

Expectations of Physics Knowledge for Certification

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“A board-certified radiologist is one who has demonstrated knowledge, problem-solving, and application of those skills to a degree worthy of the public’s and the profession’s trust. This is someone deemed capable of working in various sectors of the field safely and effectively.”

ABR Web page <http://theabr.org/>

The Physics knowledge expected for certification is that level needed to practice Radiology with this degree of capability and professionalism.

Defining the Physics Knowledge Needed

For the Certification Examination, defining the physics knowledge that should be possessed by a Radiologist is a two part process – each part equally important:

- I. Determining the content appropriate for the exam**
- II. Deciding what percentage of items on the exam should be answered correctly to demonstrate competency.**

I. Determining the Content of the Exam

Determining Exam Content

Who?

The physics exam is created by a committee composed of diagnostic radiologists and of practicing medical physicists who are content experts specializing in diagnostic radiology.

Test Assembly Meeting

- Six Board-certified, clinical medical physicists who are on the Exam Committee
- One or two of the three Physics Trustees
- Three radiologists: 2 with special expertise in Radiobiology and in Nuclear Medicine

There is input and review by officers and trustees of the ABR before and after the exam is administered.

Exam Content

Part I of the cognitive examination in Diagnostic Radiology covers the Physics of Medical Imaging, Biological Effects and Safety.

Emphasis is placed on the principles and applications of physics, technology, statistical analysis, visual perception, dosimetry, radiation biology, exposure management, safety and quality assurance as they relate to the practice of diagnostic, interventional, and nuclear radiology.

- New examinations are formulated each year
- The content of the examination is carefully evaluated in order to keep current with new information and developments.

For Example:

The NRC has accepted ABR certification as evidence that a practitioner is properly trained to safely and effectively use radioactive materials in nuclear medicine. Since the ABR wishes to retain this status under the new regulations, the material on which it examines will include items relating to the final new NRC regulations.

PAST EXAM CONTENT

| Area | Number | % |
|---------------------------|--------|-------|
| Diagnostic Radiology | 79 | 60.8 |
| Nuclear Medicine | 25 | 19.2 |
| Radiobiology / Protection | 21 | 16.2 |
| “NRC” | 5 | 3.8 |
| Total | 130 | 100.0 |

Distribution of Items by Classification

Averaged over the Last 4 Years

**The actual distribution each year is fluid
and reflective of the current practice of
Radiology.**

DIAGNOSTIC RADIOLOGY - 60.7 % of Exam

- A. BASIC PHYSICS**
- B. X-RAY**
- C. RADIOGRAPHY**
- D. FLUOROSCOPY**
- E. MAMMOGRAPHY**
- F. COMPUTED TOMOGRAPHY**
- G. X-RAY IMAGING - DIGITAL**
- H. X-RAY IMAGING - OTHER**
- I. ULTRASOUND**
- J. MAGNETIC RESONANCE**
- K. GENERAL IMAGING PRINCIPLES –
 Multi-modality and/or Cross-Category**
- L. RADIATION SAFETY/ PROTECTION**
- M. DOSIMETRY/ Exposure**
- N. INFORMATION / DECISION THEORY**
- O. COMPUTERS**

A. BASIC PHYSICS*
1.9% of Exam

- 1. Atomic/Nuclear Structure (Nuclear force, Binding energy)**
- 2. Mechanics (Force, Energy, Power, Work)**
- 3. Electricity and Magnetism (Coulomb force, charge, conductivity)**
- 4. Thermodynamics (Heat, conduction, convection)**
- 5. Other**

**As relevant to Diagnostic Radiology*

B. X-RAY

7.1 % of Exam

- 1. Production (incl. x-ray tubes and generators)**
- 2. Interactions**
- 3. Attenuation (incl. HVL & filtration)**
- 4. Spectra**
- 5. Other**

C. RADIOGRAPHY - 8.5% of Exam

- 1. Basic Physical Principles**
- 2. Basic Principles of Image Formation**
- 3. Image receptors (Film/ Screen)**
- 4. Equipment/Instrumentation (incl. PBL, AEC, collimators)**
- 5. Artifacts**
- 6. Spatial Resolution**
- 7. Contrast / Contrast Resolution**
- 8. Temporal Resolution**
- 9. Image Noise**
- 10. Quality Assurance**
- 11. Patient Dose/Exposure**
- 12. Clinical Techniques (Technique factors)**
- 13. Geometry (incl. magnification, FS blur/unsharpness)**
- 14. Scatter (effects of and reduction techniques, i.e. grids, air gap, collimation)**
- 15. Film Processing/Processor QA**
- 16. Optical Density/Light Box**
- 17. Other**

D. FLUOROSCOPY – 5.6 % of Exam

- 1. Basic Physical Principles**
- 2. Basic Principles of Image Formation**
- 3. Image Receptors (Image Intensifier)**
- 4. Equipment / Instrumentation (Video camera, Photo-spot devices)**
- 5. Artifacts (Distortion)**
- 6. Spatial Resolution**
- 7. Contrast / Contrast Resolution**
- 8. Temporal Resolution**
- 9. Image Noise**
- 10. Quality Assurance**
- 11. Patient Dose/Exposure**
- 12. Clinical Techniques (Technique factors)**
- 13. Geometry (incl. magnification, FS blur / unsharpness)**
- 14. Scatter (effects of and reduction techniques, i.e. grids, air gap, collimators)**
- 15. Automatic Brightness Control (incl. AGC)**
- 16. Other**

E. MAMMOGRAPHY – 4.4 % of Exam

- 1. Basic Physical Principles**
- 2. Basic Principles of Image Formation**
- 3. Image receptors (Film/ Screen)**
- 4. Image receptors (Digital)**
- 5. Equipment/ Instrumentation**
- 6. Artifacts**
- 7. Spatial Resolution**
- 8. Contrast / Contrast Resolution**
- 9. Image Noise**
- 10. Quality Assurance (incl. MQSA)**
- 11. Patient Dose/ Exposure**
- 12. Clinical Techniques (Technique factors)**
- 13. Geometry (incl. magnification, FS blur/unsharpness)**
- 14. Scatter (effects of and reduction techniques, i.e. grids, air gap, collimators)**
- 15. Film Processing/Processor QA**
- 16. Optical Density/Light Box**
- 17. Other (incl. Stereotactic biopsy)**

F. COMPUTED TOMOGRAPHY – 5.2 % of Exam

- 1. Basic Physical Principles**
- 2. Basic Principles of Image Formation**
- 3. Image receptors**
- 4. Equipment / Instrumentation**
- 5. Artifacts**
- 6. Spatial Resolution**
- 7. Contrast / Contrast Resolution**
- 8. Temporal Resolution**
- 9. Image Noise**
- 10. Quality Assurance**
- 11. Patient Dose**
- 12. Clinical Techniques (Technique factors, contrast agents)**
- 13. Reconstruction / Display**
- 14. Other**

G. X-RAY IMAGING - DIGITAL
2.7 % of Exam

- 1. Digital Image Receptors**
- 2. Digital Subtraction Angiography (DSA)**
- 3. Computed Radiography (CR)**
- 4. Digital Radiography (DR)**
- 5. Other**

H. X-RAY IMAGING - OTHER

1.5 % of Exam

- 1. Film Tomography**
- 2. Angiography (general, excluding digital)**
- 3. Cine**
- 4. Bone Densitometry**
- 5. Clinical Techniques (Technique factors)**
- 6. Other (Stereoscopy)**

I. ULTRASOUND

6.3 % of Exam

- 1. Basic Physical Principles (including attenuation)**
- 2. Basic Principles of Image Formation**
- 3. Transducers**
- 4. Equipment/ Instrumentation**
- 5. Artifacts**
- 6. Spatial Resolution**
- 7. Contrast / Contrast Resolution**
- 8. Temporal Resolution**
- 9. Image Noise**
- 10. Quality Assurance**
- 11. Real -Time Imaging**
- 12. Doppler**
- 13. Clinical Techniques**
- 14. Special techniques: contrast agents, harmonic imaging, compounding**
- 15. Safety/Bioeffects**
- 16. Other**

J. MAGNETIC RESONANCE

6.3 % of Exam

- 1. Basic Physical Principles**
- 2. Basic Principles of Image Formation (including k-space, reconstruction)**
- 3. Equipment/ Instrumentation**
- 4. Artifacts**
- 5. Spatial Resolution**
- 6. Contrast / Contrast Resolution**
- 7. Temporal Resolution**
- 8. Image Noise**
- 9. Quality Assurance**
- 10. Clinical Techniques**
- 11. Functional imaging**
- 12. Pulse Sequences**
- 13. Special Techniques: MRA, Contrast Agents**
- 14. Safety/Bioeffects**
- 15. Other**

