

. The Human Lung Microbiome - A Hidden Link for Human Health and Diseases

Xinzhu Yi, Jingyuan Gao, Zhang Wang

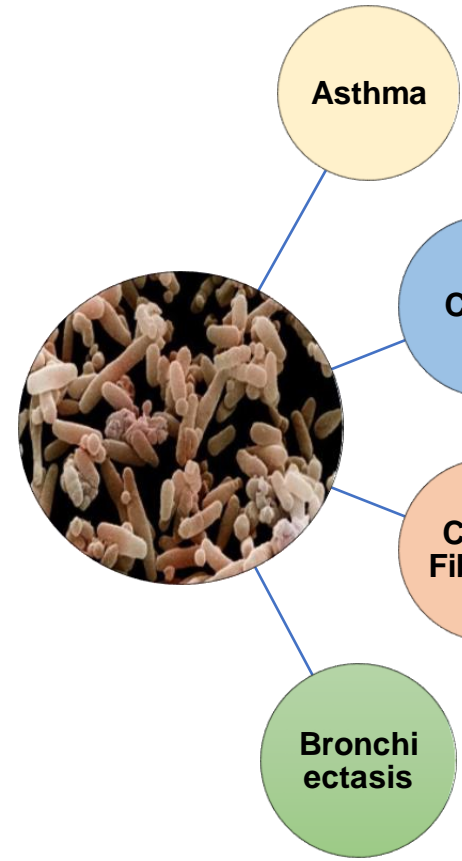
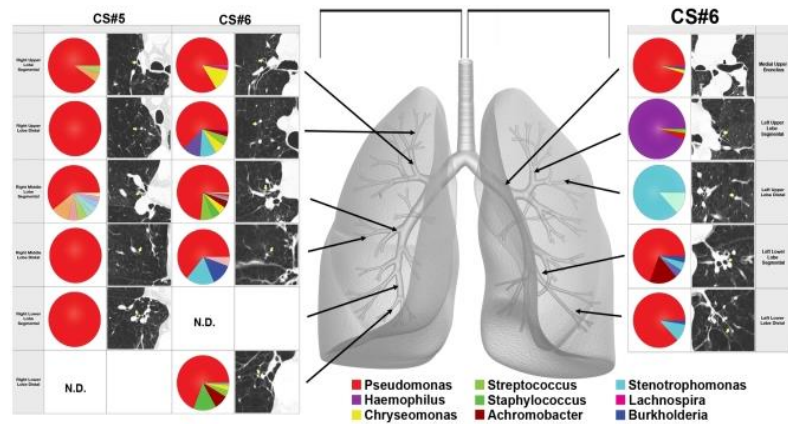
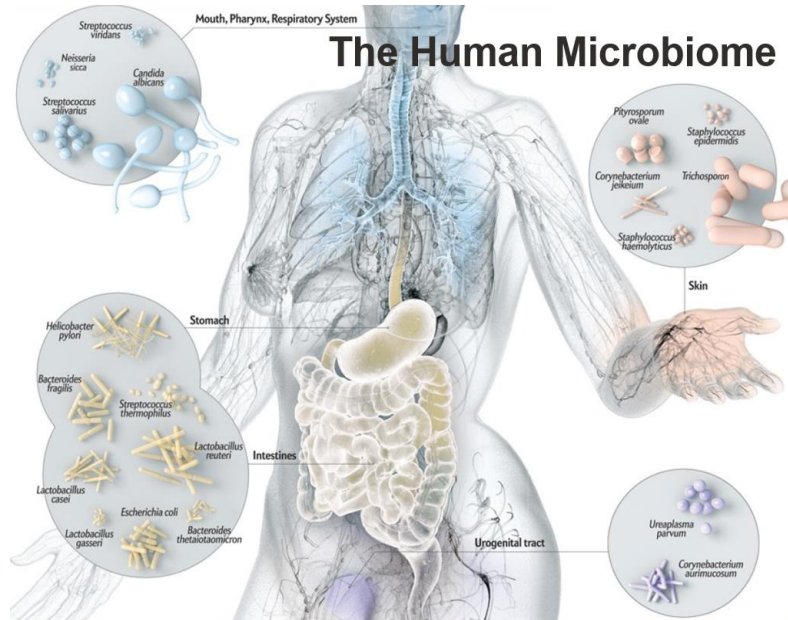
South China Normal University
Guangzhou, China



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The Human Lung Microbiome



Asthma-associated differences in microbial composition of induced sputum

Pradeep Reddy Marri, PhD,^a Debra A. Stern, MS,^b Anne L. Wright, PhD,^b Dean Billheimer, PhD,^{a,c} and Fernando D. Martinez, MD^{a,b} Tucson, Ariz.

