What's in a Name?

NOMENCLATURE CHANGES AND THE IMPACT ON MICROBIOLOGY

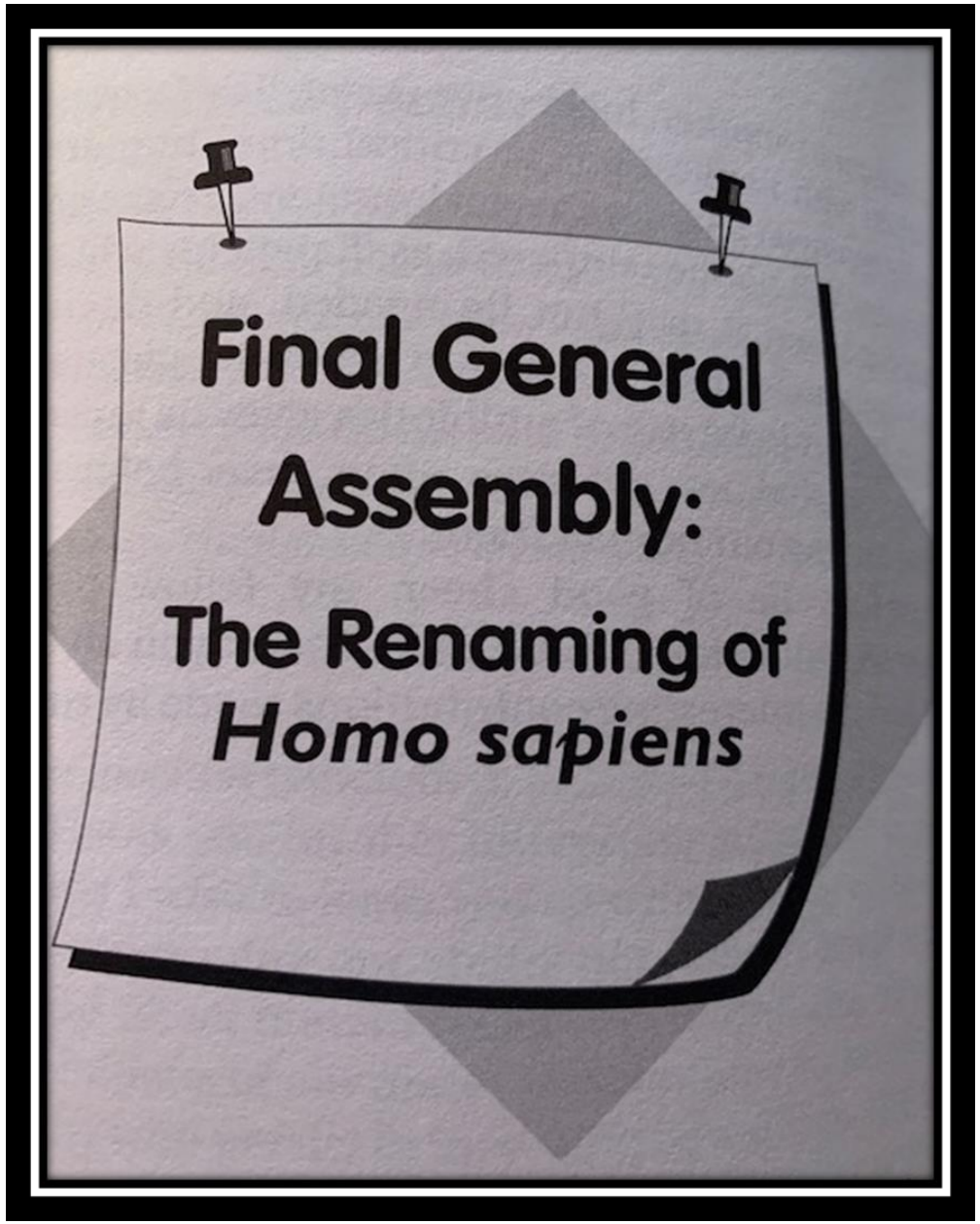
Patricia Tille Ph.D. MT (ASCP)

11/20/2019

Learning Objectives

WHAT'S IN A NAME – LAB BRIEFINGS WEBINAR

- Describe the nomenclature changes that are evident in bacteriology, parasitology and mycology
- List the potential impact that nomenclature changes may have on diagnostic testing and patient treatment
- Explain the impact that technology has had on not only the evolution of the taxonomic system in microbiology but how that influences the use of testing platforms in the laboratory



"Names are now validated to the extent that the requirements of the Code are met and assessment that the science is good. Even then, what lasts is determined by general acceptance…What is left to us these days, as we experience the ferment of ideas concerning the melding of phenotypic and molecular approaches to description, is to see that the education of microbiologists includes effective exposure to the nature and problems of bacterial taxonomy."

- R.G.E. Murray, ASM News, Dec 1988
- The Other End of the Microscope: The Bacteria Tell Their Own Story
- A Fantasy: by Elmer W. Koneman M.D.

Nomenclature Changes

- **Why are we seeing them?**
- **To what depth are we seeing them?**
- **Where are they occurring primarily?**

C. Difficile

- ***Clostridium difficile***
  - *Est. genus in 1880*
- ***Clostridiodes difficile***

- What is the reasoning for the name change?
- Is this really what it should be? Or is there a better suited name?
- What about industry?
- What about clinical practice?

