The Untapped Potential of ATCC's Mycology Collection

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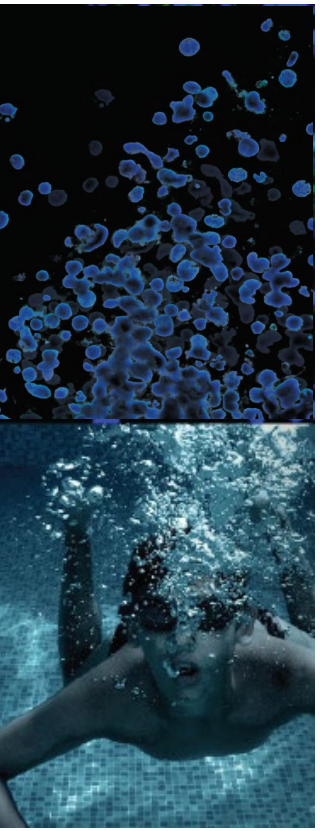
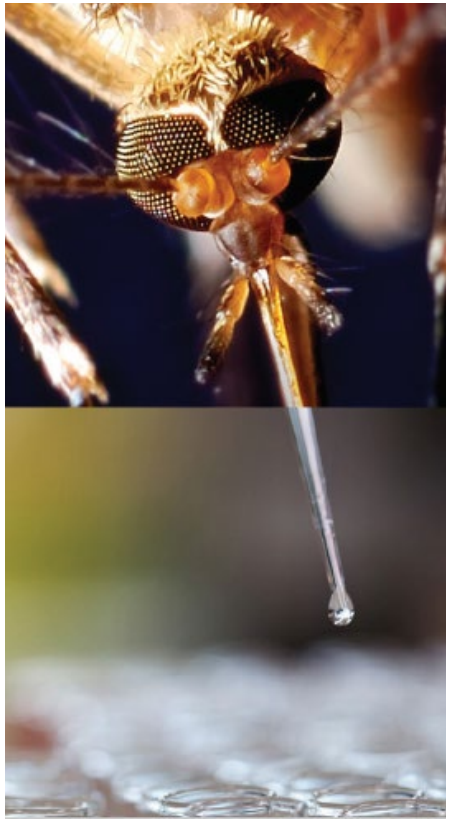
Credible leads to Incredible™

"Why science matters – health, livelihood, and the pursuit of a better quality of life – this is the story of our time."

– Raymond H. Cypess, DVM, PhD





A strategy to support the new ATCC begins here

Our Vision

To use our resources and experience as a biological resource center to be the recognized leader in biological reference materials — particularly in the acquisition of new content, development of reference standards using our unique assets, and thought leadership around how biological research can be improved through the standardization and certification of biological materials.

Our Mission

To acquire, authenticate, preserve, develop, standardize, and distribute biological materials and information for the advancement and application of scientific knowledge.

Core Values

- To listen to and observe our customer's needs and meet those needs with quality products and services.
- We welcome change and encourage an environment of innovation, creativity, and collaboration.
- We are dedicated to the highest ethical standards in our business as demonstrated by our concern for the environment, adherence to national and international laws, respect for regulations, and communication with the public.
- We recognize that scientific and technical leadership related to the authentication, propagation, and preservation of biological standards is critical to our mission and to our customers.
- We are committed to helping our employees develop their talents and make optimal use of their abilities, and we recognize performance that contributes to our success.

Credible leads to Incredible™

ATCC – Life science innovations that touch people

- Founded in 1925 - we have been supplying scientists with essential scientific resources, services, and standards for nearly a century
- ATCC is ISO 9001 and ISO 13485 certified and ISO/IEC 17025 and ISO 17034 accredited
- Leading global supplier of authenticated cell models and viral and microbial standards
- An innovative R&D company that provides better models
  - Gene editing, microbiome, NGS, primary cells, and advanced cell models
- Services provider
  - Customer base in diagnostics, drug discovery, and applied markets; cGMP and Biorepository Services
- Patent repository consists of >90% of all USA bio-patents

bsi. ISO 9001 Quality Management

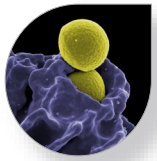
bsi. ISO 13485 Medical Devices Quality Management

ANAB ACCREDITED ISO/IEC 17025 TESTING LABORATORY

ANAB ACCREDITED ISO 17034 REFERENCE MATERIAL PRODUCER

ATCC

Credible collections



The ATCC collection of cell and microbial reference materials remain at the heart of incredible breakthroughs in scientific exploration. ATCC is dedicated to providing biological standards backed by cutting-edge authentication techniques and essential resources that accelerate innovative research and ensure scientific reproducibility within the life sciences.

