Preparing Students for a Career in Clinical Microbiology

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Objectives

As related to clinical microbiologists….

♦ Describe educational and certification requirements at various levels
♦ List career options
♦ Discuss work done
♦ Provide resource material

Get your input …

What can ASM do to help you prepare your students for a career in clinical microbiology?
Distribution of Clinical Laboratory Tests (n ≈ 6 billion)*

*Testing in CLIA-certified labs (n=172,467) 2011

Clinical Microbiology Laboratory Positions

<table>
<thead>
<tr>
<th>Title</th>
<th>Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Director</td>
<td>Doctorate</td>
</tr>
<tr>
<td>Manager</td>
<td>Masters / Bachelors*</td>
</tr>
<tr>
<td>Supervisor</td>
<td>Masters / Bachelors*</td>
</tr>
<tr>
<td>MLS</td>
<td>Bachelors*</td>
</tr>
<tr>
<td>MLT</td>
<td>Associate*</td>
</tr>
<tr>
<td>Other</td>
<td>Varied</td>
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</tbody>
</table>

*plus clinical laboratory training program

MLS – Medical Laboratory Scientist
MLT – Medical Laboratory Technician
Non-doctoral Level Clinical Microbiologists (and Medical Laboratory Professionals)
Clinical Laboratory Certification

MLT vs. MLS

**MLT**
- Perform laboratory procedures including collection, processing and analysis of specimens, the maintenance of instruments, and relating lab findings to common diseases/conditions.

**MLS***
- Perform laboratory procedures including very sophisticated analyses and also evaluate/interpret the results, integrate data, problem solve, consult, conduct research and develop new test methods.

*Aka: Medical Technologist (MT)
Clinical Laboratory Scientist (CLS)*
MLT and MLS Certification

American Society for Clinical Pathology (ASCP)

83% of microbiology staff are certified (100% of supervisors)

"How to Become a Medical Laboratory Professional"

http://www.ascp.org/functional-nav/career-center
Accredited MLT and MLS Programs

http://www.naacls.org/search/programs.asp
Find Accredited MLS and MLT Programs

http://www.naaccls.org/search/programs.asp

No. Programs:
MLT = 229
MLS = 221
## MLS Education Program Types

<table>
<thead>
<tr>
<th>Program</th>
<th>Description</th>
<th>Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 + 2</td>
<td>Students complete lower division coursework and then spend <strong>2 years</strong> in clinical laboratory training program</td>
<td>Bachelor’s Clin Lab Science</td>
</tr>
<tr>
<td>3 + 1</td>
<td>Students spend <strong>3 years</strong> in classroom and <strong>1 year</strong> in clinical laboratory rotation</td>
<td>Bachelor’s Clin Lab Science</td>
</tr>
<tr>
<td>4 + 1</td>
<td>Complete bachelor’s <strong>(4 years)</strong> and apply for clinical laboratory training program</td>
<td>Bachelor’s Biology, Microbiology, etc.</td>
</tr>
</tbody>
</table>
Science Curriculum for MLS

♦ Biology
♦ Microbiology
♦ Organic and inorganic chemistry
♦ Molecular biology
♦ Anatomy
♦ Immunology

Some MLS programs may have other requirements
State-Specific MLS / MLT Licensure Requirements
ASM Certification for Clinical Microbiologists - NRCM

♦ Bachelors, Masters, Doctoral

♦ With American Society for Clinical Pathology (ASCP), administer certification exams in clinical microbiology

♦ ≈ 5,500 certificants since inception

NRCM - National Registry of Certified Microbiologists
Will I find a job in clinical microbiology?

2012 survey of clinical labs in the USA

- 935 respondents; responding for 22,842 employees
- 5% vacancy rate
- Anticipate 9% retirement rate by 2015


“≈11,000 medical laboratory professionals will be needed each year through 2018”
Mean salary range (MLS) $43,000 - $92,000

http://www.bls.gov/oes/current/oes292011.htm
Doctoral Level Clinical Microbiologists
Training Programs

CPEP

Certification

ABMM
ABMLI

CPEP - Committee on Postgraduate Educational Programs
ABMM - American Board of Medical Microbiology
ABMLI - American Board of Medical Laboratory Immunology
CPEP Training Programs

♦ Prepare **doctoral scientists and physicians** for leadership roles in medical microbiology or immunology professions

♦ **2 year program**

♦ **Currently 17 programs and 1 pending in USA** *(5-15 new post doc positions/year)*