**K. GENERAL IMAGING PRINCIPLES
(Multi-modality and/or Cross-Category)
0.4 % of Exam**

- 1. Basic Principles**
- 2. Image receptors**
- 3. Equipment / Instrumentation**
- 4. Artifacts**
- 5. Spatial Resolution**
- 6. Contrast / Contrast Resolution**
- 7. Temporal Resolution**
- 8. Image Noise**
- 9. Quality Assurance**
- 10. Patient Dose**
- 11. Clinical Techniques**
- 12. Other**

L. RADIATION SAFETY/ PROTECTION

2.9 % of Exam

- 1. Dose to Personnel / Public**
- 2. Regulations**
- 3. Shielding Design/ Principles**
- 4. Other**

M. DOSIMETRY/ Exposure
1.9% of Exam

- 1. Detectors and Measurements**
- 2. Radiation Units**
- 3. Other**

N. INFORMATION / DECISION THEORY

2.5 % of Exam

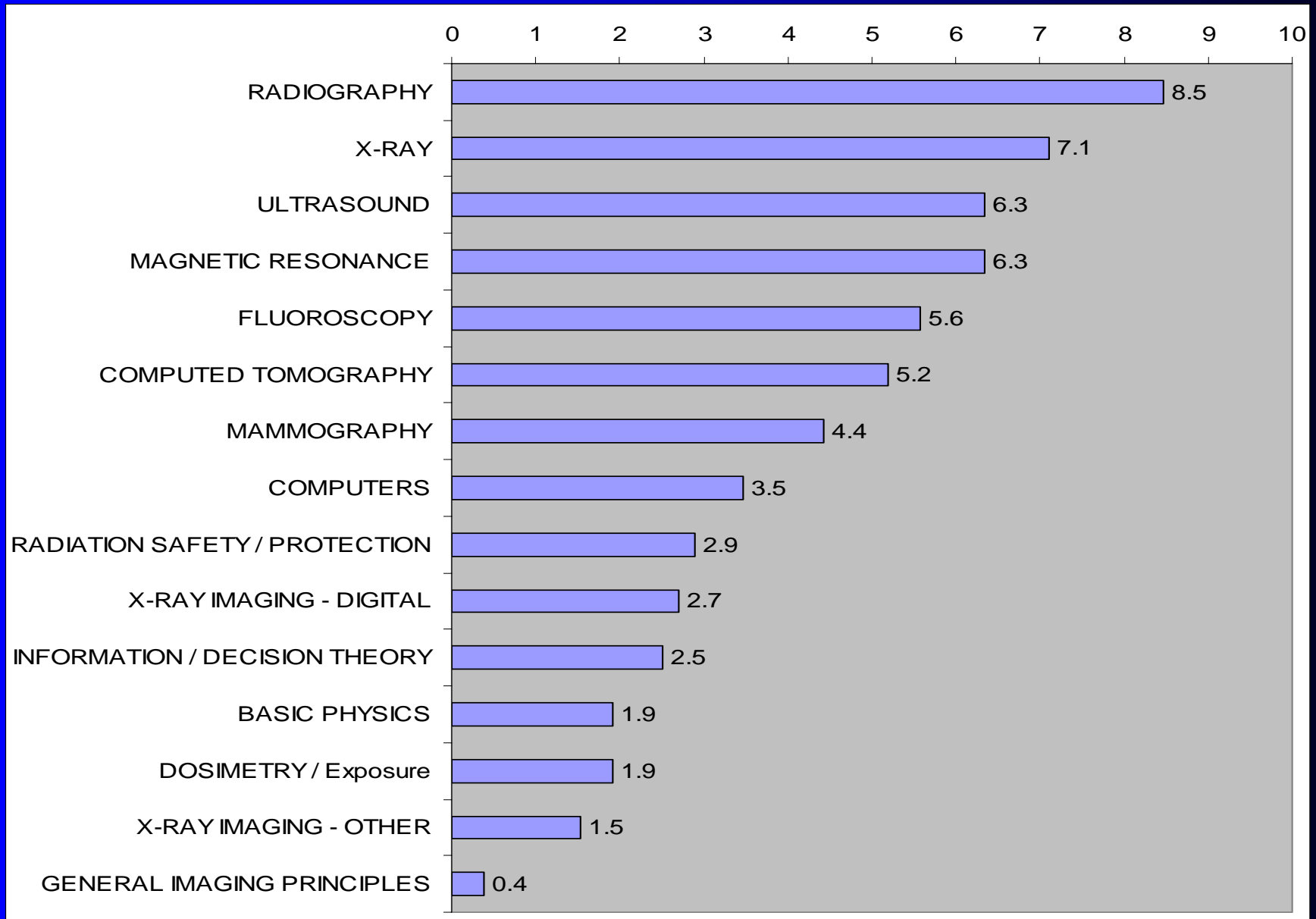
- 1. Perception (ROC / CDD curves)**
- 2. Biostatistics / Epidemiology (sensitivity, specificity, accuracy, predictive value, likelihood ratios)**
- 3. General statistics and probability (Statistical tests and significance)**
- 4. Human vision / Viewing Conditions**
- 5. Other**

O. COMPUTERS

3.5 % of Exam

- 1. Nomenclature**
- 2. Hardware**
- 3. Software**
- 4. Image Processing**
- 5. Image Digitization (incl. # of required gray levels and Nyquist limit)**
- 6. Image Management (incl. storage capacity computations)**
- 7. Teleradiology / Image Transmission**
- 8. PACS / HIS / RIS**
- 9. Workstations (monitors)**
- 10. Other**

Diagnostic Radiology – % of Items by Classification



NUCLEAR MEDICINE

22.4 % of Exam

- A. RADIONUCLIDES**
- B. RADIOACTIVE DECAY**
- C. DETECTORS**
- D. SCINTILLATION CAMERAS**
- E. SPECT**
- F. PET**
- G. DOSIMETRY**
- H. RADIATION PROTECTION**
- I. STATISTICS**

A. RADIONUCLIDES

1.5 % of Exam

- 1. Basic Atomic / Nuclear Physics**
- 2. Radiopharmaceuticals (General)**
- 3. Production / Generators (incl. equilibrium)**
- 4. Other**

B. RADIOACTIVE DECAY

3.3 % of Exam

- 1. Decay equation (incl. decay constant)**
- 2. Half life/ Half-times (Physical, biological, effective)**
- 3. Decay Schemes (Modes of decay)**
- 4. Emission Characteristics/ Energy**
- 5. Other**

C. DETECTORS

1.7 % of Exam

- 1. Gas Detectors (incl. Ion chambers & GM counters, Basic Principles)**
- 2. Scintillation Detectors (Basic Principles)**
- 3. Dose Calibrator**
- 4. Well Counters**
- 5. Uptake probes**
- 6. Other (incl. Semiconductor)**

D. SCINTILLATION CAMERAS

4.4 % of Exam

- 1. Basic Physical Principles**
- 2. Basic Principles of Image Formation**
- 3. Equipment / Instrumentation (Collimators General)**
- 4. Artifacts (Distortion)**
- 5. Spatial Resolution**
- 6. Contrast / Contrast Resolution**
- 7. Temporal Resolution**
- 8. Image Noise**
- 9. Quality Assurance**
- 10. Image Processing / Computer & Digitization Aspects**
- 11. Clinical Techniques (Procedures, Radiopharmaceuticals)**
- 12. Other**

E. SPECT

2.1 % of Exam

- 1. Basic Physical Principles**
- 2. Basic Principles of Image Formation**
- 3. Equipment / Instrumentation**
- 4. Artifacts**
- 5. Spatial Resolution**
- 6. Contrast / Contrast Resolution**
- 7. Temporal Resolution**
- 8. Image Noise**
- 9. Quality Assurance**
- 10. Image Processing / Reconstruction**
- 11. Clinical Techniques (Procedures, Radiopharmaceuticals)**
- 12. Other**

F. PET
1.7 % of Exam

- 1. Basic Physical Principles**
- 2. Basic Principles of Image Formation**
- 3. Equipment / Instrumentation**
- 4. Artifacts**
- 5. Spatial Resolution**
- 6. Contrast / Contrast Resolution**
- 7. Temporal Resolution**
- 8. Image Noise**
- 9. Quality Assurance**
- 10. Image Processing / Reconstruction**
- 11. Clinical Techniques (Procedures, Radiopharmaceuticals)**
- 12. Other**