Cell Biology

Authenticated and quality controlled

- Over 5,000 cell biology products
- Primary cells, hTERT-immortalized cells, continuous cell lines, and 2-D and 3-D patient-derived in vitro cancer models (organoids) that include clinical and sequencing data
- Many cancer cell models are annotated with their molecular profiles
- DNA available from many cell lines
- Supporting culture media and reagents

Focused new product areas

- CRISPR-edited isogenic models
- Exosomes
- Quantitative DNA

Microbiology

Comprehensive microbial collection with enhanced authentication

- Includes 70,000+ microbial strains, including bacteria, yeast, fungi, protozoa, and viruses
- Over 1,000 derivatives, including nucleic acid preparations and polysaccharides

Brand Recognition

- Organizations and regulatory agencies specify ATCC cultures in their standards and guidelines
  - USP, ISO, FDA, CLSI, USDA, ASTM, AOAC, WHO
- Over 475 reference strains recommended for use in quality control

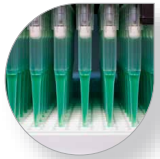
Focused new products

- Metagenomic and other standards for use in NGS
- Standards for human microbiome research
- Quantitative genomic and synthetic nucleic acids
- Highly characterized multidrug-resistant clinical isolates
- Quantitative viral reference standards for gene therapy
- Purified, high-titer viruses

Developing and maintaining biological standards that protect public interest and provide quality reference material, education, and authentication services

Providing reference materials with enhanced authentication for use in assay development, bioproduction, quality control testing, and basic research

Authentication – Quality control



ATCC uses a variety of advanced techniques to characterize and authenticate biomaterials—no single method of identification is sufficient. Researchers look to ATCC for a wide range of authentication resources to safeguard reproducibility and meet requirements for funding, publication, and quality control.

Cell Authentication

- Mycoplasma testing
  - PCR
  - Direct & indirect
- STR analysis (intraspecies testing)
- CO1 assay (interspecies testing)
- Sterility testing
- Human pathogenic viral testing
- Functional & molecular characterization with both positive and negative controls

Microbial Strain Authentication

- Genotypic & proteotypic analysis
  - Whole-genome sequencing (ATCC Genome Portal)
  - 16S rRNA and ITS region sequencing
  - MALDI-TOF MS
  - Toxinotyping
- Phenotypic analysis
  - Colony morphology
  - Cell attributes
  - Biochemical analysis
- Functional analysis
  - Serotype
  - Drug resistance
  - Virulence

Advancing authentication through credible standards combined with robust next-generation sequencing workflows

The history of mycology at ATCC

1925 — ATCC was established when a committee of scientists recognized the need for a central collection of microorganisms to serve scientists worldwide.

1927 — First ATCC catalog published.

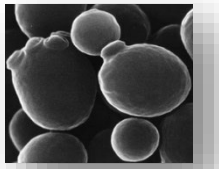
1938 — Began freezing and freeze-drying microorganisms

1975 — Mycology holdings just over 10000, with 3984 annual distributions

1977 — ATCC started Seed/DI stock system for distributing qualified materials

1981 — ATCC accepts patent materials under Budapest Treaty rules.

1999 — Mycology collection added > 22K of yeast genetic strains from Yeast Genetic Stock Center (1999) and *Saccharomyces* Genome Deletion Project (2000).



2000

2007 — Mycology holdings reached to nearly 50000; 7600 spp. in 1500 genera

2008 — End of funding support from National Science Foundation to Mycology Collection for new accession (1972-2008)

2013 — Initiated Central Accessioning Unit (CAU) to bring high-quality, new materials into ATCC for rapid distribution to the scientific community

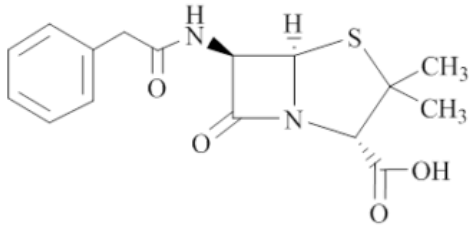
2014 — Started ATCC Type Strain Depository specified for maintaining microbial type strains efficiently

2019 — Started the ATCC Genome Portal

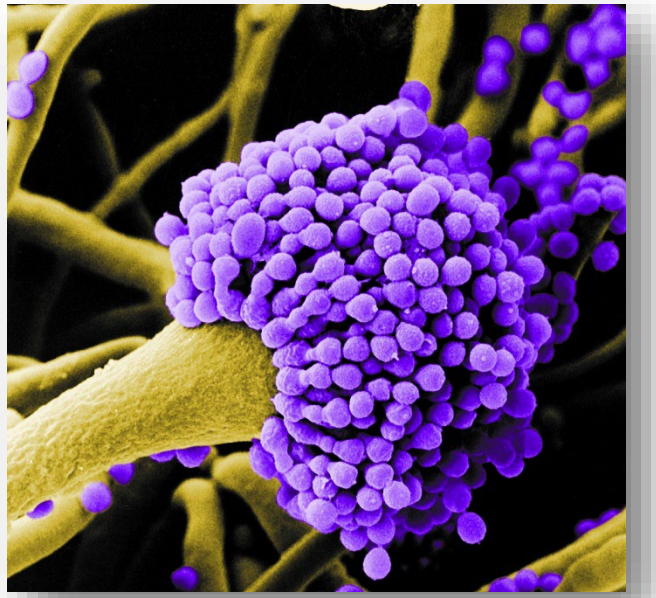
The importance of fungi

Fungi can be used to address numerous global challenges

- >148,000 fungal species have been described, but high-throughput sequencing estimates that up to 3.8 million fungal species exist
- Cultivated samples are not available for > 80% of the currently described fungi
- Fungi are metabolically creative and can be harnessed for many industrial uses (antibiotics, biocontrol, enzymes, biodegradation)