Microbes and mucosal immune responses in asthma

Trevor T. Hansel, Sebastian J. Johnston^a, Peter J. Openshaw^a

Analysis of the Lung Microbiome in the "Healthy" Smoker and in COPD

John R. Erb-Downward¹, Deborah L. Thompson¹, Meilan K. Han¹, Christine M. Freeman^{1,2}, Lisa McCloskey^{1,2}, Lindsay A. Schmidt¹, Vincent B. Young¹, Galen B. Toews^{1,2}, Jeffrey L. Curtis^{1,2}, Baskaran Sundaram¹, Fernando J. Martinez^{1,3}, Gary B. Huffnagle^{1,4,5}

Analysis of the Airway Microbiota of Healthy Individuals and Patients with Chronic Obstructive Pulmonary Disease by T-RFLP and Clone Sequencing

Tetyana Zakharkina¹, Elke Meinel², Rember A. Koczula³, Timm Greulich¹, Katharina Rentz¹, Josch K. Pauling⁴, Jan Baumbach^{5,6}, Mathias Herrmann⁵, Christiane Grünewald⁵, Hendrik Dienemann⁵, Lutz von Müller⁵, Robert Bals¹

Decade-long bacterial community dynamics in cystic fibrosis airways

Jiangchao Zhao^a, Patrick D. Schloss^b, Linda M. Kalikin^a, Usa A. Carmody^a, Bridget K. Foster^a, Joseph F. Petrosino^{a,d}, James D. Cavalcoli^e, Donald R. VanDevanter^f, Susan Murray^g, Jun Z. Li^h, Vincent B. Young^{h,i}, and John J. LiPuma^{a,i}

Sputum purulence-associated microbial community compositions in adults with bronchiectasis

Wei-Jie Guan^{1,2}, Yan Huang¹, Chun-Lan Chen¹, Jing-Jing Yuan¹, Hui-Min Li¹, Yong-Hua Gao³, Rong-Chang Chen¹, Nan-Shan Zhong^{1,2}
¹State Key Laboratory of Respiratory Disease, National Clinical Research Center for Respiratory Disease, Guangzhou Institute for Respiratory Health, The First Affiliated Hospital of Guangzhou Medical University, Guangzhou 510030, China; ²Sino-French Hoffmann Institute, Guangzhou Medical University, Guangzhou 511400, China; ³First Affiliated Hospital of Zhengzhou University, Zhengzhou 450000, China

Correspondence to: Wei-Jie Guan, MD, Rong-Chang Chen, MD, State Key Laboratory of Respiratory Disease, National Clinical Research Center for Respiratory Disease, Guangzhou Institute for Respiratory Health, The First Affiliated Hospital of Guangzhou Medical University, 151 Yanjiang Road, Guangzhou 510030, China. Email: battery203@163.com; chenrc@vip.163.com

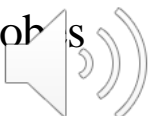
Int J Chron Obstruct Pulmon Dis. 2018; 13: 2173–2182. PMID: PMC6054765
 Published online 2018 Jul 17. doi: [10.2147/COPD.S159335](https://doi.org/10.2147/COPD.S159335) PMID: [30140149](https://pubmed.ncbi.nlm.nih.gov/30140149/)