G. DOSIMETRY

2.7 % of Exam

- 1. Calculation Methods (incl. Internal Radiation Dosimetry - MIRD)**
- 2. Patient Dose**
- 3. Special Dose Considerations: Conceptus, Infant Breastfeeding**
- 4. Other**

H. RADIATION PROTECTION

3.3 % of Exam

- 1. Regulations**
- 2. Personnel & Public Exposure (incl. Specific gamma-ray constant)**
- 3. Methods (Time, distance, shielding)**
- 4. Special Considerations (Radio iodine)**
- 5. Other**

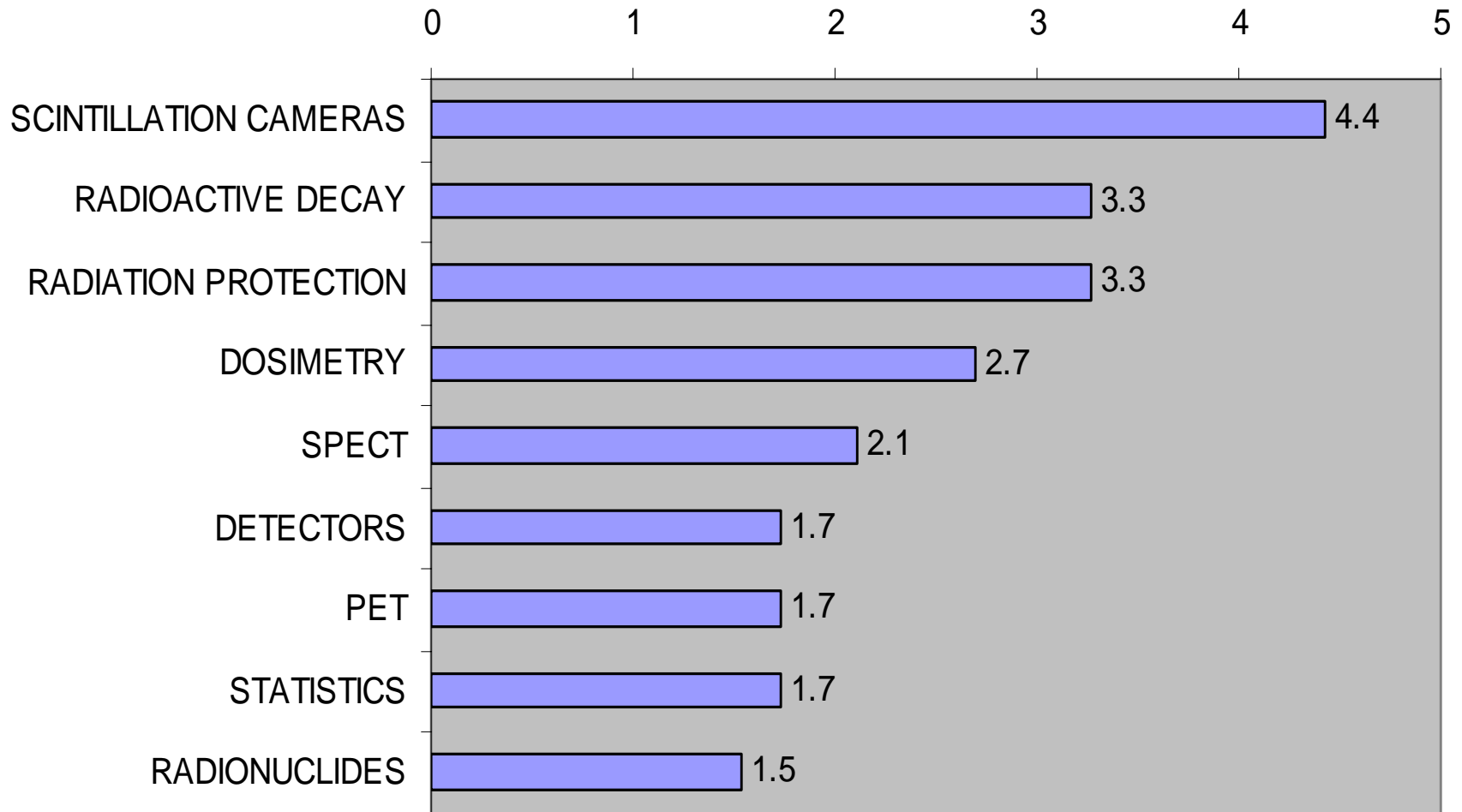
I. STATISTICS

1.7 % of Exam

- 1. Standard Deviation**
- 2. Probability Distributions**
- 3. Count / Count Rate Computations**
- 4. Confidence Intervals**
- 5. Other**

Nuclear Radiology

% of Items by Classification



RADIATION BIOLOGY / PROTECTION

16 % of Exam

- A. MECHANISMS**
- B. SOMATIC EFFECTS**
- C. GENETIC EFFECTS**
- D. MAXIMUM PERMISSIBLE DOSE**
- E. PROTECTION / MISC.**

A. MECHANISMS

2.5 % of Exam

- 1. RBE/LET/Quality**
- 2. Cell Cycle Sensitivity**
- 3. Repair**
- 4. Energy Transfer**
- 5. Direct & Indirect interactions**
- 6. Stochastic effects**
- 7. Nonstochastic effects**
- 8. Sensitivity**

B. Somatic Effects

6.0 % of Exam

- 1. Cataract formation**
- 2. Pregnancy**
- 3. Carcinogenesis**
- 4. Total Body Exposure effects**
- 5. Tissue Sensitivity**
- 6. Dose response**
- 7. "A" Bomb effects**
- 8. Miscellaneous**