♦ **Most common way to get to ABMM / ABMLI**

♦ **High demand for positions!**
States with ABMM and/or ABMLI CPEP Programs
ASM Certification for Clinical Microbiologists – ABMM / ABMLI

- Governmental agencies recognize certification as a significant component of licensure requirements to direct high complexity laboratories that diagnose infectious diseases.
- Certification requires training and Board exam.
- Since inception, number of certificants:
  - ABMM ≈ 1,140;  ABMLI ≈ 180

ABMM - American Board of Medical Microbiology
ABMLI - American Board of Medical Laboratory Immunology
ACGME Training Programs in Medical Microbiology

♦ Prepares medical doctors (MDs) for leadership roles in medical microbiology or immunology professions

♦ 1 year program
ACGME Training Programs in Medical Microbiology – Options for Eligibility

♦ Completed ACGME-accredited anatomic or clinical pathology residency program accredited by ACGME or the Royal College of Physicians and Surgeons of Canada (RCPSC)

♦ Certified in clinical pathology by ABP

♦ Completed both an ACGME-accredited residency program in internal medicine and an ACGME-accredited fellowship in infectious diseases

♦ Completed both an ACGME-accredited residency program in pediatrics and an ACGME-accredited fellowship in pediatric infectious diseases.
ASM Certification for Clinical Microbiologists – ABMM / ABMLI

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ABMM - American Board of Medical Microbiology
ABMLI - American Board of Medical Laboratory Immunology
Will I find a job in clinical microbiology?

♦ No knowledge of ABMM or ABMLI certificants unable to find job

♦ Workplace options:
  – Hospital/reference laboratories
  – Public health laboratories
  – Universities / medical schools
  – Diagnostic test manufacturers
  – Pharmaceutical companies
How much will I make (director level)?

≈ $125,000 (entry) to ≥ $250,000

http://www.bls.gov/oes/current/oes191022.htm
Learn About Clinical Microbiology Work
What do clinical microbiologists do?

Non-doctoral

- Analyze specimens / report results
- Test for antibiotic susceptibility
- Quality control
- Implement methods
- Write procedures
- Teach
- Interact with healthcare team

Doctoral

- Oversee operations of laboratory (legal responsibilities)
- Advise clinicians on test interpretation
- Select test methods
- Assist infection control
- Participate in antibiotic stewardship
- Teach
- Research
Focus on Careers in Clinical Microbiology

“Health of individuals and communities hinges on the services and expertise of clinical microbiologists.” D. Wolk, 2010

What does a clinical microbiologist do?
- Recommends methods for obtaining and transporting clinical specimens that would be most helpful in diagnosing infectious diseases.
- Identifies and identifies bacterial, viral, fungal and parasitic agents that are likely to be contributory to infections processes.
- Determines the susceptibility of microorganisms to various antimicrobial agents that could be used to treat infections caused by the microorganisms.
- Reports results to healthcare providers caring for patients in a clear, concise and clinically relevant manner.
- Works with healthcare teams, including public health officials, to improve processes to diagnose and control infectious diseases with a strong emphasis on effective communication at all levels.
- Works with pharmaceutical and medical device manufacturers to develop new and improved technologies to confront emerging infectious diseases.

Where does a clinical microbiologist work?
- Hospital Laboratories
- Commercial and Reference Laboratories (where more complex lab tests are often performed)
- Federal and State Government Laboratories
- State and Local Public Health Laboratories
- Universities and Medical Schools
- Pharmaceutical and Diagnostic Instrument Companies

Go here to learn more about the day-to-day activities of a Clinical Microbiologist: http://www.microbeaward.org/podcasts/weekly-in-microbiology/archives/1365-twm-02-clinical-
tml/0.xml?w=1100&h=700

How many ASM members have clinical microbiology as their focus?
Of the 37,000 ASM members, over 15% indicate their primary career focus is clinical microbiology.

Considering increasing challenges in healthcare today, where is the greatest need for clinical microbiologists?
- Develop new tests to identify emerging infectious diseases that are rapid, clinically relevant and cost effective.
- Identify innovative ways to assess the activity of antimicrobial agents against microorganisms that are most predictive of therapeutic outcomes.
- Provide guidance to computer programmers to develop information technology that can help serve clinicians when ordering tests, reviewing test results and integrating test results with each patients electronic medical record.
- Work with healthcare teams to better control transmission of infectious diseases within healthcare settings and in communities in the USA and beyond.

