



Tomorrow's Doctors, Tomorrow's Cures®

MR5

Ratings of the Importance of Topics in the Natural Sciences, Research Methods, Statistics, and Behavioral Sciences to Success in Medical School

Prepared for the MR5 Advisory Committee

Summer 2010

DESCRIPTION OF THE MR5 CONTENT SURVEYS

BACKGROUND ON THE MR5 PROJECT

The AAMC is in its second year of a multi-year review of the MCAT exam (or MR5 project). The MR5 committee is tasked with reviewing the MCAT exam and recommending changes that are likely to increase MCAT's value to medical school admissions committees. This review is the fifth time that the MCAT exam has been reviewed since it was first administered in 1928. In standardized testing, periodic reviews of examinations are considered a best practice and are particularly important in fields with rapidly-changing knowledge bases.

The AAMC has appointed a 22-member committee to conduct the review (see Appendix A for a complete list of members). Medical school deans; admissions, educational affairs, student affairs, and diversity officers; basic and clinical sciences faculty; pre-health advisors and other baccalaureate faculty; and a resident make up the MR5 committee. In conducting their review, committee members are considering the knowledge, skills and other characteristics that admissions committees look for in their applicants, the full range of information that already is available in student selection (through transcripts, letters of recommendation, interviews, and other sources), and the state of the art and professional standards in admissions testing. Committee members also are considering recent calls for new information about applicants' mastery of natural sciences content; behavioral sciences content; and professional characteristics like integrity, altruism, and dependability.

During the first years of the project and in many different ways, committee members are asking for input on the new exam. They are gathering input at meetings and conference sessions, administering surveys, and organizing other information-gathering activities. So far, the committee has solicited input at over 50 outreach events. In addition to the feedback gathered at these events, the committee has solicited information from the AAMC-HHMI Scientific Foundations for Future Physicians (SFFP) Committee, the AAMC Behavioral and Social Sciences Expert Panel, the Holistic Review Project Advisory Committee, and other committees and groups. Additionally, committee members already have examined data from over 2700 surveys (some of which are the subject of this report).

The MR5 Committee will continue to collect data and deliberate through 2011. The Committee is scheduled to vet its recommendations for the new test in fall 2011. It will submit recommendations to AAMC's leadership for approval in spring 2012. The earliest a new test could be introduced is 2014.

MR5 CONTENT SURVEYS

The MR5 committee recently surveyed medical school faculty, residents, and medical students to learn which concepts in the natural and behavioral sciences, research methods, and statistics concepts entering students need to know in order to succeed in medical school. These content surveys asked respondents to rate the importance of content to student success in the current and likely future medical school curriculum.

This report provides a brief description of the MR5 content surveys, including: survey content and response scales, administration plan, response rates, description of the samples, results, and next steps.

SURVEY CONTENT AND RESPONSE SCALES

The natural sciences surveys included the following disciplines: biology, general and organic chemistry, physics, biochemistry, cell and molecular biology¹. The research methods and behavioral sciences survey included the following disciplines: research methods, statistics, and behavioral sciences.

Each disciplinary survey included a list of topics and subtopics. Survey respondents were instructed to rate the degree to which students' knowledge of these topics, at the time of entrance into medical school, is likely to be important for mastery of their schools' current curriculum. Faculty respondents also made ratings about the importance of these topics to the curriculum likely to be in place in their schools five years from now given current conversations about curriculum reform in their schools and disciplines, and in medical education generally. Importance ratings were made on a 5-point Likert-type scale ranging from not important (1) to extremely important (5).

Please see Appendix B for a list of survey questions and screen shots from the research methodology survey.

ADMINISTRATION PLAN

The natural sciences surveys were administered from October 6, 2009 to December 7, 2009. The RMBS survey was administered from March 8, 2010 to April 21, 2010.

All medical schools in the United States and Canada that use the MCAT exam were invited to participate in both surveys (n = 143). In both data collection efforts, MCAT staff contacted the Dean of each medical school and asked him/her to nominate a point of contact (POC) for data collection. The POCs were asked to nominate survey respondents to make judgments about the importance of entry-level concepts.

Each POC was asked to nominate one basic science faculty, one clinical science faculty, one experienced resident, and one fourth-year medical student to complete each survey. POCs were asked to select nominees who are knowledgeable about the current curriculum and involved in discussion about curriculum reform at the medical school, in their disciplines, and in medical education. MCAT staff contacted each nominee directly via email with an invitation to complete the survey.

RESPONSE RATES

Natural Sciences Surveys

Over 2000 faculty and non-faculty respondents were invited to participate in the natural sciences survey. The overall response rate (i.e., the number of respondents who completed at least one topic rating divided by the total number invited) of 65 percent. This compares favorably to the response rate on the natural sciences survey administered by AAMC in 2000

¹ Genetics topics were included with the content in several disciplines.

which had a response rate of 61 percent. The completion rate (i.e., the number of respondents who completed all the topic ratings divided by the total number invited) was 59 percent, which included 1185 respondents who completed current importance ratings and 622 faculty respondents² who completed the future importance ratings. The school-level response rate (i.e., number of medical schools that had at least one person complete the survey divided by the total number of medical schools invited) ranged from 72 to 80 percent across the different disciplines.

Research Methods and Behavioral Sciences Surveys

Approximately, 400 faculty and non-faculty respondents were invited to participate in the RMBS survey. The response rates followed a similar pattern to the natural sciences surveys. The overall response rate was 74 percent for the research methods and statistics section and 62 percent for the behavioral sciences section of the survey. The completion rate was 65 percent for the research methods and statistics section and 60 percent for the behavioral sciences section of the survey. A range of 111 to 266 respondents completed the current or future importance ratings for the Research Methodology or Behavioral Sciences surveys. The school-level response rate was 71 percent for the research methods and statistics section and 70 percent for the behavioral sciences section of the survey.

Please see Appendix C for supplementary tables of response rates.

RESULTS

Qualifications of the Sample

In order to ensure that the survey results reflected the ratings of an “expert” sample, four questions were included to assess respondents’ expertise. These questions asked respondents to rate their knowledge about their school’s current curriculum, their involvement in discussions about the ways their school is likely to change its curriculum over the next five years, and their confidence in their ratings about their schools’ current and future curriculum (see Appendix B). Only respondents who rated themselves to be at least ‘somewhat knowledgeable’ (≥ 2 on the “knowledge of curriculum” question) about their schools’ curriculum and ‘somewhat confident’ (≥ 2 on the “confidence in ratings” question) in their ratings were included in the analysis. Records for respondents with missing data on either of those two questions were excluded from the analysis sample.