penicillin G



Paton et al. 2020

Hawksworth & Lücking, 2017

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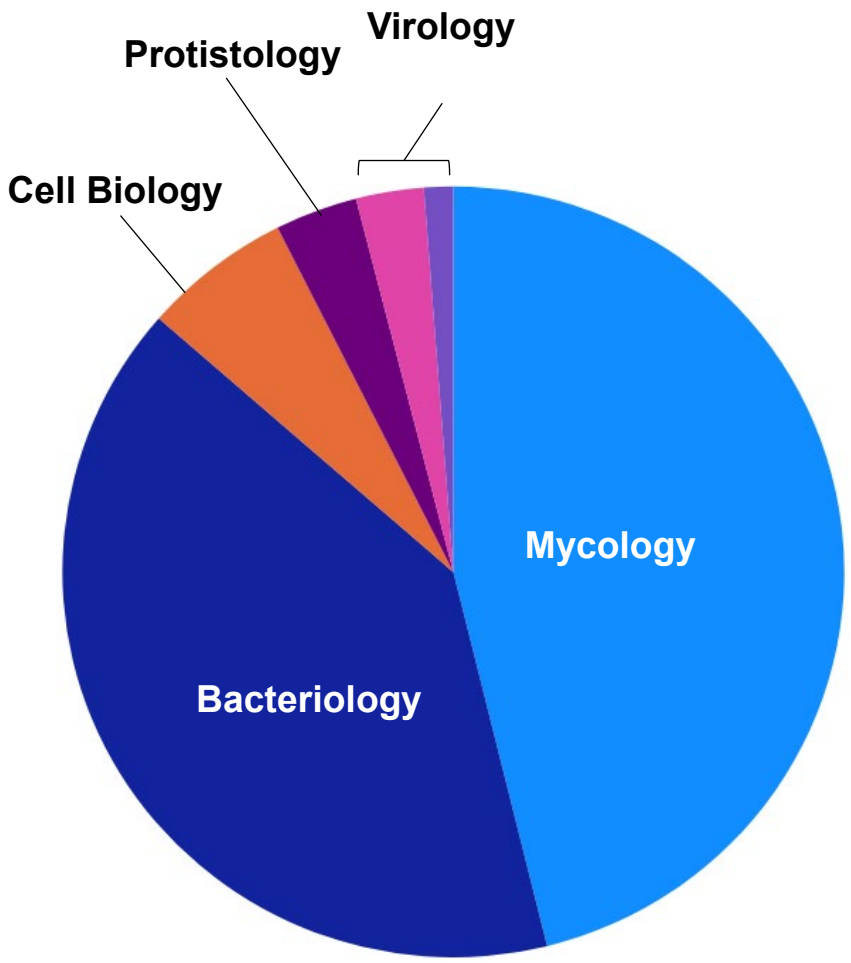
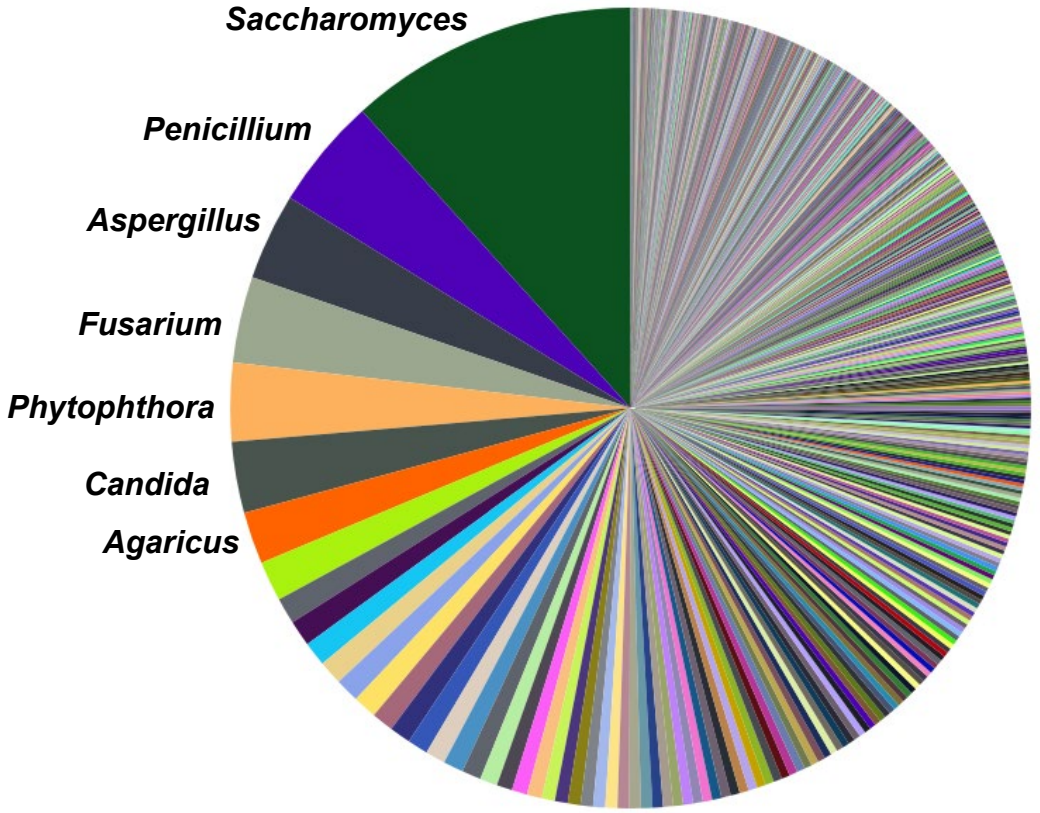
ATCC's mycology collection represents significant diversity