### Career Tracks and Educational Opportunities / Requirements for Clinical Microbiologists

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<tr>
<th>Position</th>
<th>Educational Requirements</th>
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<tbody>
<tr>
<td>Medical Laboratory Technician (MLT)</td>
<td>Associate's Degree Completion of an accredited MLT program <a href="http://www.asclls.org">more here</a> American Society for Clinical Laboratory Science (ASCLLS) <a href="http://www.asclls.org">http://www.asclls.org</a></td>
</tr>
<tr>
<td>Medical Technologist (MT)</td>
<td>BS in the biology/health-related sciences Completion of an accredited MT program <a href="http://www.asclls.org">more here</a> American Society for Clinical Laboratory Science (ASCLLS) <a href="http://www.asclls.org">http://www.asclls.org</a></td>
</tr>
<tr>
<td>Doctoral Level Clinical Microbiologist</td>
<td>PhD and/or MD in Microbiology/Molecular Biology Post Doc through ASM's Committee on Postgraduate Education Programs (CPEP) training (optional but desirable) <a href="http://clm.micro.asn.org/index.php/asm-programs/professional-development/cpep">http://clm.micro.asn.org/index.php/asm-programs/professional-development/cpep</a></td>
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**Board Certification for MLT / MT / PhD and/or MD**

**Doctoral level only:**
How can students learn about clinical microbiology careers?

♦ Social media
♦ **ASM** Student Chapters (n = 104)
♦ **ASM** Branches (n = 35)
♦ Local Clinical Microbiology Associations
♦ **ASM** General Meeting
♦ Visiting clinical microbiologists at your career day / classroom

My life as a clinical microbiologist!
What's New

New to Portal

Clinical Microbiology Mentoring
The asm2013 schedule of practicing CMs who will be available for informal mentoring sessions is posted.

Help with Bacteria
Try the ABIS lab tool for your bacterial identification or try NamesforLife Technology for nomenclature-based bibliographic retrieval.

ABCs to Public Health
CDC Launches a New Educational Website on Laboratory Science for Teachers and Students

Sentinel Level Clin Micro Lab Guidelines
Update: Laboratory Response Network (LRN) Sentinel Level Clinical Laboratory Protocols for Suspected Biological Threat Agents and Emerging Infectious Diseases.

ADMLI
Demonstrate expertise in medical laboratory immunology.

Featured Content

WITHOUT THE SYMPTOMS
Asymptomatic C. difficile infection in a tertiary care hospital.

http://clinmicro.asm.org/
Discusses USA and global experiences

http://www.microbeworld.org/podcasts
ASM Student Chapters

Forthcoming 2013!
ASM Speaker’s Bureau for Student Chapters

http://www.asm.org/index.php/asm-student-chapters
Southern California ASM Branch*
Student Activities at Annual Meeting

♦ Student poster competition
  – Send **winners** at Bachelors, Masters, and Doctorate levels to ASM General Meeting

♦ Attend exhibits

♦ Attend lectures

*SCASM clinical focus
Clinical Microbiology Associations (non-ASM)

Northeast Assn. of Clinical Microbiology and Infectious Diseases (NACMID)

Southeast Assn. of Clinical Microbiology (SEACM)

South Central Assn. of Clinical Microbiology (SCACM)

Southwest Assn. of Clinical Microbiology (SWACM)
Sat PM Career Forum includes 10 clinical microbiology advisors

Clinical microbiologists participate in all appropriate student events!
Who's Who in the Lab: A Look at Laboratory Professionals

Introduction | Positions | Summary | Outlook | Sources

Overview

You've been to the doctor and had your blood drawn, and your sample has been sent "off to the lab" for some tests. (Follow a Sample to find out what happens next.) You know your doctor and you've met the phlebotomist who drew your blood sample, but have you ever wondered who will actually receive your sample and conduct the prescribed tests?

There are a variety of skilled and educated laboratory professionals who, as a patient, you may never see face-to-face. However, these individuals play a very important role in your health care. People working in the clinical laboratory are responsible for conducting tests that provide crucial information for detecting, diagnosing, treating, and monitoring disease. They use specialized equipment and techniques to analyze patients' samples, such as blood, urine, body fluids and tissue, and stool. They may be working in the lab located in the hospital, clinic, or physician's office where you are being treated or they may be at a reference laboratory located hundreds or perhaps thousands of miles away. (See Where Lab Tests Are Performed for more information on the different laboratories and how they serve you and your physician.)

http://labtestsonline.org/lab/who/
What inspired colleagues to become a clinical microbiologist? (1)

♦ “Attended Career Lecture Series (speakers from non-academic settings) – and heard “A Career In Clinical Microbiology“ ...and was sold!”