For the natural sciences surveys and RMBS surveys, over 90 percent of faculty and non-faculty respondents rated themselves as somewhat (or more) knowledgeable about the current curriculum and confident in their ratings. Similarly, over 92 percent of faculty respondents rated themselves as somewhat (or more) involved in curriculum discussions and confident in their ratings about the future.

Importance Ratings

The data presented in Tables 1-9 are preliminary results from the medical school surveys. Table 1 compares the mean importance ratings for the natural sciences and RMBS surveys. Tables 2-9 display the mean importance ratings for each natural sciences, research methods and statistics, and behavioral sciences topic for the current and future curriculum, the difference

² Students and residents did not provide ratings about the importance of topics to future curricula.

between future and current ratings, and whether topics overlap with the entering competencies recommended by the AAMC-HHMI Scientific Foundations for Future Physicians (SFFP) committee.

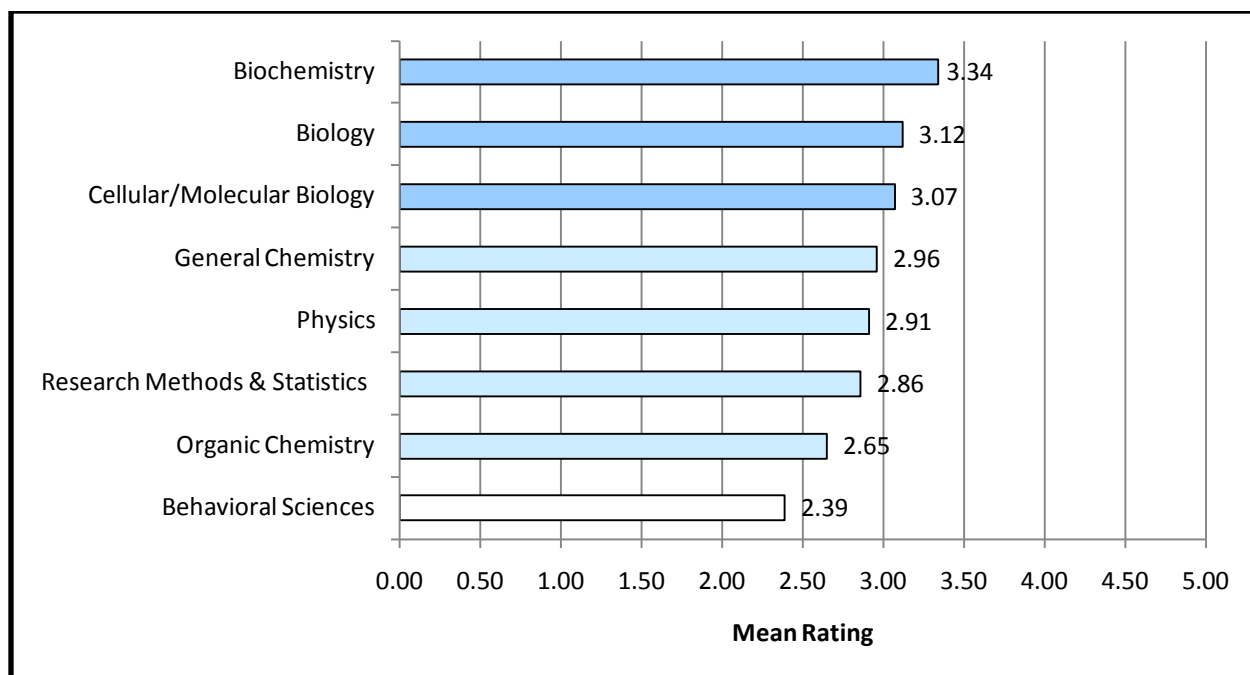
Baccalaureate faculty were surveyed to describe their treatment of the natural sciences topics in introductory and advanced courses from December 2009 to April 2010. Future research will compare results from the medical school and undergraduate surveys. Final results from the medical school and undergraduate surveys will be available in fall 2010.

NEXT STEPS

These data, along with a myriad of other data, including data about medical schools' course prerequisites and applicants' undergraduate course taking will be considered in the MR5 Committee's final recommendations for the future exam.

For more information about these and other MR5 data, please visit the MR5 website at www.aamc.org/mr5.

Table 1. Ratings of the Importance of Natural and Behavioral Sciences Topics for Mastery of Future Medical School Curricula^{1,2}



Notes

1. Medium blue = ratings between 3.00-3.49; Light blue = ratings between 2.50-2.99.
2. Ratings were made on a 5-point Likert-type scale. Importance ratings ranged from 1 = Not Important, 2 = Somewhat Important, 3 = Moderately Important, 4 = Very Important, 5 = Extremely Important, and 9 = Unable to Rate.

Table 2. Mean Importance Ratings for Biology Topics (1 of 2)