C. GENETIC EFFECTS

0.6 % of Exam

- 1. Annual GSD**
- 2. Mutation induction**
- 3. Fetal effects**
- 4. General**

D. MAXIMUM PERMISSIBLE DOSE
0.4 % of Exam

- 1. General public**
- 2. Radiation workers**
- 3. Pregnancy**

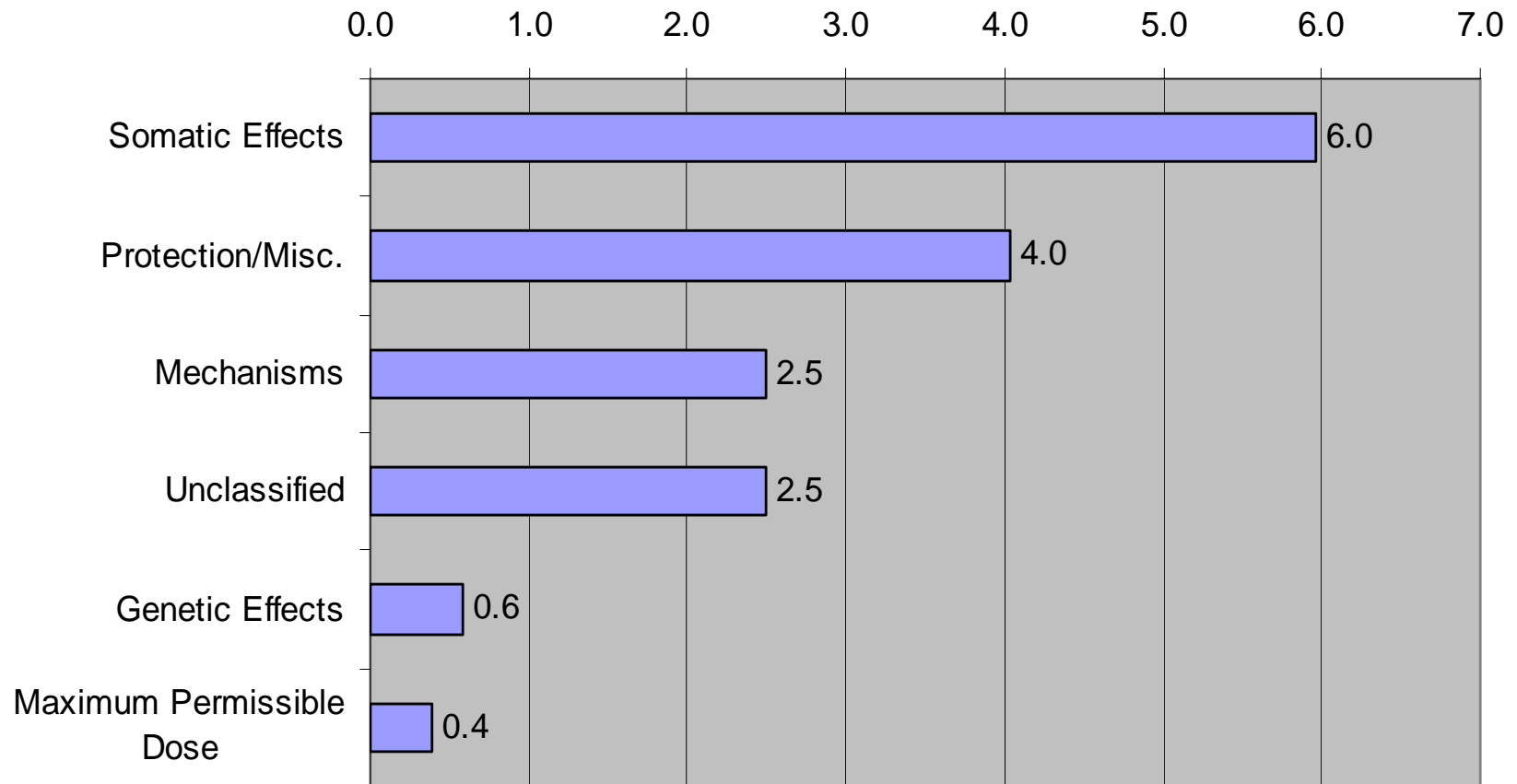
E. PROTECTION / MISCELLANEOUS

4.0 % of Exam

- 1. Radon**
- 2. Background**
- 3. ALARA**
- 4. Time/Distance/Shielding**
- 5. Exposure treatment**
- 6. Diagnostic exposure**
- 7. Monitoring**
- 8. Terrorism / WMD**

Radiobiology / Radiation Protection

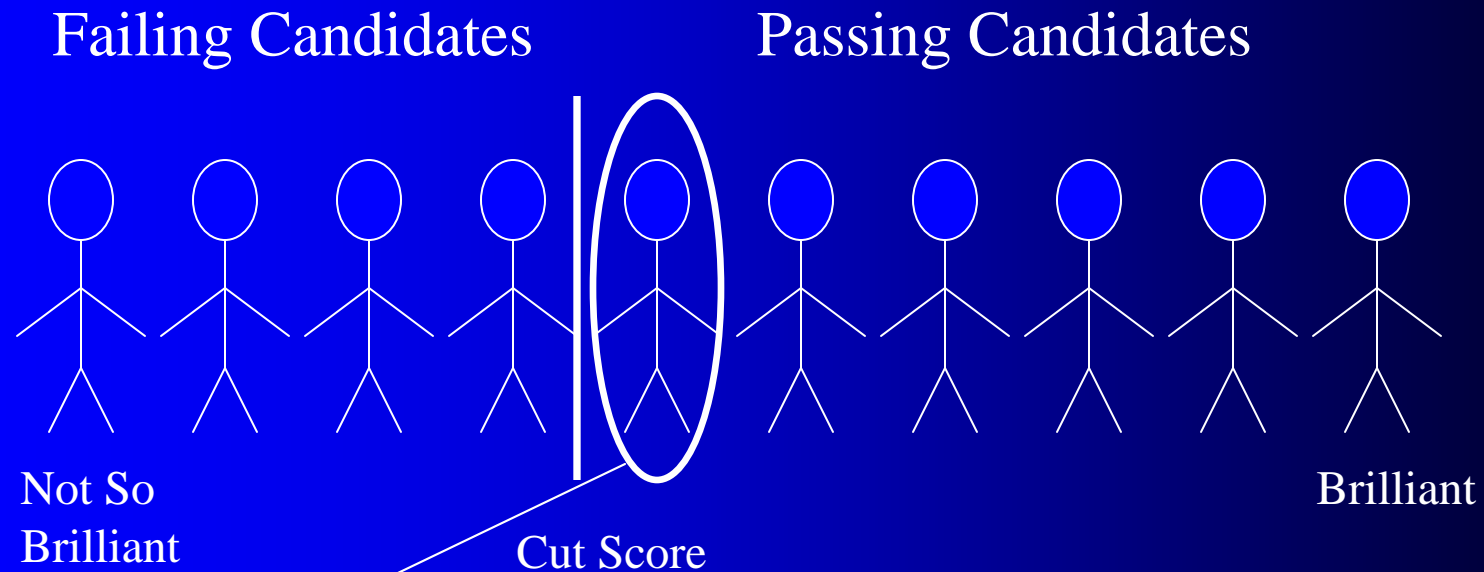
% of Items by Classification



II. Deciding What Percentage of Items Should be Answered Correctly to Pass the Exam

“Determining the Cut Score”

Determining the Cut Score



*Target group: level of knowledge is just sufficient and acceptable

Angoff Procedure: How would the target group respond to each question?

i.e., if there were 100 people just like this candidate, how many would answer the question correctly?

The Angoff Method

- Content experts examine each question in the exam and estimate how many target group candidates will respond correctly to the question.

| Item # | Raters | | | | | Avg |
|------------|--------|----|------|----|----|---------------|
| | 1 | 2 | 3 | 4 | 5 | |
| 1 | 40 | 80 | 65 | 70 | 50 | 61 |
| 2 | 90 | 90 | 60 | 60 | 75 | 75 |
| 3 | 85 | 90 | 70 | 70 | 60 | 75 |
| 4 | 80 | 70 | 45 | 70 | 40 | 61 |
| 5 | 75 | 80 | 50 | 50 | 70 | 65 |
| 6 | 75 | 30 | 40 | 40 | 50 | 47 |
| 7 | 70 | 90 | 45 | 60 | 65 | 66 |
| 8 | 65 | 80 | 60 | 50 | 75 | 66 |
| 9 | 70 | 80 | 60 | 60 | 50 | 64 |
| 10 | 75 | 40 | 80 | 60 | 50 | 61 |
| Avg | 72.5 | 73 | 57.5 | 59 | 59 | 641/10 |
| | | | | | | 64.10% |
| | | | | | | |
| | | | | | | |

- The estimates for all questions are summed and averaged across all raters, resulting in a *suggested* standard of mastery (Cut Score).

Cut Score

The Cut Score is determined using the results of Angoff Procedures conducted with radiologists and physicists and

through psychometric statistical analysis of the the item difficulty, discrimination and variability from year to year.

- There are no fixed minimum or maximum pass or fail rates.

PAST PERFORMANCE

Physics for Diagnostic Radiologists Exam

| Year | KR-20 Reliability | Mean Item Difficulty | Mean Item Discrimination |
|------|-------------------|----------------------|--------------------------|
| 2000 | 0.91 | 0.65 | 0.29 |
| 2001 | 0.89 | 0.61 | 0.26 |
| 2002 | 0.89 | 0.60 | 0.26 |
| 2003 | 0.89 | 0.67 | 0.26 |
| 2004 | 0.89 | 0.61 | 0.26 |
| 2005 | 0.90 | 0.66 | 0.28 |

KR-20 Coefficients of Reliability (Kuder-Richardson Formula 20)
Mean Item Difficulty – Average Proportion of Correct Responses
Mean Item Discrimination – Point-Biserial Correlation

PAST PERFORMANCE

Physics for Diagnostic Radiologists Exam

2nd Year Residents ONLY

| Year | % Passed |
|------|----------|
| 2000 | 93 |
| 2001 | 91 |
| 2002 | 95 |
| 2003 | 93 |
| 2004 | 92 |
| 2005 | 87 |

3rd Year Residents ONLY

| Year | % Passed |
|------|----------|
| 2000 | 90 |
| 2001 | 92 |
| 2002 | 94 |
| 2003 | 92 |
| 2004 | 94 |
| 2005 | 85 |

Future Direction

It is expected that the performance level to pass the examination will be increased incrementally over the next few years.

- Quantitative measures such as the Angoff parameter will be used as a guide.
- This will likely lead to an initially reduced pass rate.
- This change is felt to be acceptable to insure competency.



Thank You

You are invited to submit questions to the Board for the exam.

Send multiple choice items to

The American Board of Radiology
5441 East Williams Blvd., Suite 200
Tucson, AZ 85711-4493

or email to

items@theabr.org

Identify as submissions to the Physics Part
of the Exam for Diagnostic Radiologists.

Addendum

The background of the slide is a dark blue gradient that transitions to a lighter blue at the bottom. A thin, light blue curved line starts from the left edge and curves downwards towards the bottom right corner, creating a sense of movement and depth.

Procedural changes over the past 10 years

- No calculators allowed
- Multiple choice questions only (no Matching or True/False)
- Allowed to take physics part following first year of Residency.
- Added 5 "NRC" questions
- ABR takes over exam assembly and administration from ACT.
- Only SI units except where standard practice i.e., nuclear medicine.
- Exam Assembly changed from physical meeting to net meeting.