Taxonomic Organization and Establishment

- *Clostridium* spp.
- Taxonomy was traditionally based on phenotypic characteristics
  - Psychrophiles, thermophiles and acidophiles
  - G + C content 21 to 54%
- Evolution to More Extensive Molecular Technologies
  - DNA Hybridization
  - 16srRNA
  - DNA sequencing
- Process
- Began in 1994, type species of the genus *Clostridium, C. butyricum*
  - And it is not over… more to come…

Expert Recommendation

Clostridium difficile to *Peptoclostridium difficile*

- family *Peptostreptococcaceae*

"With improved genetic testing and routine 16S rRNA and ribosomal protein sequencing, it was recognized that the taxonomic classification of C. difficile should be changed."

- Monica Mahoney, PharmD, BCPS-AQID

- *Clostridium*: *"The genus Clostridium was a waste basket for gram-positive spore-forming anaerobic rods," and goes on to say, "They weren't necessarily all related, but they were related by gram stain, some biochemical tests and visually."*

- Ellie J.C. Goldstein, MD

Infectious Disease News Editorial Board member, Clinical professor of Medicine at the University of California, L.A. School of Medicine

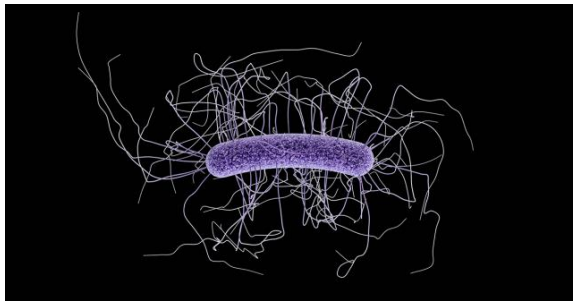
CardinalHealth

The “Global Backlash”

- Global backlash because of loss of the terms ‘C. diff’’ and ‘CDAD’ (*Clostridium difficile*-associated diarrhea).”
- Negative affect on patient care
  - Recognition of the name believed to go beyond the realms of medical practice.
- Cost to the health care system
- Cost to industry partners
  - Relabeling, the use of P instead of C….simple as that.

Resolution

Clostridiodes



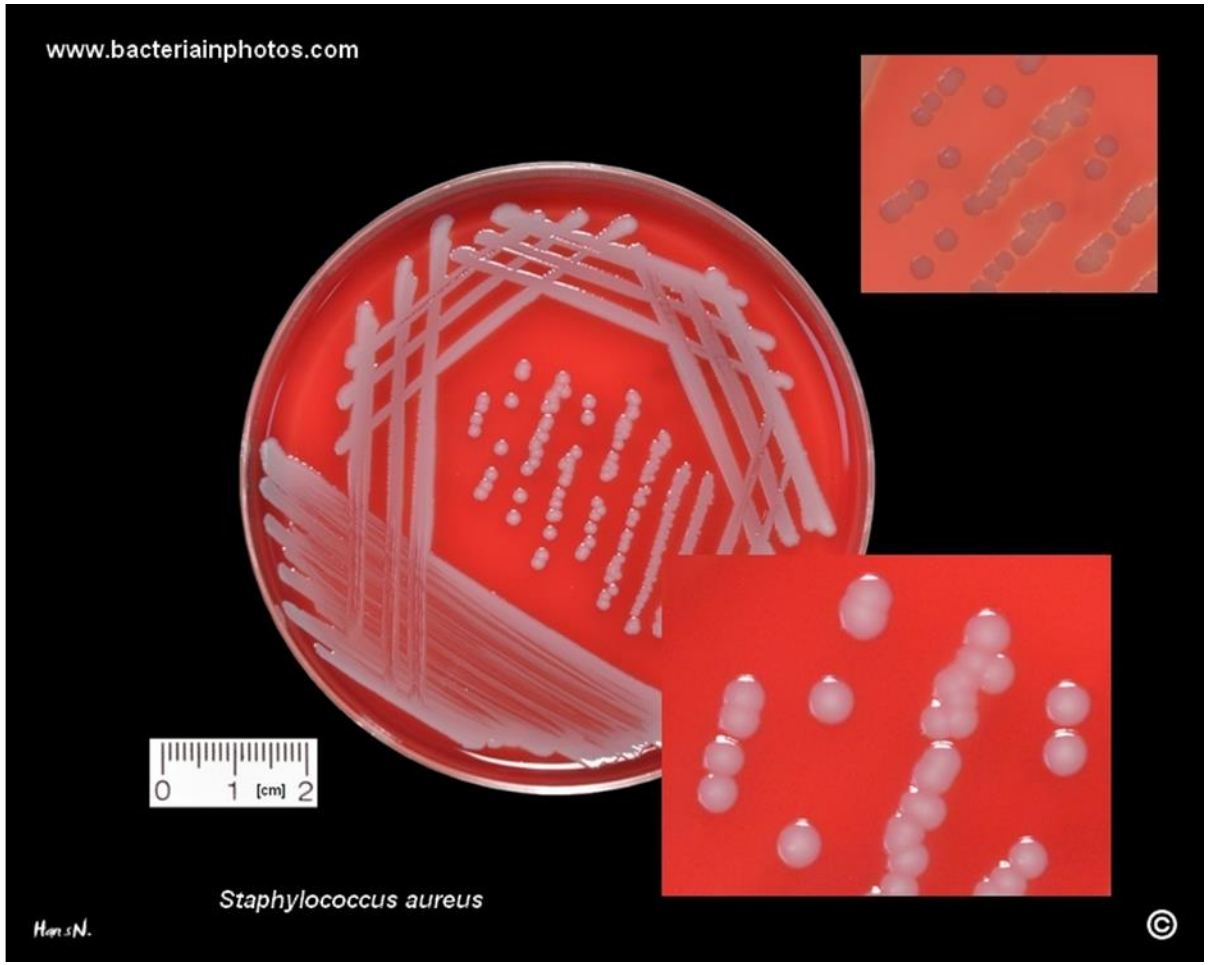
- Clostridia-like
  - Retain some of the distinctions of the old name to avoid less urgent changes
  - C to C and no P…
  - The abbreviations ‘C. diff,’ ‘CDAD,’ and others