Topic	Mean for the Current Curriculum ^{1,2} ,3,4	Mean for the Future Curriculum ^{1,2} ,3,4	Difference between Future & Current ³	Overlap with At Least One SFFP Entry-level Competency ⁵
Molecular Biology and Genetics				
Enzyme Structure and Function	3.41	3.58	0.17	✓
Control of Enzyme Activity	3.27	3.30	0.03	✓
Basic Metabolism	3.48	3.59	0.11	✓
DNA Structure and Function	3.94	4.27	0.33	
DNA Replication	3.31	3.67	0.36	
Repair of DNA	3.13	3.44	0.31	
Recombinant DNA and Biotechnology	3.04	3.75	0.71	
Genetic Code	3.61	3.85	0.24	✓
Transcription	3.39	3.71	0.32	✓
Translation	3.32	3.63	0.31	✓
Control of Gene Expression in Prokaryotes	2.23	2.51	0.28	✓
Eukaryotic Chromosome Organization	2.71	3.00	0.29	
Control of Gene Expression in Eukaryotes	2.99	3.33	0.34	✓
Genetics. - Mendelian Concepts	3.85	3.92	0.07	✓
Genetics. - Meiosis & Other Factors Affect. Gen. Var.	3.65	3.84	0.19	✓
Genetics. - Analytic Methods	2.48	2.75	0.27	
Cellular Biology				
Cell Theory	2.46	2.63	0.17	
Fungi	2.60	2.69	0.09	
Virus Structure	3.25	3.30	0.05	
Viral Life Cycle	3.14	3.27	0.13	
Prokaryotic Cell - Classification and Structure	3.13	3.15	0.02	✓
Prokaryotic Cell - Growth and Physiology	3.00	3.08	0.08	✓
Prokaryotic Cell - Genetics	2.63	2.66	0.03	✓
Eukaryotic Cell - Nucleus	3.46	3.57	0.11	✓
Eukaryotic Cell - Membrane-Bound Organelles	3.66	3.70	0.04	✓
Eukaryotic Cell - Plasma Membrane	3.75	3.78	0.03	✓
Eukaryotic Cell - Cyto-skeleton	2.88	3.05	0.17	✓
Eukaryotic Cell - Mitosis	3.64	3.68	0.04	✓
Specialized Cell - Nerve Cell	3.42	3.37	-0.05	✓
Specialized Cell - Muscle Cell	3.29	3.21	-0.08	✓
Other Specialized Cell Types	3.18	3.34	0.16	✓
Biology of Body Systems				
Endocrine System - Hormones and Their Sources	3.30	3.40	0.10	✓
Endocrine System - Mechanisms of Hormone Action	3.06	3.08	0.02	✓
Nervous System - Structure and Function	3.08	3.07	-0.01	✓
Nervous System - Sensory Reception & Processing	2.68	2.63	-0.05	✓
Immune System	3.10	3.27	0.17	✓
Respiratory System	3.06	2.99	-0.07	✓
Circulatory System	3.28	3.24	-0.04	✓
Digestive/Excretory System	3.08	3.03	-0.05	✓
Reproductive System	3.11	3.10	-0.01	✓
Lymphatic System	2.52	2.59	0.07	✓
Muscle System	2.90	2.88	-0.02	✓

<u>Importance Rating Scale</u>
5 = Extremely Important
4 = Very Important
3 = Important
2 = Somewhat Important
1 = Not Important
9 = Unable to Rate

(continued)

Table 2. Mean Importance Ratings for Biology Topics (2 of 2)

Topic	Mean for the Current Curriculum ^{1,2} ,3,4	Mean for the Future Curriculum ^{1,2} ,3,4	Difference between Future & Current ³	Overlap with At Least One SFFP Entry-level Competency ⁵
Skeletal System	2.82	2.85	0.03	✓
Skin System	2.55	2.55	0.00	✓
Integrative and Systems Biology				
Integrative Analysis of Complex Systems	1.96	2.44	0.48	✓
Ex. - Integration of Systems at Whole Body Level	2.67	2.79	0.12	✓
Developmental, Organismal, and Population Biology				
Dev. Biology - Embryogenesis	2.79	2.94	0.15	✓
Dev. Biology - Mechanisms of Development	2.75	3.05	0.30	✓
Comparative Anatomy	2.01	2.24	0.23	
Energetic Relationships	1.92	2.04	0.12	
Ecosystem Dynamic	1.87	2.28	0.41	
Evolution	2.48	2.73	0.25	✓
Individual Vertebrate Behavior	2.14	2.32	0.18	✓
Behavioral Relationships	1.95	2.14	0.19	✓
Overall Mean Topic Rating	2.97	3.12	0.15	

Notes

1. N ranges from 232-257 for current ratings and 113-130 for future ratings.
2. Standard Deviations range from .85-1.30 for current ratings and .83-1.33 for future ratings.
3. Dark blue = ratings ≥3.50; Medium blue = ratings between 3.00-3.49; Light blue = ratings between 2.50-2.99; Yellow = difference between future and current ratings ≥.25.
4. Ratings were made on a 5-point Likert-type scale. Importance ratings ranged from 1 = Not Important, 2 = Somewhat Important, 3 = Moderately Important, 4 = Very Important, 5 = Extremely Important, and 9 = Unable to Rate.
5. These topics overlap with the entering competencies recommended by the AAMC-HHMI Scientific Foundations for Future Physicians (SFFP) committee.

Table 3. Mean Importance Ratings for General Chemistry Topics

Topic	Mean for the Current Curriculum ¹ , 2,3,4	Mean for the Future Curriculum ¹ , 2,3,4	Difference between Future & Current ³	Overlap with At Least One SFFP Entry-level Competency ⁵
Classification of the Elements and Their Properties				
Atomic and Nuclear Structure	3.17	3.27	0.10	✓
Electronic Structure	2.56	2.64	0.08	✓
Periodic Tbl. - Class. of Elmts. by Elec. Structure	2.84	2.87	0.03	✓
Periodic Tbl. - Variation of Chem. Prop. Group & Row	2.67	2.67	0.00	✓
Molecular Structure				
The Ionic Bond - Electrostatic Forces Between Ions	2.05	2.18	0.13	✓
The Covalent Bond	2.89	2.87	-0.02	✓
Other Types of Bonding	2.36	2.46	0.10	
Molecular Structure and Spectra	2.71	2.91	0.20	✓
States of Matter				
Gas Phase	3.25	3.11	-0.14	
Liquid Phase - Intermolecular Forces	3.42	3.47	0.05	✓
Solid Phase - Crystal Struct.; Charge Bal. & the Unit Cell	1.89	1.90	0.01	
Phase Equilibria	3.06	2.97	-0.09	
Chemical Reactions				
Stoichiometry	3.68	3.82	0.14	✓
Energy Changes in Chem. Reactions - Thermochem.	3.13	3.19	0.06	✓
Rate Processes in Chem. Reactions - Kinetics & Equil.	3.66	3.70	0.04	✓
Solution Chemistry				
Ions in Solution	4.04	4.01	-0.03	✓
Solubility	3.75	3.86	0.11	✓
Acid/Base Equilibria	4.17	4.19	0.02	✓
Phase Titration	2.99	3.01	0.02	
Electrochemistry	2.49	2.47	-0.02	✓
Separations and Purifications	2.46	2.60	0.14	✓
Special Topics in General Chemistry				
Modern Materials	1.88	2.21	0.33	
Chemistry of the Non-metals	1.71	1.65	-0.06	
Overall Mean Topic Rating	2.91	2.96	0.05	

Importance Rating Scale

5 = Extremely Important
 4 = Very Important
 3 = Important
 2 = Somewhat Important
 1 = Not Important
 9 = Unable to Rate

Notes

1. N ranges from 229-239 for current ratings and 112-118 for future ratings.
2. Standard Deviations range from .91-1.12 for current ratings and .90-1.14 for future ratings.
3. Dark blue = ratings ≥ 3.50 ; Medium blue = ratings between 3.00-3.49; Light blue = ratings between 2.50-2.99; Yellow = difference between future and current ratings $\geq .25$.
4. Ratings were made on a 5-point Likert-type scale. Importance ratings ranged from 1 = Not Important, 2 = Somewhat Important, 3 = Moderately Important, 4 = Very Important, 5 = Extremely Important, and 9 = Unable to Rate.
5. These topics overlap with the entering competencies recommended by the AAMC-HHMI Scientific Foundations for Future Physicians (SFFP) committee.