PAST PERFORMANCE

Physics for Diagnostic Radiologists Exam

| Year | Mean Item Difficulty | Mean Item Discrimination | KR-20 Reliability |
|------|----------------------|--------------------------|-------------------|
| 2000 | 0.65 | 0.29 | 0.91 |
| 2001 | 0.61 | 0.26 | 0.89 |
| 2002 | 0.60 | 0.26 | 0.89 |
| 2003 | 0.67 | 0.26 | 0.89 |
| 2004 | 0.61 | 0.26 | 0.89 |
| 2005 | 0.66 | 0.28 | 0.90 |

Mean Item Difficulty – Average Proportion of Correct Responses

Mean Item Discrimination – Point-Biserial Correlation

KR-20 Coefficients of Reliability (Kuder-Richardson Formula 20)

ABR Mission Statement

The mission of The American Board of Radiology is to serve the public and the medical profession by certifying that its diplomates have acquired, demonstrated, and maintained a requisite standard of knowledge, skill and understanding essential to the practice of radiology, radiation oncology and radiologic physics.

Diagnostic Radiology Content Classification

A. BASIC PHYSICS

1. Atomic/Nuclear Structure (Nuclear force, Binding energy)
2. Mechanics (Force, Energy, Power, Work)
3. Electricity and Magnetism (Coulomb force, charge, conductivity)
4. Thermodynamics (Heat, conduction, convection)
5. Other

B. GENERAL IMAGING PRINCIPLES - Multi-modality and/or Cross-Category

1. Basic Principles
2. Image receptors
3. Equipment/ Instrumentation
4. Artifacts
5. Spatial Resolution
6. Contrast / Contrast Resolution
7. Temporal Resolution
8. Image Noise
9. Quality Assurance
10. Patient Dose
11. Clinical Techniques (Technique factors, contrast agents)
12. Other (Conspicuity)

C. X-RAY

1. Production (incl. x-ray tubes and generators)
2. Interactions
3. Attenuation (incl. HVL & filtration)
4. Spectra
5. Other

D. RADIOGRAPHY

1. Basic Physical Principles
2. Basic Principles of Image Formation
3. Image receptors (Film/ Screen)
4. Equipment/Instrumentation (excl. grids, x-ray tube; incl. PBL, AEC, collimators)
5. Artifacts
6. Spatial Resolution

14. Scatter (effects of and reduction techniques, i.e. grids, air gap, colli)
15. Film Processing/Processor QA
16. Optical Density/Light Box
17. Other (Conspicuity)

E. FLUOROSCOPY

1. Basic Physical Principles
2. Basic Principles of Image Formation
3. Image Receptors (Image Intensifier)
4. Equipment/Instrumentation (Video camera, Photo-spot devices)
5. Artifacts (Distortion)
6. Spatial Resolution
7. Contrast / Contrast Resolution
8. Temporal Resolution
9. Image Noise
10. Quality Assurance
11. Patient Dose/Exposure
12. Clinical Techniques (Technique factors)
13. Geometry (incl. magnification, FS blur/unsharpness)
14. Scatter (effects of and reduction techniques, i.e. grids, air gap, colli)
15. Automatic Brightness Control (incl. AGC)
16. Other (Conspicuity)

F. MAMMOGRAPHY

1. Basic Physical Principles
2. Basic Principles of Image Formation
3. Image receptors (Film/ Screen)
4. Image receptors (Digital)
5. Equipment/ Instrumentation
6. Artifacts
7. Spatial Resolution
8. Contrast / Contrast Resolution
9. Image Noise
10. Quality Assurance (incl. MQSA)

Diagnostic Radiology Content Classification

G. COMPUTED TOMOGRAPHY

1. Basic Physical Principles
2. Basic Principles of Image Formation
3. Image receptors
4. Equipment/ Instrumentation
5. Artifacts
6. Spatial Resolution
7. Contrast / Contrast Resolution
8. Temporal Resolution
9. Image Noise
10. Quality Assurance
11. Patient Dose
12. Clinical Techniques (Technique factors, contrast agents)
13. Reconstruction/Display
14. Other

H. X-RAY IMAGING - DIGITAL

1. Digital Image Receptors
2. Digital Subtraction Angiography (DSA)
3. Computed Radiography (CR)
4. Digital Radiography (DR)
5. Other

I. X-RAY IMAGING - OTHER

- 1 Film Tomography
- 2 Angiography (general, excluding digital)
- 3 Cine
- 4 Bone Densitometry
- 5 Clinical Techniques (Technique factors)
- 6 Other (Stereoscopy)

J. ULTRASOUND

1. Basic Physical Principles (including attenuation)
2. Basic Principles of Image Formation
3. Transducers
4. Equipment/ Instrumentation
5. Artifacts
6. Spatial Resolution
7. Contrast / Contrast Resolution
8. Temporal Resolution
9. Image Noise
10. Quality Assurance
11. Real -Time Imaging
12. Doppler
13. Clinical Techniques
14. Special techniques: contrast agents, harmonic imaging, compounding
15. Safety/Bioeffects
16. Other

K. MAGNETIC RESONANCE

1. Basic Physical Principles
2. Basic Principles of Image Formation (including k-space, reconstruction)
3. Equipment/ Instrumentation
4. Artifacts
5. Spatial Resolution
6. Contrast / Contrast Resolution
7. Temporal Resolution
8. Image Noise
9. Quality Assurance
10. Clinical Techniques
11. Functional imaging
12. Pulse Sequences
13. Special Techniques: MRA, Contrast Agents
14. Safety/Bioeffects
15. Other

L. RADIATION SAFETY/ PROTECTION

1. Dose to Personnel / Public
2. Regulations
3. Shielding Design/ Principles
4. Other

M. DOSIMETRY/ Exposure

1. Detectors and Measurements
2. Radiation Units
3. Other

N. INFORMATION / DECISION THEORY

1. Perception (ROC/ CDD curves)
2. Biostatistics / Epidemiology (sensitivity, specificity, accuracy, predictive value, likelihood ratios)
3. General statistics and probability (Statistical tests and significance)
4. Human vision / Viewing Conditions
5. Other

O. COMPUTERS

1. Nomenclature
2. Hardware
3. Software
4. Image Processing
5. Image Digitization (incl. # of required gray levels and Nyquist limit)
6. Image Management (incl. storage capacity computations)
7. Teleradiology/Image Transmission
8. PACS/ HIS/RIS
9. Workstations (monitors)
10. Other

Nuclear Radiology Content Classification

A. RADIONUCLIDES

1. Basic Atomic/Nuclear Physics
2. Radiopharmaceuticals (General)
3. Generators (incl. Equilibrium conditions)
4. Other

B. RADIOACTIVE DECAY

1. Decay equation (incl. decay constant, etc.)
2. Half life/ Half-times (Physical, biologic, effective)
3. Decay Schemes (Modes)
4. Emission Characteristics/ Energy
5. Other

C. DETECTORS

1. Gas Detectors (incl. Ion chambers & GM counters, Basic Principles)
2. Scintillation Detectors (Basic Principles)
3. Dose Calibrator
4. Well Counters
5. Uptake probes
6. Other (incl. Semiconductor)

D. SCINTILLATION CAMERAS (Planar)

1. Basic Physical Principles
2. Basic Principles of Image Formation
3. Equipment/ Instrumentation (Collimators General)
4. Artifacts (Distortion)
5. Spatial Resolution
6. Contrast / Contrast Resolution
7. Temporal Resolution
8. Image Noise
9. Quality Assurance
10. Image Processing / Computer & Digitization Aspects
11. Clinical Techniques (Procedures, Radiopharmaceuticals)
12. Other

E. SPECT

1. Basic Physical Principles
2. Basic Principles of Image Formation
3. Equipment/ Instrumentation
4. Artifacts
5. Spatial Resolution

6. Contrast / Contrast Resolution

7. Temporal Resolution
8. Image Noise
9. Quality Assurance
10. Image Processing / Reconstruction
11. Clinical Techniques (Procedures, Radiopharmaceuticals)
12. Other

F. PET

1. Basic Physical Principles
2. Basic Principles of Image Formation
3. Equipment/ Instrumentation
4. Artifacts
5. Spatial Resolution
6. Contrast / Contrast Resolution
7. Temporal Resolution
8. Image Noise
9. Quality Assurance
10. Image Processing / Reconstruction
11. Clinical Techniques (Procedures, Radiopharmaceuticals)
12. Other

G. DOSIMETRY

1. Calculation Methods (incl. Parameters of the MIRD)
2. Patient Dose
3. Special Dose Considerations: Conceptus, Infant Breast
4. Other

H. RADIATION PROTECTION

1. Regulations
2. Personnel & Public Exposure (incl. Specific gamma ray constants)
3. Methods (Time, distance, shielding)
4. Special Considerations (Radio iodine)
5. Other

I. STATISTICS

1. Standard Deviation
2. Probability Distributions
3. Count/Count Rate Computations
4. Confidence Intervals
5. Other

Radiobiology / Protection Content Classification

A. Mechanisms

1. RBE/LET/Quality
2. Cell Cycle Sensitivity
3. Repair
4. Energy Transfer
5. Direct & Indirect interactions
6. Stochastic effects
7. Nonstochastic effects
8. Sensitivity

B. Somatic Effects

1. Cataract formation
2. Pregnancy
3. Carcinogenesis
4. TBI effects
5. Tissue Sensitivity
6. Dose response
7. A Bomb effects
8. Misc.