- Why the resolution and what happens next?
  - Even if parties do not adapt, the similarities will not cause serious concerns.
  - For the time being…???

A horse of a different color!

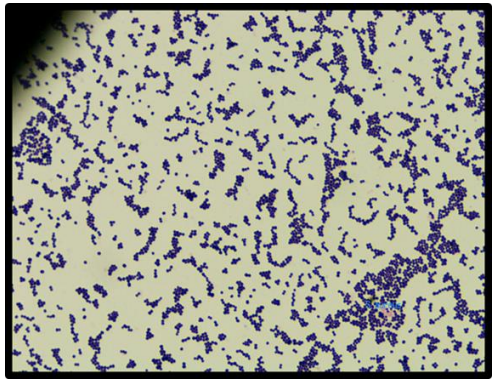
Staphylococcus aureus

Can you spot the *Staphylococcus aureus*?



CardinalHealth

S. aureus complex



Proposal that two members of the *Staphylococcus aureus* complex be given species names. (WGS)

- Clonal complexity with <2% nucleotide divergence
- Phenotypically identified previously as *S. aureus* (humans, primates and bats)
- Vitek (95-98%) certainty that they are the same organism
- Limitation identical to near identical 16s rRNA profiles

EXCEPT….

- *Staphylococcus argenteus*
- *Staphylococcus schwietzeri*

How was this determined?

- DNA to DNA hybridization <70%
- Distinct peptidoglycan types
- Different protein profiles on MALDI-TOF MS

CardinalHealth

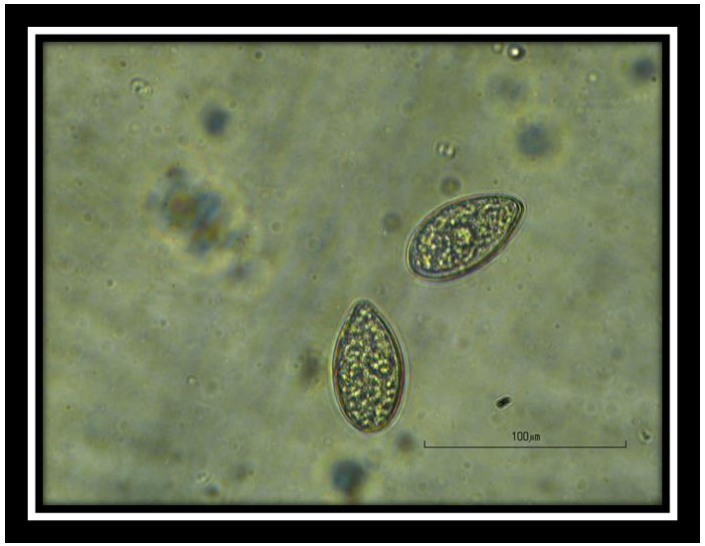
Clinically What will this do?

S. argenteus seems to cause similar disease (*S. aureus*)

- Prevalence, disease and mortality
- Skin and soft tissue infections
- Lacks yellow pigment
- Demonstrates a 12-15-fold increase in expression of quorum sensing loci that are found in *S. aureus*
- Molecular mechanisms still not fully elucidated