Table 4. Mean Importance Ratings for Organic Chemistry Topics

Topic	Mean for the Current Curriculum ^{1,2} ,3,4	Mean for the Future Curriculum ¹ 2,3,4	Difference between Future & Current ³	Overlap with At Least One SFFP Entry-level Competency ⁵
Molecular Structure				
The Covalent Bond	2.89	2.87	-0.02	✓
Molecular Structure and Spectra	2.71	2.91	0.20	✓
Separations and Purifications	2.46	2.60	0.14	✓
Aliphatic Hydrocarbons and Related Groups				
Alkanes	2.63	2.74	0.11	✓
Alkenes	2.19	2.27	0.08	✓
Alkynes	2.07	2.17	0.10	✓
Alkyl Halides	2.15	2.15	0.00	✓
Dienes	1.92	2.01	0.09	✓
Units of Unsaturation	2.1	2.2	0.10	
Aromatic Hydrocarbons and Related Groups				
Benzene and Aromatic Hydrocarbons	2.33	2.43	0.10	✓
Arenes	2.03	2.19	0.16	✓
Compounds Containing Oxygen				
Alcohols	2.68	2.7	0.02	✓
Phenols	2.3	2.49	0.19	✓
Ethers	2.15	2.27	0.12	✓
Aldehydes and Ketones	2.5	2.58	0.08	✓
Carboxylic Acids	2.67	2.82	0.15	✓
Acid Derivatives (Acid Chlorides, Anhydrides, Amides, Esters)	2.5	2.66	0.16	✓
Dicarboxylic Acids, Anhydrides, Imides	2.31	2.34	0.03	✓
α, β-Unsaturated Carbonyl Compounds	1.99	2.1		✓
1,3- β -dicarbonyl compounds	1.82	2.01	0.19	✓
Compounds Containing Nitrogen				
Amines	2.51	2.68	0.17	✓
Other Nitrogen-Containing Compds. (Nitriles, Nitro, etc.)	2.16	2.25	0.09	✓
Organic Compounds Containing Other Elements				
Sulfur Compounds	2.37	2.58	0.21	✓
Phosphorus Compounds	3.52	3.59	0.07	✓
Organometallic Compounds	1.62	1.67	0.05	✓
Carbohydrates	3.77	3.89	0.12	✓
Polyfunctional Compounds				
Nucleic Acids	4.47	4.5	0.03	✓
Lipids	4.28	4.25	-0.03	✓
Amino Acids and Proteins	4.17	4.27	0.10	✓
Overall Mean Topic Rating	2.60	2.70	0.10	

Importance Rating Scale

5 = Extremely Important
 4 = Very Important
 3 = Important
 2 = Somewhat Important
 1 = Not Important
 9 = Unable to Rate

Notes

1. N ranges from 227-239 for current ratings and 112-118 for future ratings.
2. Standard Deviations range from .69-1.14 for current ratings and .69-1.13 for future ratings.
3. Dark blue = ratings ≥3.50; Medium blue = ratings between 3.00-3.49; Light blue = ratings between 2.50-2.99; Yellow = difference between future and current ratings ≥.25.
4. Ratings were made on a 5-point Likert-type scale. Importance ratings ranged from 1 = Not Important, 2 = Somewhat Important, 3 = Moderately Important, 4 = Very Important, 5 = Extremely Important, and 9 = Unable to Rate.
5. These topics overlap with the entering competencies recommended by the AAMC-HHMI Scientific Foundations for Future Physicians (SFFP) committee.

Table 5. Mean Importance Ratings for Physics Topics

Topic	Mean for the Current Curriculum ^{1,2} ,3,4	Mean for the Future Curriculum ^{1,2} ,3,4	Difference between Future & Current ³	Overlap with At Least One SFFP Entry-level Competency ⁵
Basic Concepts and General Techniques				
Units and Dimensions	4.00	4.02	0.02	✓
Basic Concepts	4.05	4.13	0.08	✓
Graphing Techniques	3.17	3.38	0.21	✓
Error Analysis	3.77	4.09	0.32	✓
Mechanics				
Translational Motion	2.84	3.00	0.16	✓
Force and Motion, Gravitation	2.67	2.88	0.21	✓
Equilibrium	2.60	2.78	0.18	✓
Momentum	2.22	2.37	0.15	✓
Work	2.46	2.60	0.14	✓
Energy	2.74	2.82	0.08	✓
Rotational Motion	1.60	1.78	0.18	✓
Waves				
Periodic Motion	2.45	2.61	0.16	✓
Wave Characteristics	2.65	2.73	0.08	✓
Sound	3.06	3.19	0.13	✓
Molecular Motion, Heat and Work and Statistical Physics				
Thermodynamics	2.93	2.97	0.04	✓
Kinetic Theory and Ideal Gas Law	3.20	3.32	0.12	✓
Statistical Physics	2.96	3.19	0.23	
Transport Processes	4.40	4.33	-0.07	
Bulk Properties of Matter				
Solids	2.87	2.98	0.11	✓
Fluids	3.46	3.47	0.01	✓
Electricity and Magnetism				
Electrostatics	2.62	2.79	0.17	✓
Circuit Elements	3.01	3.07	0.06	✓
Circuits	1.85	1.87	0.02	✓
Electronic Devices	2.15	2.49	0.34	✓
Magnetism	2.05	2.21	0.16	✓
Electromagnetic Induction	1.86	2.00	0.14	✓
Alternating Currents and Reactive Circuits	1.70	1.82	0.12	✓
Electromagnetic Radiation and Geometrical Optics				
Light, Electro-magnetic Radiation	2.62	2.68	0.06	✓
Geometrical Optics	2.61	2.52	-0.09	✓
Topics in Modern Physics				
Quantum Mechanics	2.72	2.96	0.24	✓
Atomic Structure and Spectra	2.38	2.60	0.22	✓
Atomic Nucleus	2.93	3.16	0.23	✓
Feedback and Control				
Feedback and Control	3.14	3.33	0.19	✓
Overall Mean Topic Rating	2.78	2.91	0.13	