♦ “Learned how Gram stains are used to help sick patients...and not just something I had to learn.”

♦ “I loved science and realized some people can work on a single protein for 10 years and be happy as can be, others need variety and multidisciplinary projects to fulfill them. ...like available with clinical microbiology”.
What inspired colleagues to become a clinical microbiologist? (2)

♦ “I liked to do puzzles. .. working on a patient’s culture really is a puzzle and so satisfying (and rewarding).”

♦ “Watched a video of people working in a clinical microbiology lab and interacting with physicians about patient’s infections.”

♦ “Watched NOVA episode - Hunt For The Legion Killer about discovering cause of Legionnaire's disease.”

♦ “Learned Streptococcus pneumoniae committed microbial suicide; may not have viable organisms in blood culture but detectable antigens.”
ASMC Clinical Microbiology Mentoring Committee

♦ Seeking opportunities to **mentor**
  – Practicing clinical microbiologists
  – Future clinical microbiologists

♦ Identify clinical microbiologists at **local level** to visit colleges / universities

♦ Provide **materials** to professors to share with students
What does it all mean in terms of sick people? How can we help?
18 y.o. girl presents to ER 3 wks after knee injury while playing softball
- knee “feels like jelly”, extremely painful
- chest tightness, fever (101.6°C), ↑ WBC (33,600 WBC/μL)

1 year ago treated for “spider bite cellulitis” on shin following softball injury
- Resolved with antimicrobial treatment

Respiratory and blood cultures obtained

Admitted to hospital
- Treated with 2 broad spectrum IV antibiotics: piperacillin-tazobactam; vancomycin
Blood specimen for bacterial culture: blood is injected directly into bottle of broth at bedside and sent to the lab.
Bottles are placed in blood culture instrument and continuously monitored. If bacteria are present, they multiply and sound an alarm when a threshold is reached.
“Positive” blood cultures are removed from instrument
“Positive” blood cultures are processed by removing a sample of broth and...

- preparing slide for Gram stain and...
- inoculating to agar media
Gram stain: gram-positive cocci in clusters + WBCs
Probably a “Staphylococcus”...

♦ Questions:

#1 Is this *Staphylococcus aureus*?
   If yes, is this methicillin-susceptible *S. aureus* (MSSA) or methicillin-resistant *S. aureus* (MRSA)?

#2 Is this another species of *Staphylococcus*, typically lumped into “coagulase-negative staphylococci” (CoNS) group?
   Usually much less clinically significant than MSSA or MRSA
For serious *S. aureus* infections:

- **MSSA**
  - Usual Therapy
    - Oxacillin* or Nafcillin*

- **MRSA**
  - Vancomycin

*Methicillin* very similar but no longer available
Blood Culture Workup (Option 1)

- **Pos Blood Culture**: 1-4 hours (or longer)
- **Gram Stain**
- **Coagulase Test Results**: Pos = S. aureus; Neg = CoNS
Blood Culture Workup (Option 2)

Results:
S. aureus or CoNS

Fluorescent In Situ Hybridization (FISH)

Pos Blood Culture

Gram Stain

15 Min.

90 min

www.advandx.com
Blood Culture Workup (Option 3)

Pos Blood Culture

Gram Stain

Molecular Assay Results:
MSSA or MRSA or CoNS

1-2 hours

www.bd.com/geneohm
Antimicrobial Susceptibility Tests

Disk diffusion

Broth dilution MIC

Commercial Automated Methods
Case #1

Diagnosis: MRSA

- Severe right thigh pyomyositis; surgical debridement
- Osteomyelitis of right knee
- Extensive pulmonary emboli
- In hospital for 2 months; sent home on IV antibiotics
- Returns 2 months later with repeat osteomyelitis, additional surgery
- 1 year later → total hip replacement
- Recovered
MRSA Infections

♦ Risk factors:
  - Central venous catheter
  - Indwelling hardware
  - Known MRSA colonization / prior infection
  - Previous hospitalization within 3 mos
  - Transfer from nursing home
  - IV drug use

♦ Broad spectrum of disease
  - Impetigo, ulcers, abscesses, pneumonia, meningitis, sepsis, osteomyelitis
Staphylococcus aureus