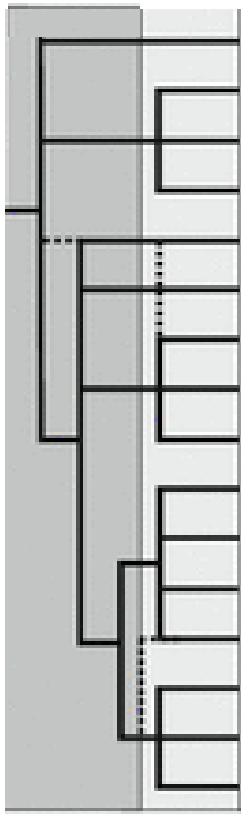
The fungal collection is extremely diverse and could be targeted for expanded use



Mycology Collection
7,904 species/1,864 Genera



We have isolates from almost all phylum in our collection

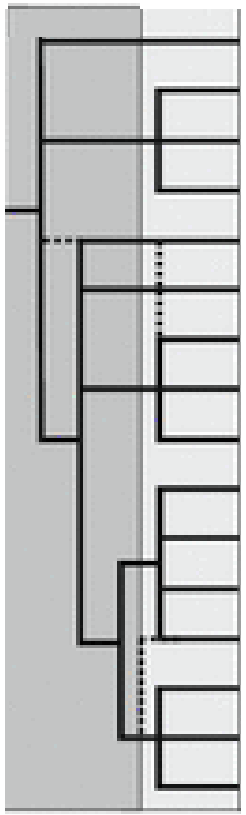


Phylum	Number of genera
Blastocladiomycota	3
Chytridiomycota	21
Monoblepharomycota	3
Neocallimastigomycota	4
Olpidomycota	
Basidiobolomycota	1
Zoopagomycota	4
Kickxellomycota	11
Entomophthoromycota	7
Calcarisporiellomycota	1
Mucoromycota	49
Mortierellomycota	4
Glomeromycota	
Entorrhizomycota	
Basidiomycota	507
Ascomycota	1225

Fungal Diversity volume 90:135–159 (2018)

We have isolates from almost all phylum in our collection

Our collection encompasses multiple classes of Basidiomycota



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Mortierellomycota	4
Glomeromycota	
Entorrhizomycota	
Basidiomycota	**507**
Ascomycota	1225

Sub-phylum	Class	Number of genera
Agaricomycotina	Agaricomycetes	367
	Dacrymycetes	6
	Tremellomycetes	41
Ustilaginomycotina	Cintractiellales	1
	Exobasidiomycetes	17
	Ustilaginomycetes	10
Pucciniomycotina	Agaricostilbomycetes	7
	Atractiellomycetes	4
	Cystobasidiomycetes	10
	Microbotryomycetes	28

Fungal Diversity volume 90:135–159 (2018)

We have isolates from almost all phylum in our collection

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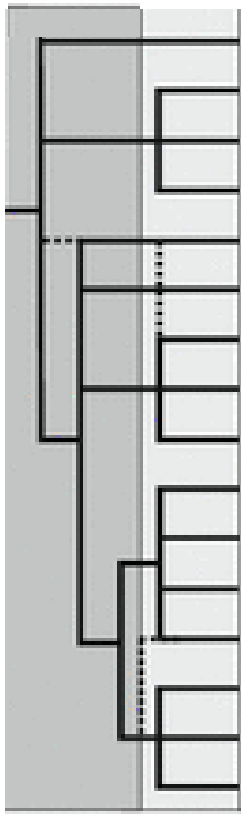