<u>Importance Rating Scale</u>
5 = Extremely Important
4 = Very Important
3 = Important
2 = Somewhat Important
1 = Not Important
9 = Unable to Rate

Notes

1. N ranges from 212-217 for current ratings and 89-91 for future ratings.
2. Standard Deviations range from .78-1.15 for current ratings and .81-1.20 for future ratings.
3. Dark blue = ratings ≥ 3.50 ; Medium blue = ratings between 3.00-3.49; Light blue = ratings between 2.50-2.99; Yellow = difference between future and current ratings $\geq .25$.
4. Ratings were made on a 5-point Likert-type scale. Importance ratings ranged from 1 = Not Important, 2 = Somewhat Important, 3 = Moderately Important, 4 = Very Important, 5 = Extremely Important, and 9 = Unable to Rate.
5. These topics overlap with the entering competencies recommended by the AAMC-HHMI Scientific Foundations for Future Physicians (SSFP) committee.

Table 6. Mean Importance Ratings for Biochemistry Topics

Topic	Mean for the Current Curriculum ^{1, 2,3,4}	Mean for the Future Curriculum ^{1, 2,3,4}	Difference between Future & Current ³	Overlap with At Least One SFFP Entry-level Competency ⁵
Structure and Catalysis				
Water	3.70	3.81	0.11	✓
Amino Acids, Peptides, Proteins	3.57	3.71	0.14	✓
The Three-Dimensional Protein Structure	3.05	3.27	0.22	✓
Protein Function	3.18	3.29	0.11	
Enzymes	3.38	3.48	0.10	✓
Carbohydrates and Glycobiology	2.91	3.24	0.33	✓
Nucleotides and Nucleic Acids	3.53	3.78	0.25	✓
DNA-Based Information Technology	3.44	4.12	0.68	✓
Lipids	2.91	3.18	0.27	✓
Biological Membranes and Transport	3.32	3.28	-0.04	✓
Biosignalling	3.45	3.41	-0.04	✓
Bioenergetics and Metabolism				
Principles of Bioenergetics	3.00	3.23	0.23	✓
Glycolysis, Gluconeogenesis & the Pentose-Phosphate Pathway.	3.27	3.37	0.10	
Principles of Metabolic Regulation	2.80	3.15	0.35	✓
Glucose and Glycogen	3.12	3.30	0.18	✓
Citric Acid Cycle	2.85	3.09	0.24	✓
Fatty Acid Catabolism	2.92	3.18	0.26	✓
Amino Acid Oxidation and Urea Production	2.55	2.88	0.33	✓
Oxidative Phosphorylation	3.00	3.15	0.15	✓
Lipid Biosynthesis	2.75	2.99	0.24	✓
Biosynthesis of Amino Acids, Nucleotides	2.44	2.62	0.18	✓
Hormonal Regulation & Integration of Mammalian Metabolism	2.95	3.28	0.33	✓
Genes and Chromosomes	3.31	3.56	0.25	✓
DNA Metabolism	3.51	3.63	0.12	✓
RNA Metabolism	3.28	3.36	0.08	✓
Protein Metabolism	3.31	3.48	0.17	✓
Regulation of Gene Expression	3.09	3.45	0.36	✓
Overall Mean Topic Rating	3.13	3.34	0.21	✓

Importance Rating Scale

5 = Extremely Important
 4 = Very Important
 3 = Important
 2 = Somewhat Important
 1 = Not Important
 9 = Unable to Rate

Notes

1. N ranges from 222-224 for current ratings and 108-109 for future ratings.
2. Standard Deviations range from .93-1.16 for current ratings and .91-1.23 for future ratings.
3. Dark blue = ratings ≥3.50; Medium blue = ratings between 3.00-3.49; Light blue = ratings between 2.50-2.99; Yellow = difference between future and current ratings ≥.25.
4. Ratings were made on a 5-point Likert-type scale. Importance ratings ranged from 1 = Not Important, 2 = Somewhat Important, 3 = Moderately Important, 4 = Very Important, 5 = Extremely Important, and 9 = Unable to Rate.
5. These topics overlap with the entering competencies recommended by the AAMC-HHMI Scientific Foundations for Future Physicians (SFFP) committee.

Table 7. Mean Importance Ratings for Cell and Molecular Biology Topics (1 of 3)