♦ Humans are natural reservoir for *S. aureus*
  - 10-20 percent persistently colonized
  - Nares (25%), axilla (6%), inguinal (11%), rectum (13%)

♦ Those colonized with *S. aureus* strains are at increased risk of infection with these strains

♦ MRSA carriers / infected transmit to others, including healthcare workers
Case #2

- 13 mo boy brought to ER with severe respiratory distress
- Multiple medical problems since birth
- Prior medical care in Pakistan
- Initially treated with broad-spectrum antimicrobial agents, including meropenem, a carbapenem class antibiotic
- Respiratory secretions grew multidrug-resistant (MDR) Klebsiella pneumoniae
- Ultimately treated with 10 day course of colistin, a “last resort” antibiotic

Antibiotic options for infections due to *Klebsiella pneumoniae*
Amikacin: R
Amp-sulbactam: R
Aztreonam: R
Cefazolin: R
Cefepime: R
Cefotaxime: R
Ceftazidime: R
Ceftriaxone: R
Chloramphenicol: R
Ciprofloxacin: R
Colistin: S
Doripenem: R
Ertapenem: R
Gentamicin: R
Imipenem: R
Levofloxacin: R
Meropenem: R
Minocycline: R
Piper-tazobactam: R
Tigecycline: R
Tobramycin: R
Trimeth-sulfa: R

Respiratory specimen: *Klebsiella pneumoniae*

**Case #2**

Drug of last resort!

R = resistant
S = susceptible

**Carbapenems** = ertapenem, doripenem, imipenem, meropenem
Questions from MD…

• *Is the Klebsiella pneumoniae a carbapenemase producer?*

• *Since patient was recently in Pakistan, might this be an NDM-1 metallo-β-lactamase type of carbapenemase?*

**Carbapenemase** = enzyme that destroys carbapenem-type antimicrobial agents

**Carbapenems** = ertapenem, doripenem, imipenem, meropenem
Drug-Defying Germs From India Speed Post-Antibiotic Era

Lil-Karin Skaret, a 67-year-old grandmother from Sweden, was rushed to the Amrita Institute of Medical Sciences in Kochi, India, the arrival of a vacation villa near India's port city of Kochi in May. She was flown back to Sweden two days later and is now recovering.

Bloomberg Markets Magazine

By Jason Gale and Ali Narayan - May 7, 2012 2:00 PM PT

"medical tourism" concerns

Search: India spawns 'superbug' germs through antibiotic overuse

As the supplier of nearly one-third of the world's antibiotics, India's citizens have easy access to prescription drugs and are known to take such medicines for even the most mundane illnesses. But such antibiotic overuse has serious drawbacks — among them the creation of "superbug" germs that have mutated as to be immune to drugs and can be spread quickly by visitors to the country.

More in the news:

Find out what old-school method is said to be the best weapon to fight "superbugs."

Popular searches: News

2012
Confirmation of Patient’s Isolate Carbapenem Resistance Mechanism

♦ *Klebsiella pneumoniae* isolate:
  - Sent to Los Angeles County Public Health Laboratory and then to Centers for Disease Control and Prevention
  - Confirmed to produce NDM-1 carbapenemase by molecular assay
NDM-1 Metallo β-Lactamase Type of Carbapenemase

- Bacteria with NDM-1 originally in New Delhi; many in UK, Europe, Israel; first noted 2008
  - Linked to medical care in India, Pakistan
  - Found in sewage and drinking water in New Delhi
- Reported (but uncommon) in USA - CA, IL, MA, MD, VA, WA
  - *E. coli* (2), *K. pneumoniae* (2), *E. cloacae*
  - 3 urine, 2 respiratory sources
- NDM-1 gene on plasmid; highly transferrable
- Isolates with NDM-1 highly resistant to many antibacterial agents

MMWR - June 22, 2012. 61(24):446; June 10, 2011. 60(22):756
Unusual forms of Carbapenem-resistant Enterobacteriaceae (CRE) increasing in USA

Majority from patients receiving overnight medical treatment outside USA

MDs and Infection control (IC) should consider additional precautions when such patients are hospitalized in USA
Patient Outcome

- Patient treated with **colistin** (last resort antibiotic) and **recovered**
- **No other patients** at UCLA contracted infection with NDM-1 producing *K. pneumoniae*
So those of us in the profession.....

Can explain..... what clinical microbiologists do,

the educational requirements needed,

and where jobs are and what they pay

but.....
We need your help!

We want to engage you as partners in carrying the message to your students about the opportunities available to them.
THANK YOU!