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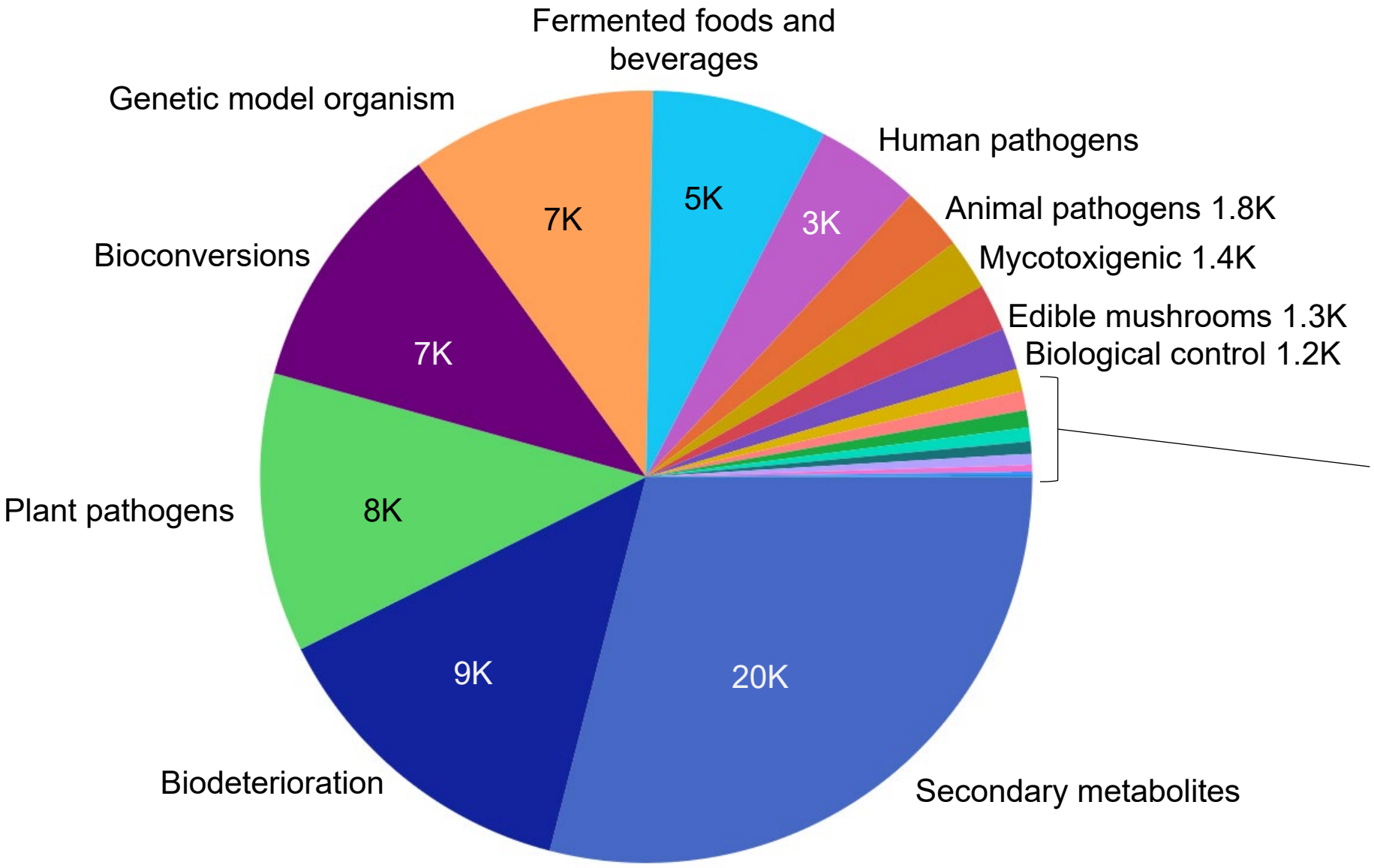
Entorrhizomycota	
Basidiomycota	507
Ascomycota	**1225**

Sub-phylum	Class	Number of genera
Pezizomycotina	Arthoniomycetes	3
	Cacumisporium	1
	Candelariomycetes	1
	Dothideomycetes	277
	Eurotiomycetes	125
	Lecanoromycetes	19
	Leotiomycetes	133
	Orbiliomycetes	12
	Pezizomycetes	40
	Sareomycetes	1
	Sordariomycetes	461
	Xylobotryomycetes	1
Saccharomycotina	Saccharomycetes	88
Taphrinomycotina	Schizosaccharomycetes	1