S. schwietzeri has not been reported as a cause of infection

- Produces alpha-toxin, like *S. aureus*



Parasitology

LIFE IS LIKE A BOX OF CHOCOLATES…

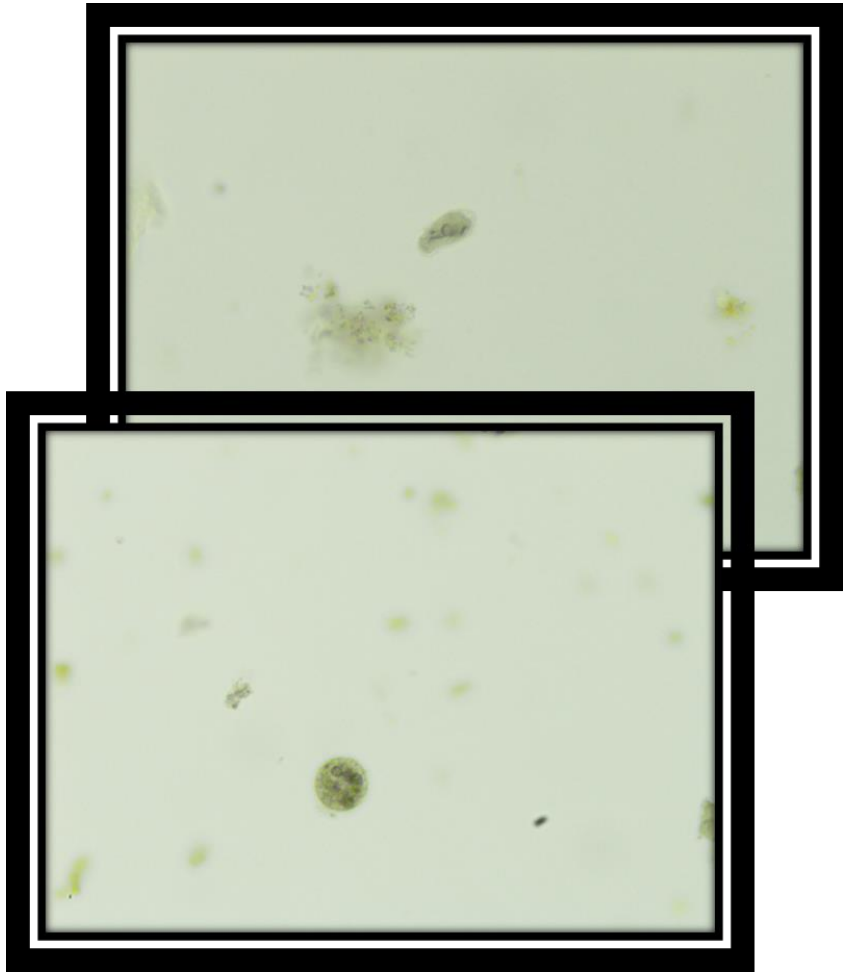
OR IN THIS CASE PARASITES!

Different Place and Time

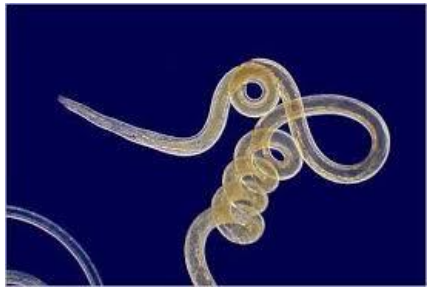
- Morphology
  - Still extremely focused on identification and demonstration of the organisms
- Molecular Technology
  - Lack of the need
  - Lack of the technology (even where there is need)
  - Lack of per personnel
  - Difficulty in the development of methodologies

Parasitology Changes

- *Balantidium coli*
  - *Neobalantidium coli*
- *Giardia lamblia*
  - *Giardia duodenalis*
- *Entamoeba (Round and Round we go)*
- *E. histolytica/E.dispar group*
  - *E. moskovskii*
  - *E. bangladeshi*
- *E. histolytica*



Parasitology Changes

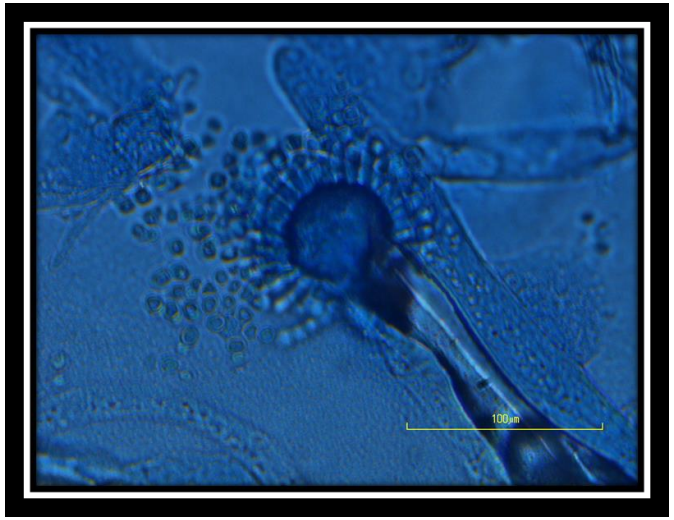


- New Discoveries (Changing the clinical perception)
  - *Dientamoeba fragilis*
- New species
  - *Leishmania* spp.
  - *Trichinella* spp.
  - *Brugia* spp. (Filarial worms)
  - *Taenia* spp.
  - *Diphyllobothrium* spp.
  - *Echinococcus granulosus* (now a complex)

Clinical Relevance in Parasitology

- Transmission routes
- Control methods
- Diagnostics may improve
  - Rule in or rule out other diseases
- Treatment options