C. Genetic Effects

1. Annual GSD
2. Mutation induction
3. Fetal effects
4. General

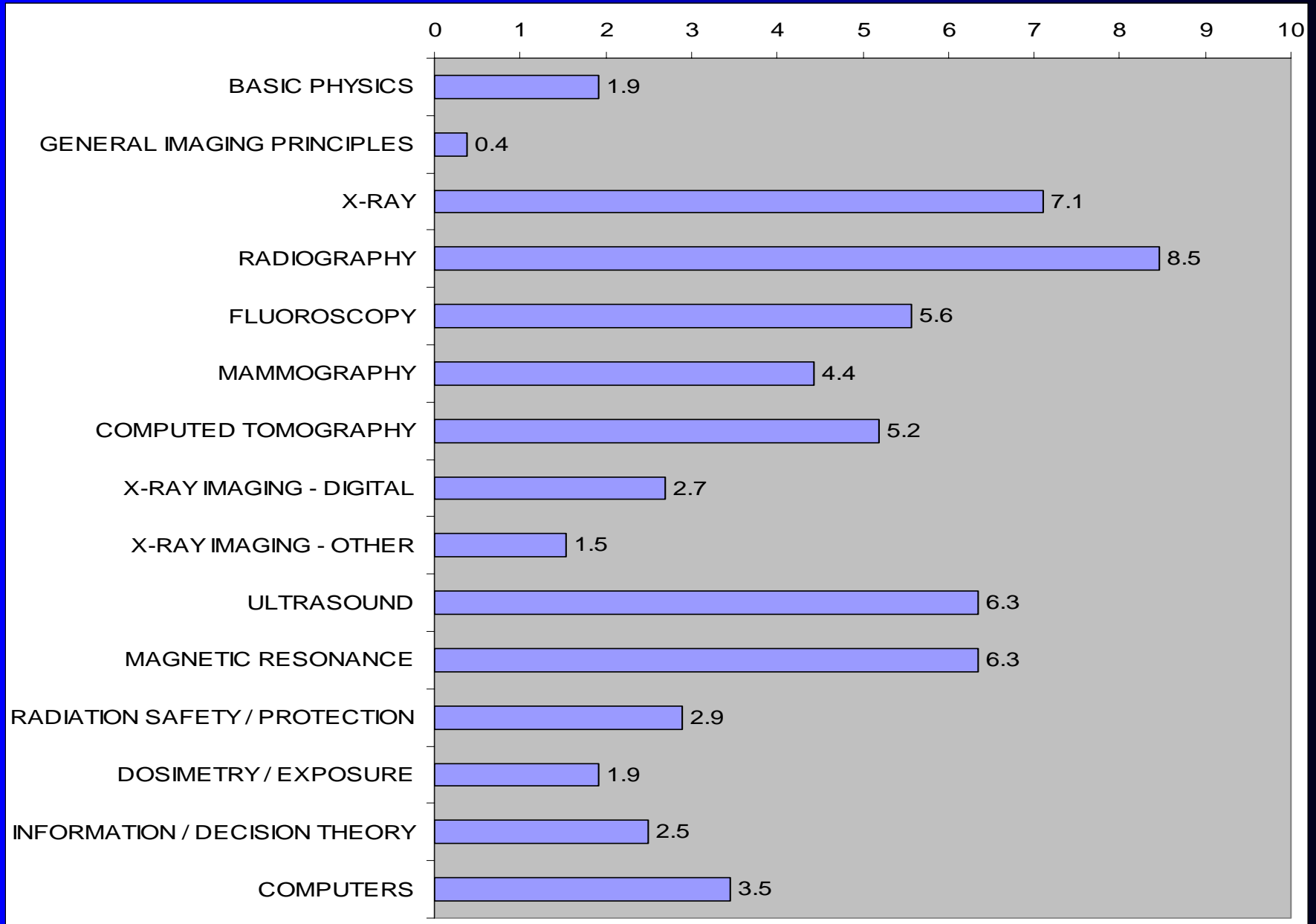
D. MPD

1. General public
2. Rad workers
3. Pregnancy

E. Protection/Misc.

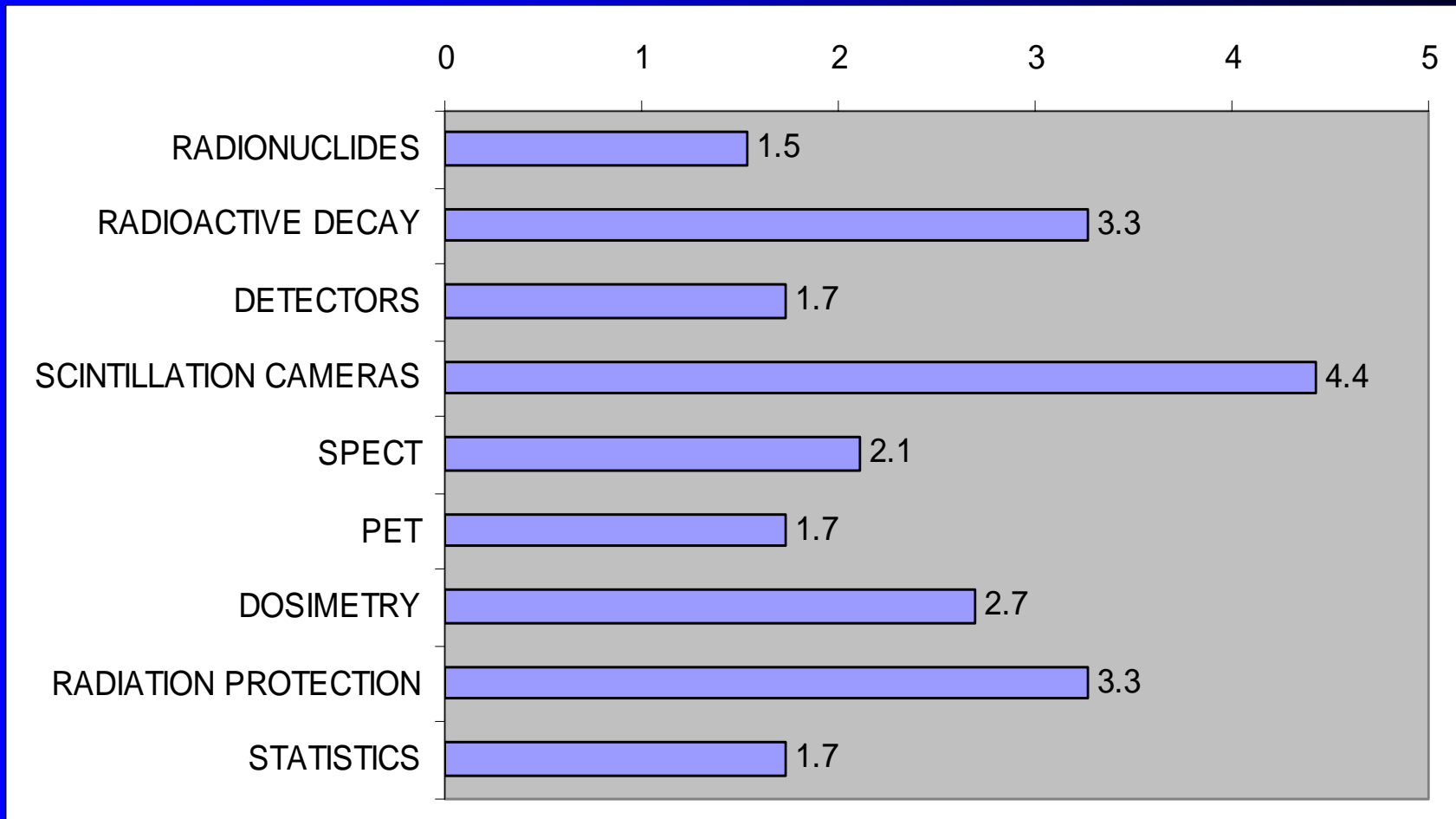
1. Radon
2. Background
3. ALARA
4. Time/Distance/Shielding
5. Exposure treatment
6. Diagnostic exposure
7. Monitoring
8. Terrorism/WMD