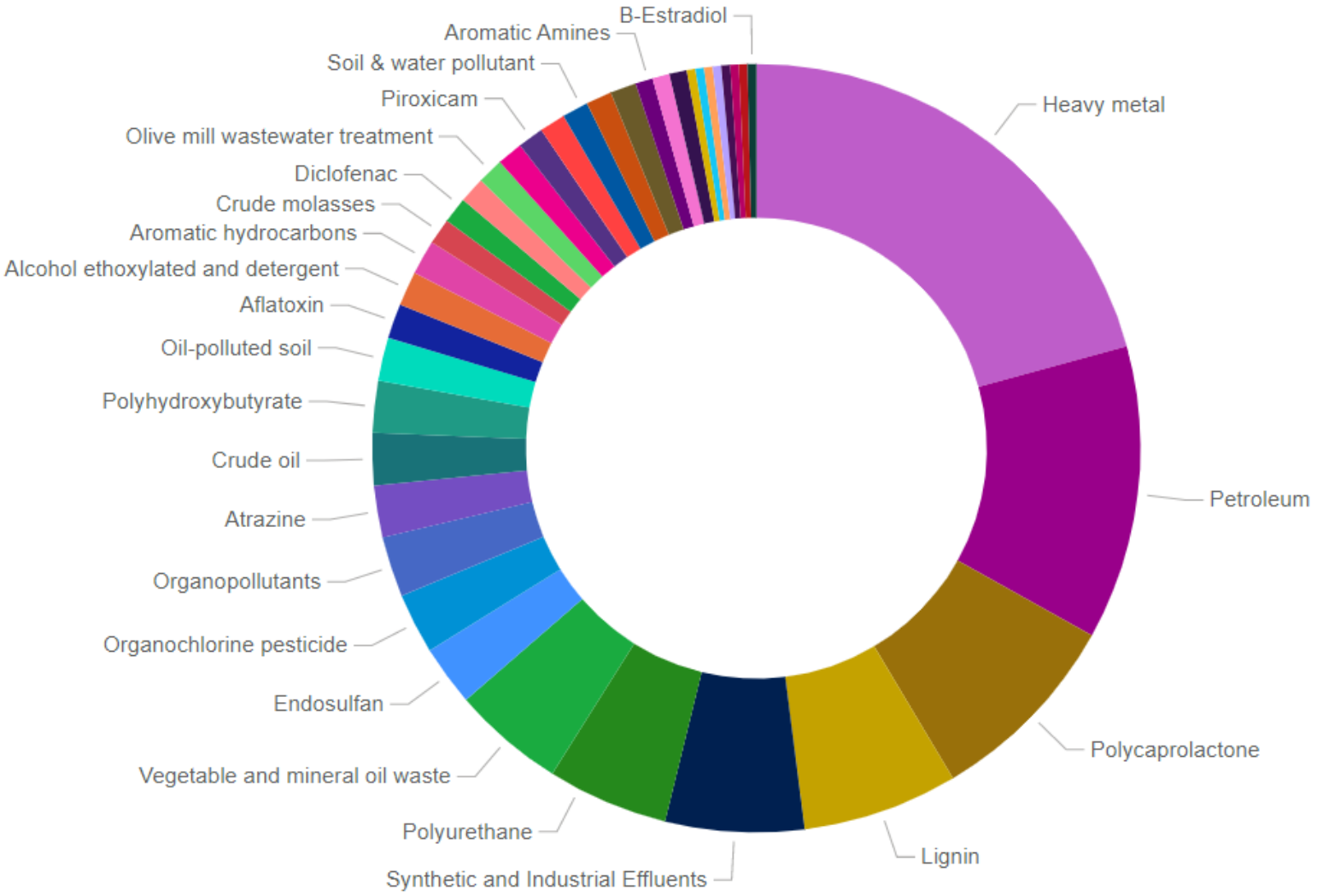
Fungal Diversity volume 90:135–159 (2018)

The mycology collection has many uses in industrial processes



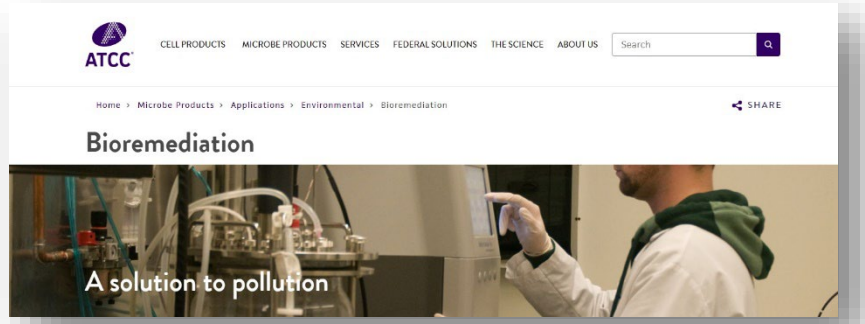
Use	#
Biopolymers	652
Organic acids	564
Fatty acids	502
Plant growth promotion	405
Enzymes	354
Mycorrhizae	326
Hydrocarbon degradation	198
Food coloring and pigments	92
Pullulan	49
Algal parasite	2

Potential of the ATCC fungal collection: Bioremediation



We have fungi with the potential to degrade a wide range of recalcitrant compounds