- Economic Development
  - Livestock Health Improvement
  - Food preparation



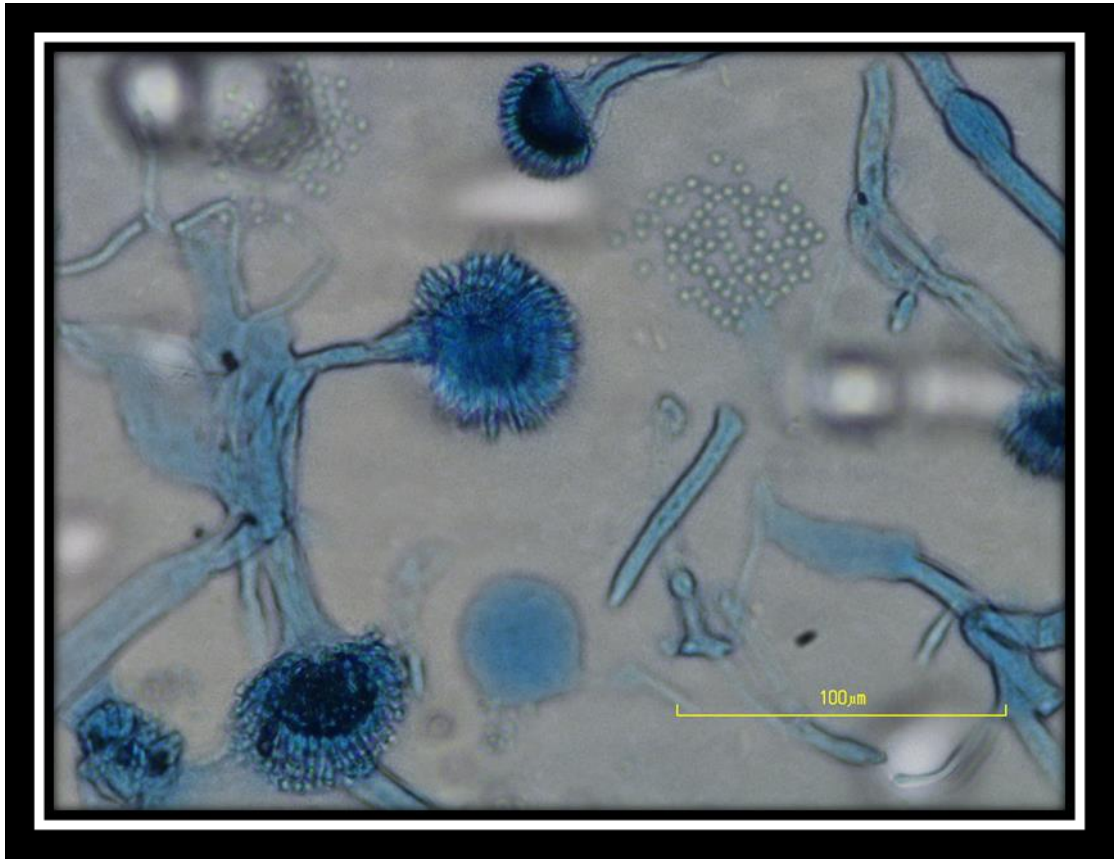
Fungus

WHAT ABOUT THE FUNGUS AMONG US AND THE CHANGING PATIENT POPULATION?

Mycology

Diagnostic Challenges

- Slow growth
  - Biochemical differentiation poor
- Lack of expertise
- Lack of new technology
  - Molecular
  - Discovering new organisms
  - Reclassifying others



Are they pathogenic or not?

- Patient population changes
- Immunocompromised
- Increase in use of anti-fungal medications
- Superficial, subcutaneous, systemic

Subcutaneous

DEMATIACEOUS (MELANIZED GROUPINGS). HOW DO WE LIMIT THIS?

Approximately 33 plus genera (many with new names)

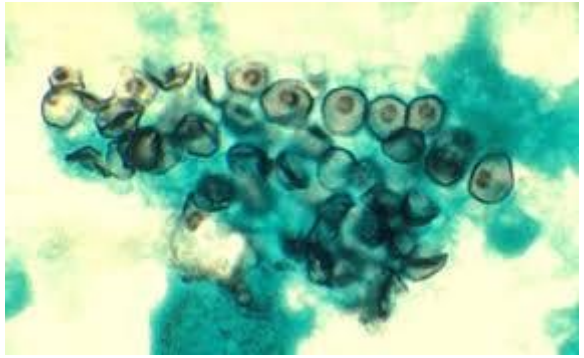
- From superficial to systemic
- It has been recommended that in medical mycology the term dematiaceous only be applied to rapidly growing members of the *Ploesoporales* (*Alternaria, Bipolaris, Curvularia, Exoserohilum,* and *Hongkongmyces*)
- Mycetoma, Chromoblastomycosis and Phaeohyphomycosis
- Let me show you a few…

Is it an Infection?

- *Exophiala bergeri*
- *Exophialia dermatitidis*
- *Exolphiala jeanselmei*
- *Exophiala oligosperma*
- *Exophiala xenobiotica*
- *Exoserohilum rostratum*
- *Knufia epidermidis*
- *Lasiodiplodia theobromae*
- *Macrophomina phaseolina*
- *Neoscytalidium dimidiatum*
- *Sporothrix pallida*
- *Alternaria alternate*
- *Alternaria infectoria*
- *Bipolaris oryzae*
- *Cladophialophora boppii*
- *Cladophialophora emmonsii*
- *Cladophialophora saturnica*
- *Cladorrhinum bulbillosum*
- *Cladosporium cladosporioides*
- *Cladosporium oxysporum*
- *Curvularia lunata*
- *Curvularia senegalensis*
- *Curvularia spicifera*
- *Diaporthe longicolla*
- *Diaporthe phaseolorum*
- *Diaporthe phoenicicola*

Etc. etc. etc.

