Writing Multiple Choice Questions That Assess Learning Objectives at Higher Cognitive Levels
Faculty Development in Medical Education Certificate Workshop
Christine M. Peterson, MD
14 June 2012

MOST IMPORTANT RESOURCE:
http://www.nbme.org/publications/item-writing-manual.html

Helpful hints

Modified from:
Mike Dickinson, "Writing Multiple Choice Questions for Higher-Level Thinking"
http://www.learningsolutionsmag.com/articles/804/writing-multiple-choice-questions-for-higher-level-thinking
and
Teaching Effectiveness Program, Teaching and Learning Center, University of Oregon.
"Techniques for Writing Multiple-Choice Items that Demand Critical Thinking"
http://tep.uoregon.edu/resources/assessment/multiplechoicequestions/sometechniques.html
and
Lucy C. Jacobs, Ph.D. "How to Write Better Tests: A Handbook for Improving Test Construction Skills" http://www.indiana.edu/~best/write_better_tests.shtml#II-1

I. Thinking about Bloom's Taxonomy

Bloom's higher two levels (sometimes called "divergent thinking") do not require a single pre-determined correct answer and therefore cannot be *directly* assessed by MCQs. However, students can be asked to choose the "best" ("most appropriate", "most comprehensive", "most feasible", etc.) among several options that reflect evaluation or synthesis of information.

Taxonomy Level	Representative Verbs
6. Evaluation	Critique
	Summarize
5. Synthesis	Organize
	Design

MCQs can be developed for Bloom's lower four levels (sometimes called "convergent thinking") because they require a unique correct (predictable or calculable) answer:

4. Analysis	Compare
	Categorize
3. Application	Organize
	Solve
2. Comprehension	Distinguish
	Match
1. Knowledge	Identify
	Label

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II. Techniques for transforming "recall" questions into "comprehension" or "application" questions

1. Many recall questions are intended to test a "rule" (e.g., "The mechanisms of action of combined oral contraceptives are w, x, y, z,...") They ask the learner to identify one characteristic of that rule or concept (e.g., "Is x a mechanism of action of oral contraceptives?")
To transform the question to a higher level, give the learner a statement that includes the characteristic and ask the learner to distinguish whether it is consistent with the rule, concept, or principle.
Example:
"Recall" question:

Which of the following is a contraceptive mechanism of action for oral contraceptives?
a. suppression of pituitary gonadotropin release
b. direct toxicity for sperm
c. increase in hepatic synthesis of coagulation factors
d. decrease in sex hormone binding globulin

"Comprehension" question:

A patient is using a contraceptive method that works by suppression of pituitary gonadotropins. Which physiologic phenomenon is a direct result of this mechanism of action?
a. Interference with implantation
b. Immobilization of sperm
c. Failure of stimulated endometrium to shed
d. Positive feedback on estrogen production
e. Inhibition of ovulation

"Analysis" question:

A patient presents with these symptoms (w, x, y, z...). Which of the following diseases is the most likely diagnosis?

2. **Use plausible distracters and examples that are new to the learner.**
When possible, include anticipated wrong answers.
Example: "A patient presents with symptoms w, x, y, z,... Which of the following is the correct diagnosis?"

a. Disease A
b. Disease A-1 (which differs from Disease A in one significant variable)
c. Disease B
d. Disease B-1 (ditto)

3. **Ask the learner to interpret charts, graphs, or images.**
Note: when using a graph or image, try to lay it out differently than how the students have seen it. This is equivalent to using new language to present a familiar concept and prevents students from using rote memorization to answer the question. For example, the diagram may originally have been split left to right instead of top to bottom, and this diagram may not be as detailed as the diagram they saw in the book.

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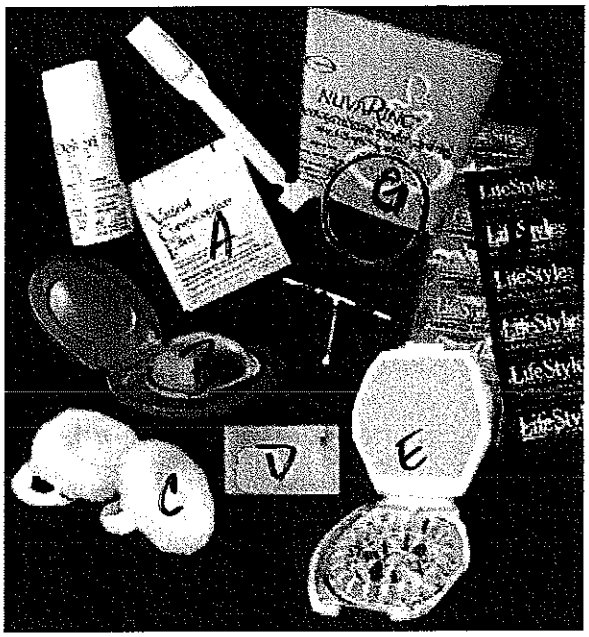
Example:
Which of the contraceptive devices illustrated below requires insertion into the uterine cavity by a clinician?



a.
b.
c.
d.
e.
f.
g.
h.