Topic	Mean for the Current Curriculum ^{1,2,3,4}	Mean for the Future Curriculum ^{1,2,3,4}	Difference between Future & Current ³	Overlap with At Least One SFFP Entry-level Competency ⁵
Introduction to the Study of Cell Biology				
Basic Properties of Cells and the Cell Theory	4.10	4.32	0.22	✓
Two Fundamentally Different Classes of Cells	3.43	3.65	0.22	
Viruses	3.37	3.65	0.28	
The Origin of Eukaryotic Cells	2.05	2.11	0.06	
The Chemical Basis of Life				
Attractions Between Atoms and Molecules	3.44	3.71	0.27	✓
The Life Supporting Properties of Water	2.80	2.89	0.09	✓
Acids, Bases, and Buffers	4.23	4.33	0.10	✓
Biological Molecules	4.05	4.34	0.29	✓
Bioenergetics, Enzymes, and Metabolism				
Bioenergetics	2.55	2.84	0.29	✓
Enzymes as Biological Catalysts	3.59	3.80	0.21	✓
Metabolism	3.57	3.79	0.22	✓
The Structure and Function of the Plasma Membrane				
An Overview of Membrane Functions	3.54	3.79	0.25	✓
History of Studies on Plasma Membrane Structure	3.48	3.69	0.21	
The Chemical Composition of Membranes	2.92	3.07	0.15	
The Structure and Functions of Membrane Proteins	3.00	3.32	0.32	
Membrane Lipids and Membrane Fluidity	2.68	3.01	0.33	
The Dynamic Nature of the Plasma Membrane	2.73	2.85	0.12	
The Movement of Substances Across Cell Membranes	3.53	3.50	-0.03	
Membrane Potentials and Nerve Impulses	3.60	3.40	-0.20	
Aerobic Respiration and the Mitochondrion				
Mitochondrial Structure and Function	2.82	3.03	0.21	✓
Oxidative Metabolism and the Formation of ATP	3.36	3.43	0.07	
Peroxisomes	2.33	2.48	0.15	
Interactions Between Cells and Their Environment				
The Extracellular Space	2.45	2.81	0.36	✓
Interactions of Cells with Extracellular Materials	2.36	2.66	0.30	✓
Interactions of Cells with Other Cells	2.56	2.80	0.24	✓
Tight Junctions - Sealing the Extracellular Space	2.47	2.68	0.21	✓
Gap Junctions - Mediating Intercellular Communication	2.48	2.59	0.11	✓
Cytoplasmic Membrane Systems: Structure, Function, and Membrane Trafficking				
An Overview of the Endomembrane System	2.75	3.00	0.25	✓
Approaches to the Study of Endomembranes	1.98	2.41	0.43	
The Endoplasmic Reticulum	3.11	3.26	0.15	
The Golgi Complex	2.76	3.01	0.25	
Types of Vesicle Transport and Their Functions	2.10	2.35	0.25	
Lysosomes	2.69	2.88	0.19	
Endocytic Pathway: Moving Membrane & Materials into the Cell Inter	3.03	3.14	0.11	
Posttranslational Uptake of Proteins by Peroxisomes, and Mitochondria	2.00	2.13	0.13	✓
The Cytoskeleton and Cell Motility				
Overview of the Major Functions of the Cytoskeleton	2.94	3.28	0.34	✓
The Study of the Cytoskeleton	2.10	2.46	0.36	
Microtubules	2.93	3.04	0.11	
Intermediate Filaments	2.14	2.33	0.19	✓
Microfilaments	2.67	2.75	0.08	
The Sliding Filament Model of Muscle Contraction	3.10	2.94	-0.16	
Nonmuscle Motility	2.36	2.36	0.00	
The Nature of the Gene, Genome, and Genetic Expression				
The Concept of a Gene as a Unit of Inheritance	4.32	4.37	0.05	✓
Chromosomes - The Physical Carriers of the Genes	3.97	4.11	0.14	

<u>Importance Rating Scale</u>
5 = Extremely Important
4 = Very Important
3 = Important
2 = Somewhat Important
1 = Not Important
9 = Unable to Rate

(continued)

Table 7. Mean Importance Ratings for Cell and Molecular Biology Topics (2 of 3)

Topic	Mean for the Current Curriculum ^{1, 2,3,4}	Mean for the Future Curriculum ^{1, 2,3,4}	Difference between Future & Current ³	Overlap with At Least One SFFP Entry-level Competency ⁵
The Chemical Nature of the Gene	4.09	4.25	0.16	✓
The Structure and Complexity of the Genome	3.22	3.34	0.12	
The Stability of the Genome	2.94	3.24	0.30	
Sequencing Genomes - The Genetic Basis of Being Human	3.25	3.51	0.26	
The Relationship Between Genes and Proteins	4.27	4.47	0.20	✓
An Overview of Transcription in Both Prokaryotic and Eukaryotic Cells	3.54	3.76	0.22	✓
Synthesis and Processing of Ribosomal and Transfer RNAs	2.75	2.85	0.10	✓
Synthesis and Processing of Messenger RNAs	3.30	3.58	0.28	✓
Small Noncoding RNAs and RNA Interference	2.25	3.07	0.82	✓
Encoding Genetic Information	3.96	4.09	0.13	✓
Decoding the Codons - The Role of Transfer RNAs	3.38	3.50	0.12	✓
Translating Genetic Information	3.24	3.44	0.20	✓
The Nucleus of a Eukaryotic Cell	3.39	3.71	0.32	✓
Control of Gene Expression in Prokaryotes	2.41	2.47	0.06	✓
Transcriptional-Level Control of Gene Express. in Eukaryotes	3.10	3.49	0.39	✓
Processing-Level Control of Gene Expression in Eukaryotes	2.92	3.15	0.23	✓
Translational-Level Control of Gene Expression in Eukaryotes	2.71	2.93	0.22	✓
Posttranslational Control: Determining Protein Stability	2.57	3.01	0.44	✓
DNA Replication	3.18	3.21	0.03	
DNA Repair	2.92	2.95	0.03	
Cellular Reproduction				
The Cell Cycle	3.40	3.57	0.17	✓
M Phase - Mitosis	3.39	3.53	0.14	✓
Cytokinesis	2.80	3.04	0.24	✓
Meiosis	3.59	3.64	0.05	
Cell Signaling and Signal Transduction: Communication Between Cells				
The Basic Elements of Cell Signaling Systems	3.27	3.63	0.36	✓
G Protein-Coupled Receptors and Their Second Messengers	3.16	3.30	0.14	✓
Protein-Tyrosine Phosphorylation as a Mechanism for Signal Transduction	2.57	2.67	0.10	✓
The Role of Calcium as an Intracellular Messenger	2.82	2.86	0.04	✓
The Role of NO as an Intercellular Messenger	2.63	2.51	-0.12	✓
Apoptosis (Programmed Cell Death)	2.77	2.92	0.15	✓
Cancer				
Basic Properties of a Cancer Cell	3.15	3.21	0.06	
The Causes of Cancer	3.10	3.23	0.13	
The Genetics of Cancer	3.02	3.11	0.09	
Strategies for Combating Cancer	2.55	2.73	0.18	
The Immune Response				
An Overview of the Immune Response	3.29	3.33	0.04	✓
The Clonal Selection Theory	3.00	3.03	0.03	✓
Antigen Processing and Presentation	2.81	2.77	-0.04	✓
T Lymphocytes - Activation and Mechanism of Action	2.79	2.81	0.02	✓
Cellular and Molecular Basis of Immunity	2.93	3.02	0.09	✓
Techniques in Cell and Molecular Biology				
The Light Microscopes	2.13	2.35	0.22	
Electron Microscopy	1.91	2.12	0.21	
The Use of Radioisotopes	2.25	2.53	0.28	
Cell Culture	2.27	2.48	0.21	
The Fractionation of a Cell's Contents by Diff. Centrifugation	1.89	1.92	0.03	
Isolation, Purification, and Fractionation of Proteins	2.08	2.22	0.14	
Flow Cytometry	2.11	2.15	0.04	
Determination of Protein Structure	1.63	1.77	0.14	