Diagnostic Radiology – % of Items by Classification



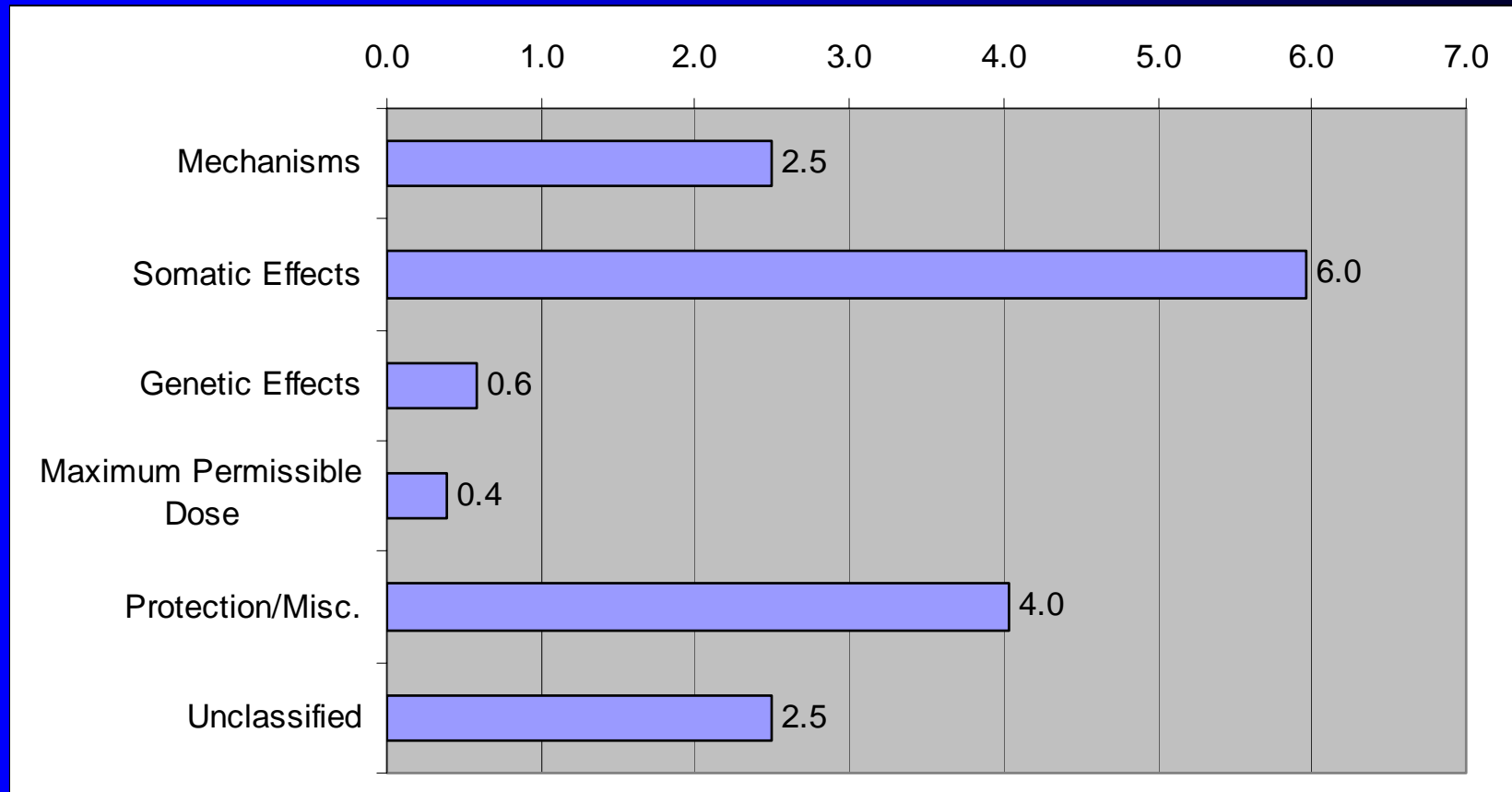
Nuclear Radiology

% of Items by Classification



Radiobiology / Radiation Protection

% of Items by Classification

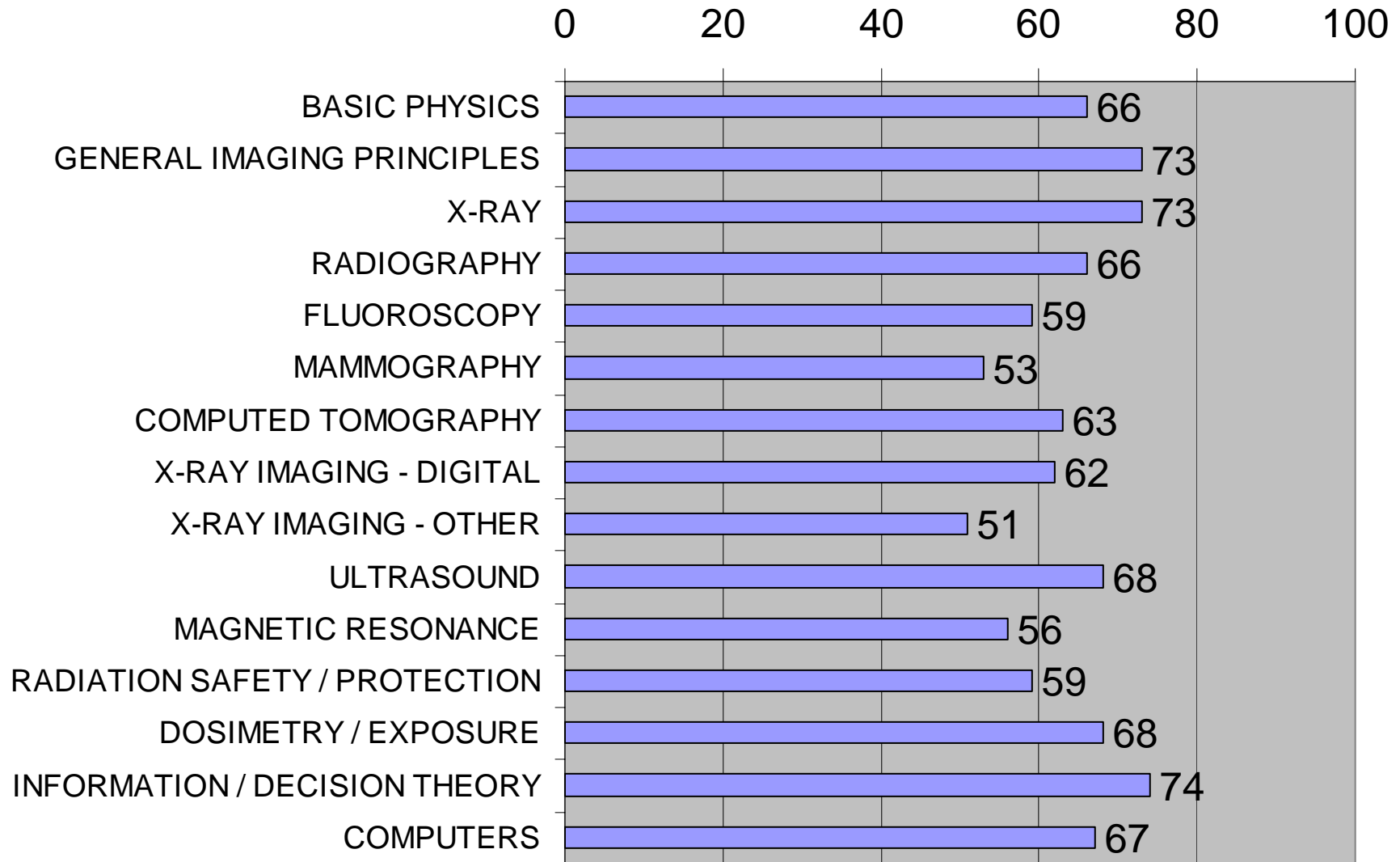


Difficulty of Items by Classification

(Averaged over latest 5 years)