4. Ask the learner to work with linked concepts.

For example, a list of stages of development (or change or disease) is linked to a list of characteristic behaviors (or findings) of each stage. Present an example of one of the behaviors/findings to the learner and ask the learner to identify the stage associated with that behavior/finding.

Another example: Present a side effect of medication that a particular patient wishes to avoid and ask the learner which on a list of appropriatemedicatins the physician should recommend to that patient.

To increase the difficulty, ask the learner to work with more than one premise.

For example, ask the learner to select the most appropriate antibiotic for a patient with a cluster of symptoms that suggest a particular disease given that the patient is allergic to a specific class of antibiotics.

5. "Bury the verb".

Change a Bloom's higher-order verb to a noun and ask the learner to choose the best option. For example, ask the learner to "describe", "infer", or "evaluate" by asking him/her to

Select the best *description*
Identify the most accurate *interpretation or explanation*
Choose the correct *evaluation statement*

Example, "Which of the following best explains the onset of uterine bleeding during the 4th week of a pack of combined oral contraceptives?"

a. Increase in serum estrogen level
b. Decrease in GnRH stimulation of pituitary
c. Decrease in serum progestin level
d. Increase in serum FSH level
e. Increase in LH stimulation of ovary

6. Incomplete scenario
Ask the learner to respond to what is missing or needs to be changed within a provided scenario.
Example: Which of the following symptoms/lab results/imaging results would make Diagnosis A most likely?
a……

7. Problem/Solution Evaluation
Learners are presented a problem and a proposed solution. **Ask the learner to evaluate the proposed solution based upon criteria provided.**
Example: A patient wishes to avoid contraceptive methods that could possibly have a post-fertilization contraceptive effect. Which of the following pairings of methods and mechanisms is the most accurate explanation of why that method meets the patient's criterion?

a. Combined oral contraceptives provide negative feedback to the pituitary
b. Progestin-only contraceptives thicken cervical mucus
c. Intrauterine devices alter the intrauterine environment
d. Barrier methods prevent the sperm's access to the egg

From Jacobs (see above):
Table 3. Multiple-Choice Items That Measure at Various Levels.

1. Knowledge
   Which of the following are the raw materials for photosynthesis?
   a. Water, heat, sunlight
   b. Carbon dioxide, sunlight, oxygen
   c. Water, carbon dioxide, sunlight
   d. Sunlight, oxygen, carbohydrates
   e. Water, carbon dioxide, carbohydrates
2. Comprehension
   If living cells similar to those found on earth were found on another planet where there was no molecular oxygen, which cell part would most likely be absent?
   a. Cell membrane
   b. Nucleus
   c. Mitochondria
   d. Ribosome
   e. Chromosomes
3. Application
   Phenylketonuria (PKU) is an autosomal recessive condition. About one in every fifty individuals is heterozygous for the gene but shows no symptoms of the disorder. If you select a symptom-free male and a symptom-free female at random, what is the probability that they could have a child afflicted with PKU?
   a. (.02)(.02)(.25) = 0.0001 = 0.01%, or about 1/10,000
   b. (.02)(.02) = 0.0004 = 0.04%, or about 1 /2,500
   c. (1)(50)(2) = 100% = all
   d. (1)(50)(0) = 0 = none
   e. 1/50 = 2%, or 2/100

4. Analysis
   Mitochondria are called the powerhouses of the cell because they make energy available for cellular metabolism. Which of the following observations is *most* cogent in supporting this concept of mitochondrial function?
   a. ATP occurs in the mitochondria.
   b. Mitochondria have a double membrane.
   c. The enzymes of the Krebs cycle, and molecules required for terminal respiration, are found in mitochondria.
   d. Mitochondria are found in almost all kinds of plant and animal cells.
   e. Mitochondria abound in muscle tissue.
5. Evaluation
   Disregarding the relative feasibility of the following procedures, which of these lines of research is likely to provide us with the most valid and direct evidence as to evolutionary relations among different species?
   a. Analysis of the chemistry of stored food in female gametes.
   b. Analysis of the enzymes of the Krebs cycle.
   c. Observations of the form and arrangement of the endoplasmic reticulum.
   d. Comparison of details of the molecular structure of DNA.
   e. Determination of the total percent protein in the cells.

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