As we sequence the genomes of these strains, we can mine their potential



www.atcc.org/bioremediation

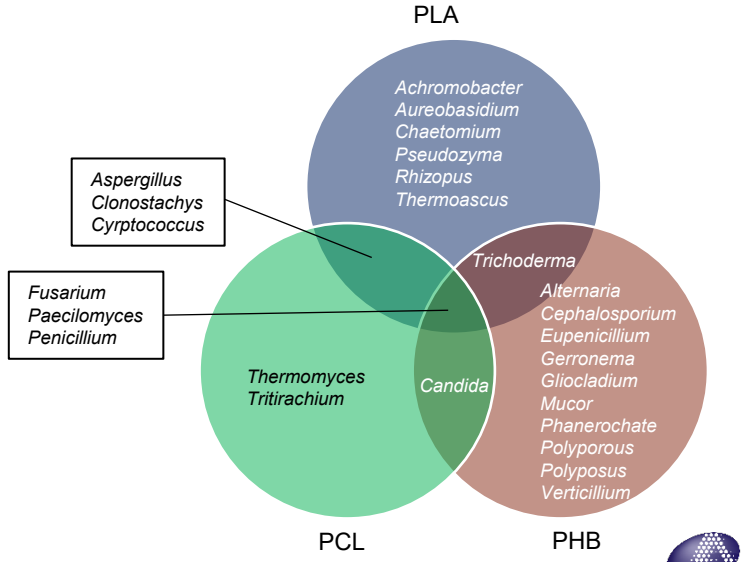
ATCC fungal strains are globally sourced

Our fungal strains with bioremediation potential have been isolated from across the world

Case Study: Biodegradation of plastics

- Petroleum-based plastics are wildly used in industry as they are resistant to temperature, pressure, UV light, and chemical solvents.
  - Worldwide production increased from 1.5 million tons in 1950 to 388 million tons in 2015 → 109 kg/person/year
  - Only a small portion of plastics are recycled or incinerated, resulting in most of these materials in landfills or scattered across the planet.
- Some petroleum-based plastics, such as polycaprolactone (PCL), are biodegradable.
- Bioplastics such as polylactic acid (PLA), poly-3-hydroxybutyrate (PHB) are being explored as alternatives to petroleum-based plastic as they can be degraded by microorganisms.
- We have many representatives of the fungal genera reported to degrade these compounds in our collection.

https://bioplasticsnews.com

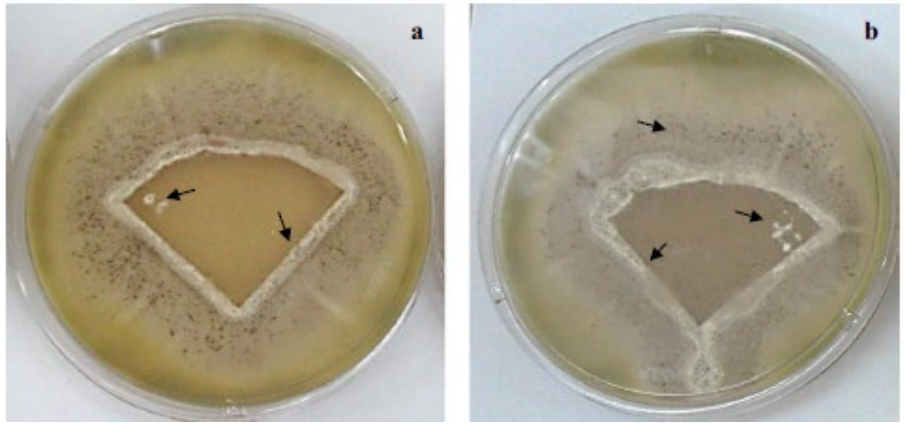


Sankhla et al. 2020. https://doi.org/10.1016/B978-0-12-821007-9.00004-8

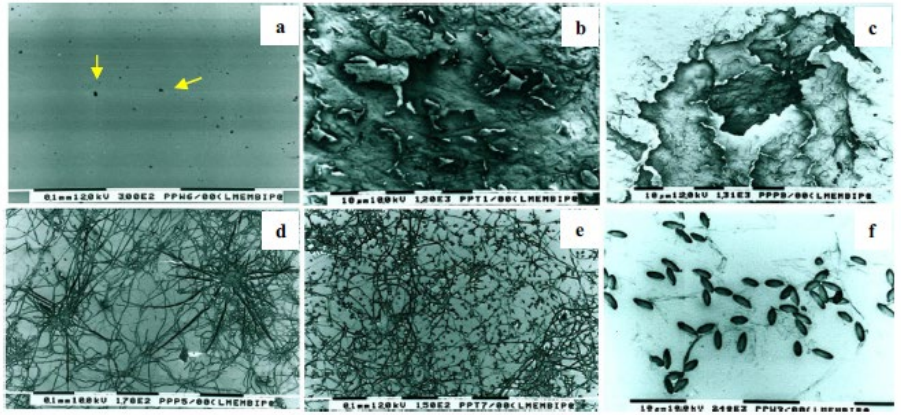
Case Study: Biodegradation of plastics by ATCC fungi

- *Five fungi* were tested for degradation of polycaprolactone (PCL) and polyvinyl alcohol (PVC) plastics as outlined in ISO 846-1978 “Testing of plastics - Influence of bacteria and fungi.”
  - *Aspergillus brasiliensis* (ATCC® 9642™)
  - *Chaetomium globosum* (ATCC® 16021™)
  - *Penicillium funiculosum* (ATCC® 11797™)
  - *Paecilomyces variotii* (ATCC® 16023™)
  - *Trichoderma virens* (ATCC® 9645™)
- No significant degradation of PVC occurred by any axenically grown fungi in 28 days
- There was up to 75% loss by the consortium of microbes on PCL films within 28 days
- Degradation was attributed to *Chaetomium globosum* (ATCC 16021), which completely degraded the PCL film within 90 days in soil.