Importance Rating Scale

5 = Extremely Important
4 = Very Important
3 = Important
2 = Somewhat Important
1 = Not Important
9 = Unable to Rate

(continued)

Table 7. Mean Importance Ratings for Cell and Molecular Biology Topics (3 of 3)

Topic	Mean for the Current Curriculum ¹ , 2,3,4	Mean for the Future Curriculum ¹ , 2,3,4	Difference between Future & Current ³	Overlap with At Least One SFFP Entry-level Competency ⁵
Purification and Fractionation of Nucleic Acids	2.19	2.24	0.05	
Measurement of Protein and Nucleic Acid Concentration	1.91	2.08	0.17	
Ultracentrifugation	1.46	1.54	0.08	
Nucleic Acid Hybridization	2.56	2.56	0.00	
Recombinant DNA Technology	2.81	3.21	0.40	
Overall Mean Topic Rating	2.90	3.07	0.17	

Notes

1. N ranges from 208-218 for current ratings and 110-114 for future ratings.
2. Standard Deviations range from .75-1.42 for current ratings and .63-1.41 for future ratings.
3. Dark blue = ratings ≥ 3.50 ; Medium blue = ratings between 3.00-3.49; Light blue = ratings between 2.50-2.99; Yellow = difference between future and current ratings $\geq .25$.
4. Ratings were made on a 5-point Likert-type scale. Importance ratings ranged from 1 = Not Important, 2 = Somewhat Important, 3 = Moderately Important, 4 = Very Important, 5 = Extremely Important, and 9 = Unable to Rate.
5. These topics overlap with the entering competencies recommended by the AAMC-HHMI Scientific Foundations for Future Physicians (SSFP) committee.

Table 8: Mean Importance Ratings for Research Methods and Statistics Topics

Topic	Mean for the Current Curriculum ^{1,2} ,3,4	Mean for the Future Curriculum ^{1,2} ,3,4	Difference between Future & Current ³	Overlap with At Least One SFFP Entry-level Competency ⁵
Understanding the Scientific Method				
The Scientific Approach	3.67	3.92	0.25	✓
Role of Natural and Social Science Research	3.34	3.57	0.23	
Basic and Applied Research	3.10	3.44	0.34	✓
Generating Research Ideas, Conducting Lit. Searches, & Reading Research Articles				
Developing Research Questions	3.33	3.60	0.27	✓
Choosing a Research Method	2.82	3.15	0.33	✓
Ethical Research Practices				
Normative Ethics	3.34	3.37	0.03	
Scientific Integrity	4.10	4.30	0.20	✓
Studying Biological, Behavioral, and Social Relationships				
Variables	2.31	2.68	0.37	
Independent and Dependent Variables	1.97	2.29	0.32	
Nonexperimental vs. Experimental Methods	2.89	2.94	0.05	✓
Criteria for Establishing Causality	2.54	2.73	0.19	✓
Measurement Concepts and Sampling				
Reliability/Precision and Accuracy of Measures	2.44	2.57	0.13	✓
Validity	2.43	2.64	0.21	✓
Measurement Scales	1.99	2.34	0.35	
Population and Samples	2.93	3.09	0.16	
Sampling Techniques	2.00	2.19	0.19	
Evaluating Samples	1.83	2.08	0.25	
Study Design				
Qualitative vs. Quantitative Approaches	2.42	2.74	0.32	
Survey Design	2.19	2.36	0.17	
Observational Studies/Case-Control and Cohort	2.07	2.31	0.24	
Quasi-Experimental Design	1.71	1.97	0.26	
Population Comparisons or Ecological Studies	1.98	2.28	0.30	
Randomized Trials	2.63	2.69	0.06	
Factors that Introduce Bias (Major Confounding Variables)	2.43	2.50	0.07	✓
Strategies to Reduce Bias	2.39	2.39	0.00	✓
Understanding Research Results: Descriptive Statistics and Displaying Data				
Roles of Analysis	2.42	2.77	0.35	
Analyzing the Results of Research Investigations	2.77	2.98	0.21	✓
Frequency and Probability Distributions	2.78	2.93	0.15	✓
Using and Interpreting Frequency Distributions	3.21	3.37	0.16	✓
Measures of Central Tendency	4.03	4.01	-0.02	✓
Measures of Dispersion	3.38	3.44	0.06	✓
Using and Interpreting Graphical Data	2.83	3.00	0.17	✓
Understanding Research Results: Effect Size, Inference, and Power				
Tests/Indices of Statistical Relationships - Continuous Variables	2.40	2.71	0.31	
Tests/Indices of Statistical Relationships - Categorical Variables	2.60	2.98	0.38	
Selection of Appropriate Statistical Significance Test	2.26	2.57	0.31	✓
Inferring Statistical Significance	3.14	3.35	0.21	✓
Uncertainty in Statistical Significance Testing	3.09	3.22	0.13	
Power	2.48	2.60	0.12	
Bayes' Theorem	3.00	2.97	-0.03	
Generalizing Results				
External Validity (Generalizability)	2.17	2.33	0.16	
Importance of Replications	1.58	1.80	0.22	
Other Techniques	2.94	3.15	0.21	
Overall Mean Topic Rating	2.67	2.86		

Importance Rating Scale

5 = Extremely Important
4 = Very Important
3 = Important
2 = Somewhat Important
1 = Not Important
9 = Unable to Rate

Notes

1. N ranges from 242-258 for current ratings and 116-123 for future ratings.
2. Standard Deviations range from .86-1.49 for current ratings and .84-1.41 for future ratings.
3. Dark blue = ratings ≥ 3.50 ; Medium blue = ratings between 3.00-3.49; Light blue = ratings between 2.50-2.99; Yellow = difference between future and current ratings $\geq .25$
4. Ratings were made on a 5-point Likert-type scale. Importance ratings ranged from 1 = Not Important, 2 = Somewhat Important, 3 = Moderately Important, 4 = Very Important, 5 = Extremely Important, and 9 = Unable to Rate.
5. These topics overlap with the entering competencies recommended by the AAMC-HHMI Scientific Foundations for Future Physicians (SFFP) committee.