Atypical and Para fungal Agents



Pneumocystis carinii to *Pneumocystis jirovecii*

There are five species

1. Morphology is similar to that of protozoa
2. Clinically it responds to antiprotozoal drugs but not to antifungal drugs in patients
3. DNA says it is a fungus
4. Multiple types of molecular analyses
   - None FDA approved
5. There are several other Para fungal agents
   - Tropical and subtropical

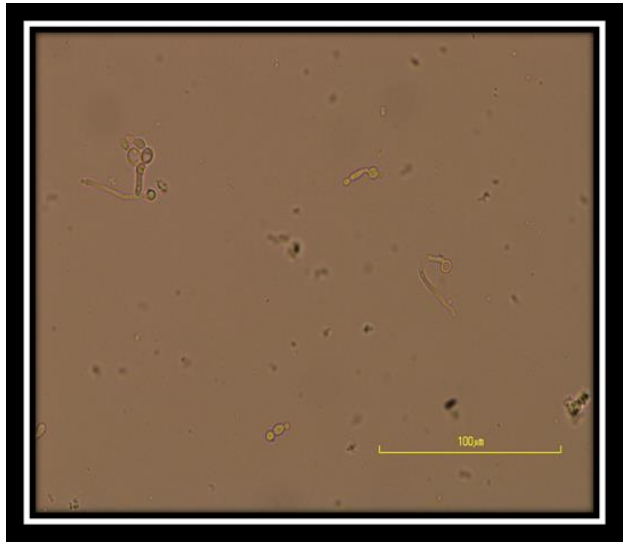
Molds and Environmental

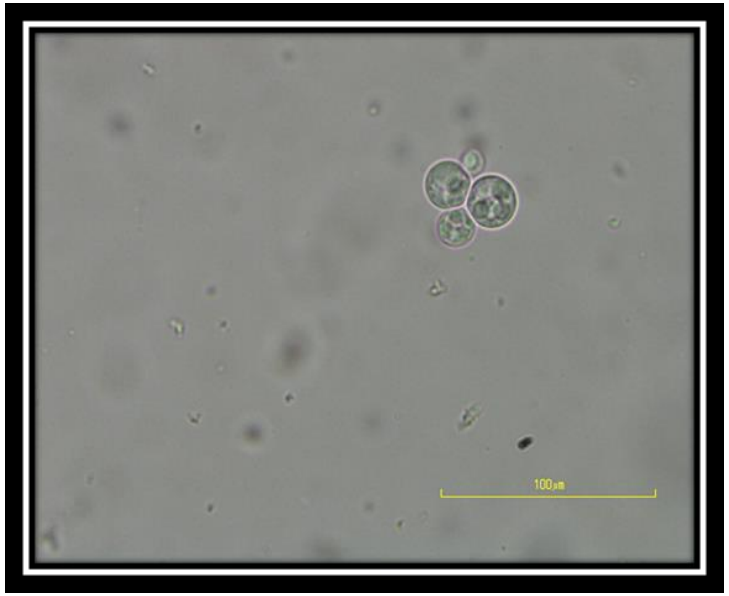
DIAGNOSTICS HAS NOT KEPT UP WITH THE NEEDS OF THE PATIENT

Yeast

Approximately 8 new genera

- Many stem from previous grouping in *Cryptococcus* spp.
  - Reorganized, multiple species
  - Non-neoformans being recognized as pathogens.
- *Candida* spp. (> 200)
- Mortality rates can be more than 50%
- *Candida albicans* complex
  - *C. albicans, C. dublinensis, C. africana*
- *C. auris* (emerging pathogen)
  - Multi drug resistant
  - Unable to identify (traditional methods)



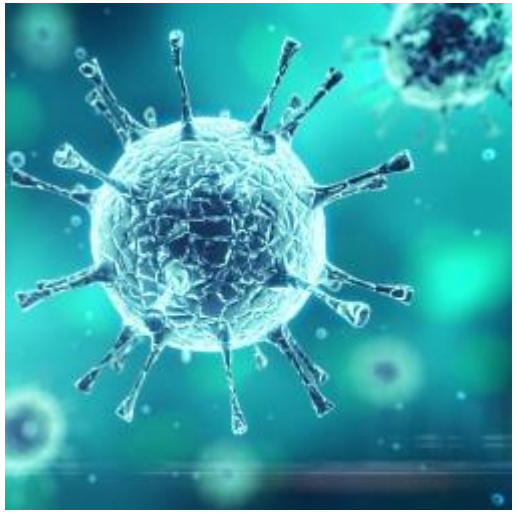


CardinalHealth

CardinalHealth
Essential to care™

Differentiating among the *Candida* spp. in the clinical mycology laboratory is vital as susceptibility to antifungal agents can no longer be reliably predicted due to mutations in drug targets and the acquisition of resistance determinants.

