural explanations for the genetic code, the sequences of genetic information necessary to specify life, the biochemical machinery needed to translate genetic information into functional biosystems, and the formation of proto-cells; and c. The sudden rather than gradual emergence of organisms near the time that the Earth first became habitable.***" (Ind. 7, BM 3, St 3, G 8-12)