Table 9. Mean Importance Ratings for Behavioral Science Topics

Topic	Mean for the Current Curriculum ¹ , 2,3,4	Mean for the Future Curriculum ¹ , 2,3,4	Difference between Future & Current ³
Nature, Nurture, and Human Diversity			
Behavior Genetics - Predicting Individual Differences	3.36	3.55	0.19
Personality Influences	2.95	3.09	0.14
Evolutionary Psychology - Understanding Human Nature	2.85	2.79	-0.06
Parents and Peers	2.79	2.80	0.01
Cultural Influences	2.86	3.00	0.14
Gender Development	2.86	2.98	0.12
Learning			
Associative Learning	2.61	2.76	0.15
Observational Learning	2.00	2.10	0.10
Memory			
The Phenomenon of Memory	2.01	2.27	0.26
Encoding	1.72	1.94	0.22
Storage	2.09	2.36	0.27
Retrieval	1.91	2.04	0.13
Forgetting	1.85	2.05	0.20
Memory Construction	1.71	1.78	0.07
Thinking and Language			
Cognition	2.07	2.09	0.02
Language	2.08	2.12	0.04
Thinking About Language	1.85	1.95	0.10
Intelligence			
Intelligence	2.09	2.28	0.19
Assessing Intelligence	1.85	1.98	0.13
The Dynamics of Intelligence	1.66	1.78	0.12
Genetic and Environmental Influences on Intelligence	2.41	2.48	0.07
Motivation			
Motivational Concepts	1.90	2.13	0.23
Hunger	2.50	2.84	0.34
Sexual Motivation	2.68	2.84	0.16
Other Types of Needs	1.83	2.03	0.20
Social Psychology			
Social Thinking	1.78	2.01	0.23
Social Influence	2.03	2.26	0.23
Social Relations	2.48	2.68	0.20
Overall Mean Topic Rating	2.24	2.39	

<u>Importance Rating Scale</u>
5 = Extremely Important
4 = Very Important
3 = Important
2 = Somewhat Important
1 = Not Important
9 = Unable to Rate

Notes

1. N ranges from 227-238 for current ratings and 98-105 for future ratings.
2. Standard Deviations range from .83-1.19 for current ratings and .92-1.26 for future ratings.
3. Dark blue = ratings ≥ 3.50 ; Medium blue = ratings between 3.00-3.49; Light blue = ratings between 2.50-2.99; Yellow = difference between future and current ratings $\geq .25$
4. Ratings were made on a 5-point Likert-type scale. Importance ratings ranged from 1 = Not Important, 2 = Somewhat Important, 3 = Moderately Important, 4 = Very Important, 5 = Extremely Important, and 9 = Unable to Rate.

Appendix A

Members of the MR5 Committee

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Appendix B

Survey Questions

Current Curriculum²

- First, **UNCHECK** the box associated with any subtopic that **IS NOT** important for students to know when they enter medical school given the current curriculum and instructional methods at your school
- Second, rate the degree to which students' knowledge of this topic **at the time they enter medical school** is important for mastery of your school's current curriculum. (In making this rating, you should consider the topic as you have defined it in the step above.)
 - 1=Not important
 - 2=Somewhat important
 - 3=Moderately important
 - 4=Very important
 - 5=Extremely important

Future Curriculum (faculty respondents only)

- Third, think about the way your school is likely to change its curriculum and instructional methods over the next 5 years. Then **UNCHECK** the box associated with any subtopic that **IS NOT** important for students to know when they enter medical school given the likely future curriculum and instructional methods at your school.
- Finally, rate the degree to which students' knowledge of this topic **at the time they enter medical school** is important for mastery of your school's future curriculum. (In making this rating, you should consider the topic as you have defined it in the step above.)
 - 1=Not important
 - 2=Somewhat important
 - 3=Moderately important
 - 4=Very important
 - 5=Extremely important

² The wording of the current curriculum questions was slightly modified on the resident survey to ensure that resident responded with the school from which s/he graduated in mind rather than his/her current residency program.

Knowledge/Involvement

- **Please rate your level of knowledge of your school's current curriculum based on your teaching and/or participation in discussion about curriculum development and instructional methods.**

1=Not knowledgeable
2=Somewhat knowledgeable
3=Moderately knowledgeable
4=Very knowledgeable
5=Extremely knowledgeable

- **Please rate your level of involvement in discussions about the way your school is likely to change its curriculum and instructional methods over the next five years.**
(faculty respondents only)

1=Not involved
2=Somewhat involved
3=Moderately involved
4=Very involved
5=Extremely involved

Confidence in Ratings

- **Please rate the extent to which you are confident in the ratings you provided pertaining to the current curriculum.**

1=Not confident at all
2=Somewhat confident
3=Moderately confident
4=Very confident
5=Extremely confident

- **Please rate the extent to which you are confident in the ratings you provided pertaining to the way your school is likely to change its curriculum and instructional methods over the next five years.** (faculty respondents only)

1=Not confident at all
2=Somewhat confident
3=Moderately confident
4=Very confident
5=Extremely confident

Appendix C

Response Rates

Table A1. Number of Respondents Providing Current Importance Ratings by Group for the Natural Sciences Surveys			
Respondent Group	Invited¹	Current²	Future³
Basic Science Faculty	1088	343	342
Clinical Science Faculty		280	280
Experienced Resident	400	208	--
Medical Student	513	354	--
All	2001	1185	622

Note.

1. Invited sample includes all participants invited.
2. Includes # cases where 100% of current topic ratings were completed.
3. Includes # cases where 100% of future topic ratings were completed.

Table A2. Number of Respondents Providing Current and Future Importance Ratings by Group for the Research Methodology and Behavioral Sciences surveys					
Respondent Group	Invited¹	<u>Research Methodology</u>		<u>Behavioral Sciences</u>	
		Current²	Future³	Current²	Future³
Basic Science Faculty	103	70	70	46	46
Clinical Science Faculty	107	67	67	65	65
Experienced Resident	87	57	--	58	--
Medical Student	97	72	--	71	--
All	394	266	137	240	111

Note.

1. Invited sample includes all participants invited.
2. Includes # cases where 100% of current topic ratings were completed.
3. Includes # cases where 100% of future topic ratings were completed.

Table A3. School-level Response Rates for the Natural Sciences and Research Methodology and Behavioral Sciences Surveys	
Behavioral Sciences	70%
Biochemistry	72%
Biology	74%
Cellular/Molecular Biology	80%
Chemistry	80%
Physics	76%
Research Methodology	71%