Bailey and Scott's, 15th Edition



Virology

DIAGNOSTICALLY – SIGNIFICANT PROCESS

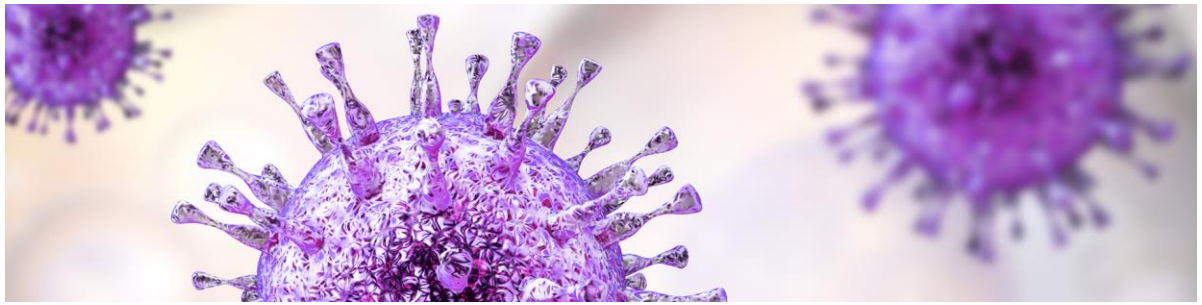
MAIN CHALLENGE RELIES IN TREATMENT AND THERAPEUTIC MONITORING

Virology

Diagnostics have not changed

- Minor movement and creation of new families
  - Seven to ten DNA families
  - Fourteen to twenty-one RNA families
- Bunyaviridae
  - Hantaviridae

Molecular Virology

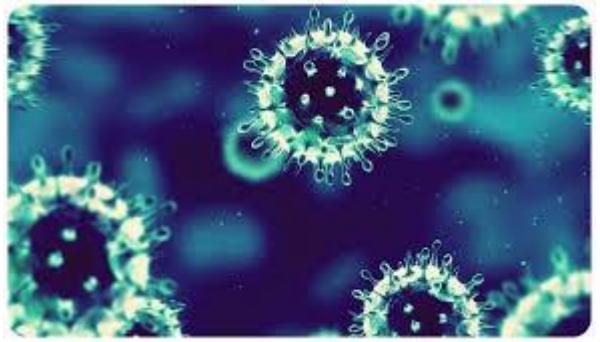


- Serotypes to Genotypes
- 52 to 85 adenoviruses
  - Genotypes more closely related to virulence and clinical symptoms
  - Serotype and genotype differentiation not required unless immunological response is varied based on virulence.
- Species A – G
  - Subspecies example B1 and B2

Calciviridae

- Norwalk-like virus, *Noroviruses*
  - Genogroups 1-IV
- Sapporo-like virus, *Sapporoviruses*
  - Genogroups 1-V
- Each genogroup then has a genetic cluster
- Multiplex assays detect them in the major groupings (Genera)
  - No differentiation noted at this time.

Coronaviridae



- Five genera (RNA viruses)
  - Collectively referred to as coronaviruses (CoVs)
- SARS and MERS
  - Severe acute respiratory syndrome-related coronavirus
  - Middle East respiratory syndrome-related coronavirus
- Diagnostics
  - Multiplex assays are available for the rapid detection of the human endemic species of corona-virus

Wrapping it up!

BACTERIOLOGY, PARASITOLOGY, MYCOLOGY AND VIROLOGY

Lions and Tigers and Bears… Oh MY!

- *Staphylococcus*
  - 45 species and 21 subspecies
  - 49 species and 25 subspecies
- *Streptococcus (Enterococcus)*
  - Are now different families
  - 14 additional genera that are confused with streptococci in the clinical laboratory
  - *Enterococcus* 57 species alone.
- Bacillus
  - The has been the largest genus, >100 related genera and species
- *Corynebacterium*
  - More than 8 new potentially clinically relevant species
  - 8 closely related genera

Giraffes and Elephants and Kangaroos… Oh MY!

- *Nocardia, Streptomyces, Rhodococcus*, and Similar Organisms
  - Approximately 12 new related genera
- *Enterobacteriaceae*
  - *Shigella* versus *E. coli*
  - Slight changes
    - *Klebsiella aerogenes* (*Enterobacter aerogenes*)
- Subspecies
- Increase in species in many genera
  - Identification of new species (*Proteus* spp.)

Fixing the Outliers

CDC Groups

- CDC 1c, O3 and on and on….
- Classified more appropriately
- CDC group 2 a

Organisms that did not grow well, or other unique characteristics

- *Anaerobes*
- *Mycobacterium* spp.
- *Mycoplasma* spp.
- *Spirochetes*

Elizabethkingia meningosepticum

(and then there were three)

- *E. miricola*
- *E. anophelis*

- DISTINCTIONS THAT MAY OR MAY NOT BE RELEVANT

“The organism ID is not important; it is the sensitivity profile that matters.”

HAVE YOU EVER HEARD A LABORATORIAN SAY THIS?

WHAT ABOUT A PRIMARY CARE PROVIDER?