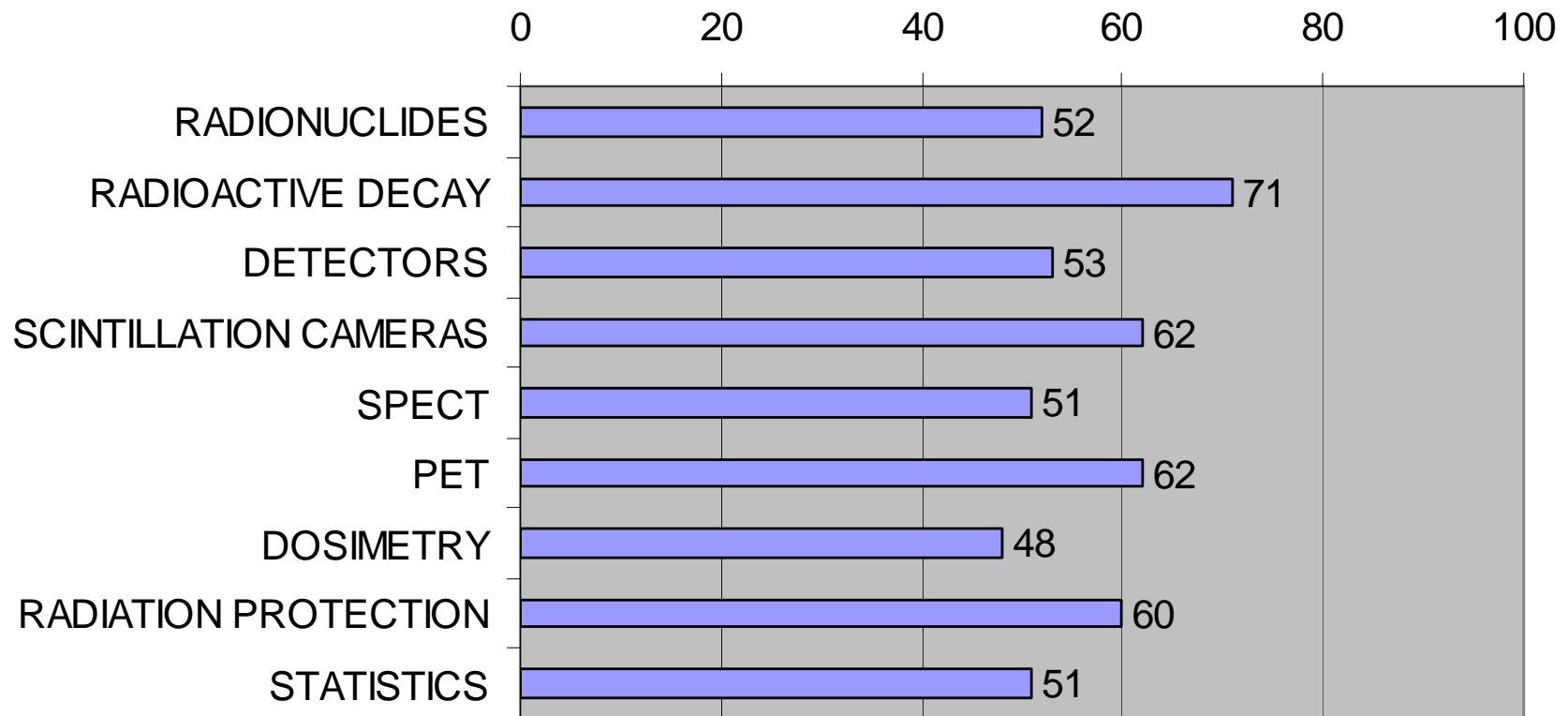
Diagnostic Radiology

% of Items Answered Correctly (2000-2004)



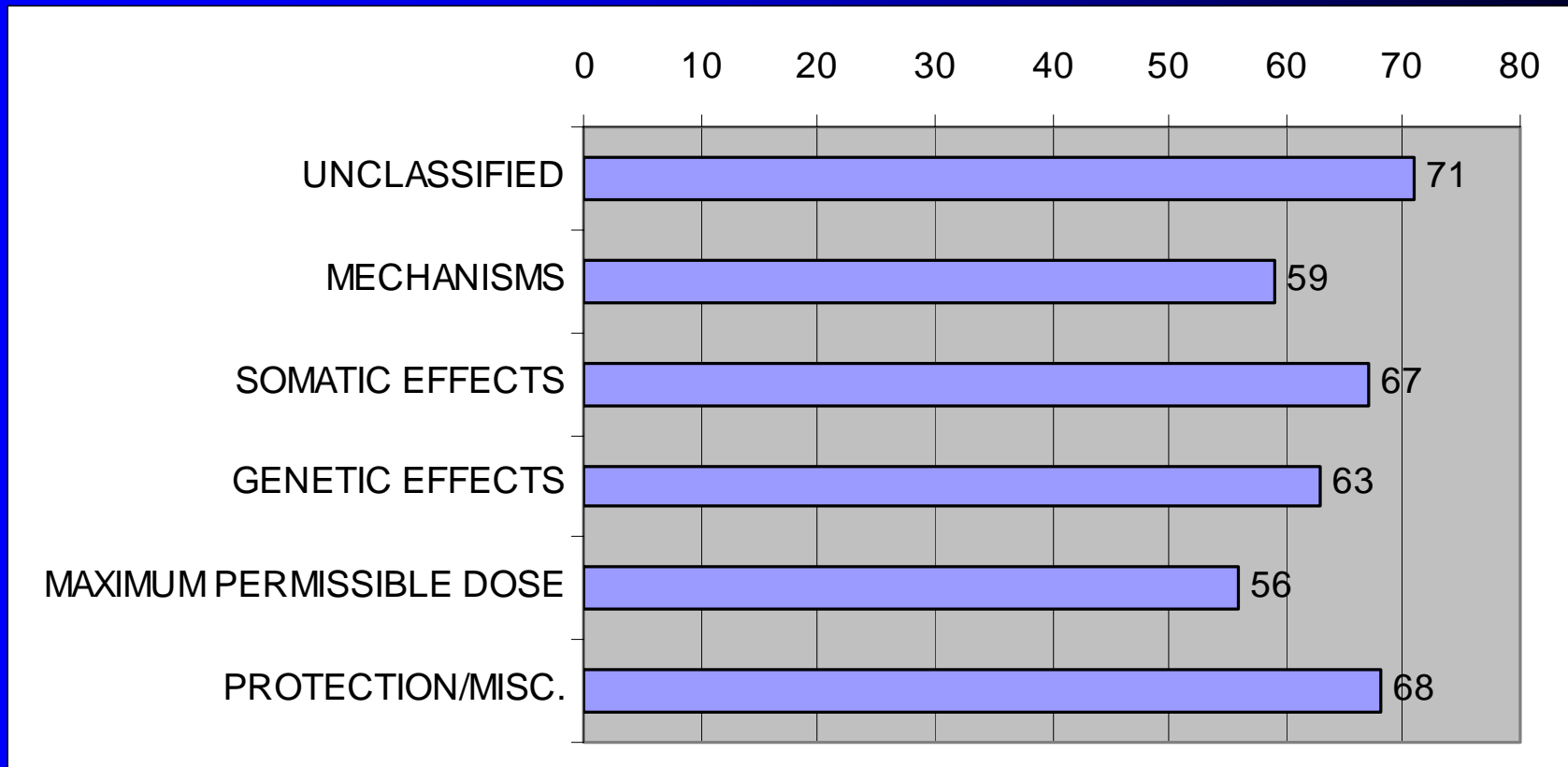
Nuclear Radiology

% of Items Answered Correctly (2000-2004)



Radiobiology / Radiation Protection

% of Items Answered Correctly (2000-2004)



PROCESS TIMELINE

Minus 18 – 15 months: The process of new item development by the committee begins with item writing, review and rewriting.

Minus 11 months: Items are chosen for the Test Assembly Book from the used and unused pool of items to have a balanced content and to contain 50% more items than on the exam.

Minus 10- 8 months:

Exam-assembly meeting – The committee reviews, discusses and selects items from the Test Assembly Book for the exam.

Post Exam-Assembly Meeting - The ABR staff edits the selected items and prepares them for the test. The committee chair reviews all edits to ensure that item content and accuracy have not been altered.

PROCESS TIMELINE

Minus 6 months:

The ABR staff formats the exam and prepares proofs, which are again reviewed by the chair before it is sent to the printer.

EXAM DAY

Post Exam:

The statistical performance of each question is analyzed by the ABR psychometrician for difficulty and discrimination (point-biserial correlation) to flag potential problem items and any such items are reviewed for possible ambiguity or for inaccuracy of the key.