Growth of *Chaetomium globosum* on (a) PVC and (b) PCL



SEM Images of *Chaetomium globosum* on PCL film



Vivi et al. 2019. https://doi.org/10.1007/s12223-018-0621-4

Case Study: Biodegradation of volatile organic compounds

- Volatile organic compounds (VOCs) are by products of industrial processes and require air pollution control technologies.
- Biofiltration using a biolayer on a solid support is a promising treatment option
- Five fungal strains were tested for their ability to degrade nine compounds commonly found in off gas emissions:
  - *Cladosporium resinae* (ATCC® 34066™)
  - *Cladosporium sphaerospermum* (ATCC® 200384™)
  - *Exophiala lecanii-corni* CBS 102400
  - *Mucor rouxii* (ATCC® 44260™)
  - *Phanerochaete chrysosporium* (ATCC® 24725™)
- Each fungal strain was tested on a solid support with each compound as the sole c source at three different pH ranges

Rick Stowell, University of Nebraska

Qi et al. 2022. DOI 10.1007/s00253-002-0938-3a

ATCC®

Case Study: Biodegradation of volatile organic compounds

- *Cladosporium resinae* (ATCC 34066) *and Phanerochaete chrysosporium* (ATCC 24725) grew on all compounds as sole carbon source.
- All fungi grew on at least two VOCs

Growth of fungi on VOCs as sole C source om solid support media

	C. resinae	*C. sphaerospermum*	*E. lecanii-corni*	*M. rouxii*	*P. chrysosporium*
No carbon source	–	–	–	–	–
Glucose	+	+	+	+	+
Ethyl-3-ethoxypropionate	+	+	+	+	+
n-Butyl acetate	+	+	+	+	+
Methyl ethyl ketone	+	+	+	–	+
Methyl propyl ketone	+	+	+	–	+
Methyl isobutyl ketone	+	+	+	–	+
Benzene	–	+	+	–	+
Toluene	+	+	+	–	+
Ethylbenzene	+	+	+	–	+
Styrene	–	+	+	–	–

- These results highlight the potential of these fungi to degrade these VOCs and provide a quick method to screen for microbes for use in biofilters.

ATCC

We are adding genomes to our authentication pipeline

- How do we bring authentication into the genomics era while maintaining our commitment to our customers that we've fully and accurately authenticated our material?
- Typically, authentication* may refer to:
  - Morphology
  - Purity
  - Viability
  - Phenotypic testing
  - Genotypic testing
    - ITS and D1D2
  - Biochemical profiling
- Genomes will allow mining for biochemical potential and production of secondary metabolites.

ATCC

CERTIFICATE OF ANALYSIS

ATCC® Number: 12228D-5™
Lot Number: 70006950

Designation: Staphylococcus epidermidis genomic DNA
Fill Volume Prior to Drying: 80 µL
Product Format: Dried microbial DNA
Expiration Date: Not applicable
Storage Conditions: 2°C to 8°C

Test / Method	Specification	Result
OD_{260}/OD_{280} ratio (Spectrophotometer method)	1.6 to 2.1	1.8
Total amount of DNA (PicoGreen® measurement)	≥ 5 µg per vial	6 µg/vial
Agarose gel electrophoresis	High molecular weight chromosomal DNA; No visible RNA	High molecular weight chromosomal DNA; No visible RNA See photograph below
PCR Functionality	Successful PCR amplification of selected gene(s)	Successful PCR amplification of selected gene(s)
Sequencing of selected gene(s)	Consistent with source organism	Consistent with source organism

1 2

Lane 1: Invitrogen™ TrackIt™ 1 Kb Plus DNA Ladder
Lane 2: 12228D-5™

Quality Assurance Specialist, Quality Assurance
ATCC hereby represents and warrants that the material provided under this certificate is pure and has been subjected to the tests and procedures specified and that the results described, along with any other data provided in this certificate, are true and correct to the

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Fax: 703-365-2750
E-mail: tech@atcc.org
or contact your local distributor

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Template Doc ID: 51164 | Template Revision: 4 | Template Effective Date: 12/31/2014

*not an inclusive list

ATCC Genome Portal

The ATCC Genome Portal is a cloud-based platform that enables users to easily browse genomic data and metadata by simply logging into the portal

Download whole-genome sequences and annotations of ATCC materials

Search for nucleotide sequences or genes within genomes

View genome assembly metadata and quality metrics

genomes.atcc.org

Accession with us!

- We are always looking for new microbes to add to our collection
- We are sequencing our collection of microbes and are starting with new deposits
- If you deposit your strain with ATCC, we will send you the genome
- These microbes can be used in research and commercial processes

Thank you