Antimicrobial Sensitivities

- How does the new technology and new naming system have an affect on antimicrobial sensitivity…and patient treatment?
- It **does** matter
- The panels are designed based on recommended drug regimens for specific organism types
- Antibiogram accuracy
  - Mixed results if the organism identifications have been inaccurate

What's in a Name? Taxonomic

- Phenotypic
- Genotypic
- Polyphasic Taxonomy

- Molecular Advancements
- PCR (polymerase chain reaction)
- Multi-locus sequence typing
- Ribosomal RNA (16s rRNA)
- Whole Genome Sequencing

- Testing platforms
- Biochemical, proteomic and genomic

What's in a Name? Diagnostics

- Improvement in diagnostic methods
  - Faster, newer, more accurate
- Improvement in surveillance
  - Faster, newer, more accurate
- Improvement in patient treatment
  - Accurate organism, accurate treatment
- Improvement in patient outcomes
  - Rapid, accurate treatment, better outcomes

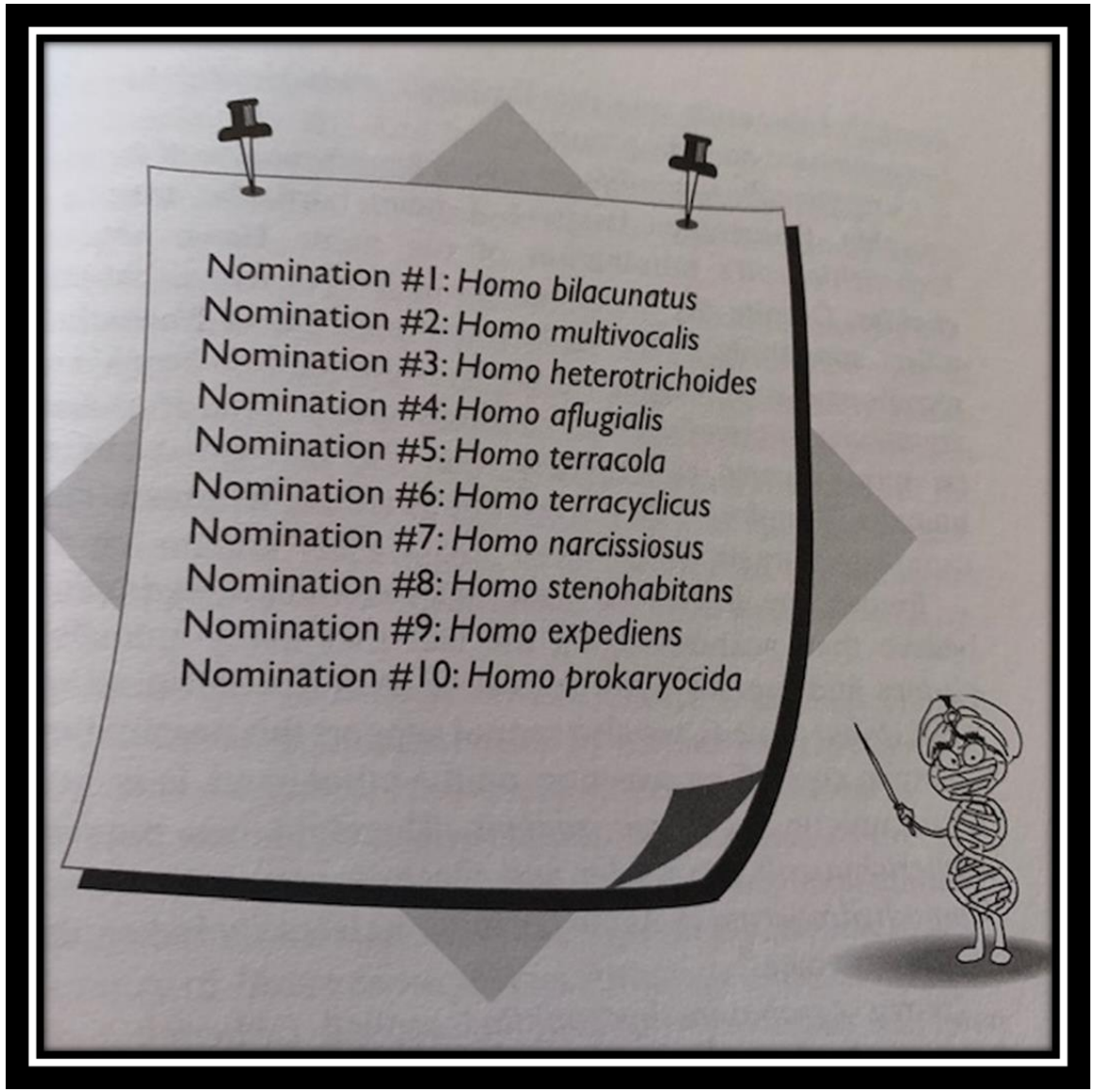
✓Long term benefits

✓Improve health care costs

✓Reduce mortality

“The purpose of scientific names of organisms is unambiguous communication.”

2007, comment from The Lancet Infectious Diseases laid out the case for using *Pneumocystis jirovecii* as the cause of pneumocystis pneumonia, rather than *Pneumocystis carinii.*



"*Escherichia coli* then proclaimed, "Be it known, then that Homo multivocalis shall be placed in the formal records as the prokaryotes" new name for *Homo sapiens*, as duly nominated and passed this assembly."

- The Other End of the Microscope: The Bacteria Tell Their Own Story
- A Fantasy: by Elmer W. Koneman M.D.

Thank you!