Altered community compositions of *Proteobacteria* in adults with bronchiectasis

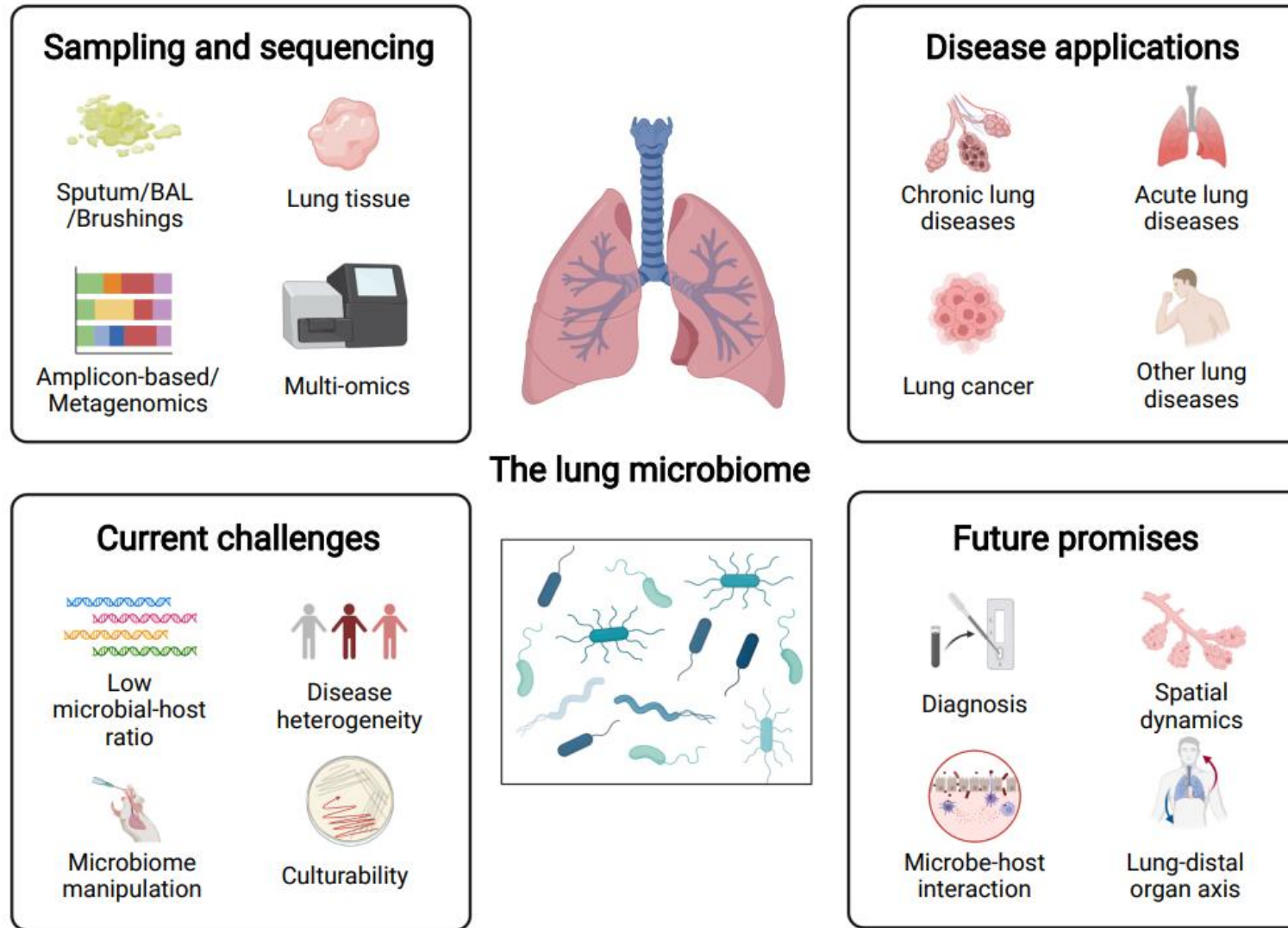
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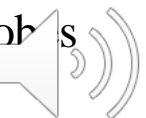
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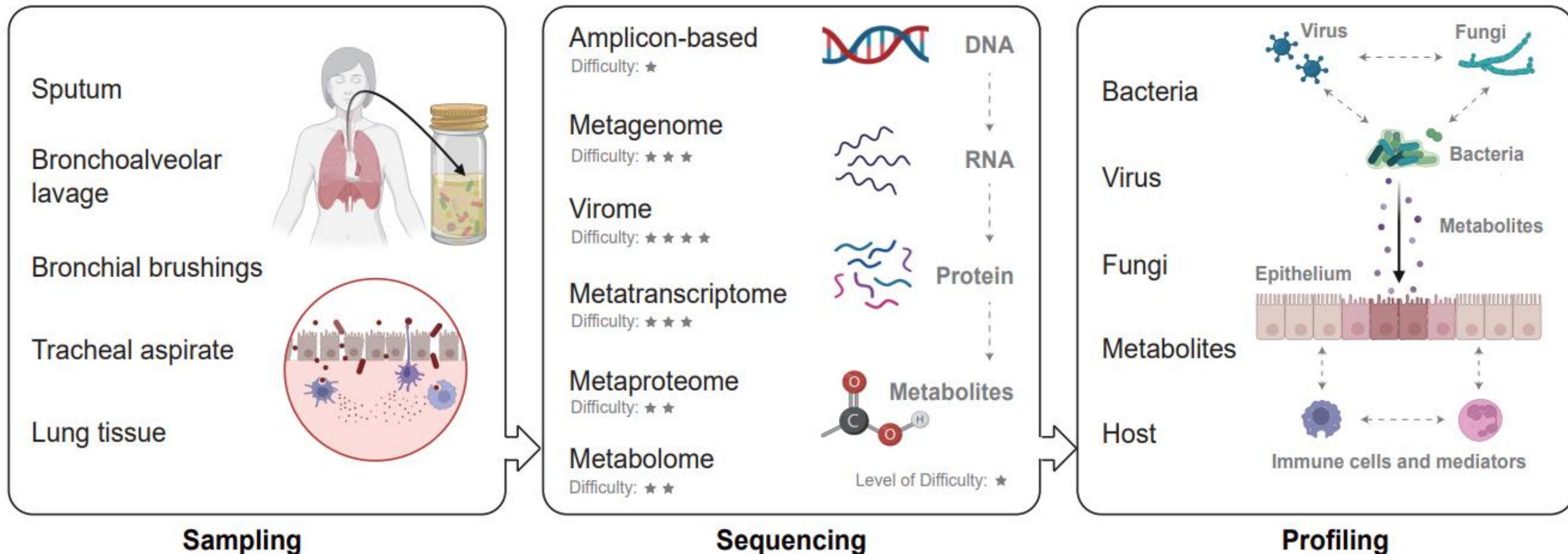
Lung Microbiome - Summary



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Lung Microbiome - Methodologies



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Lung Microbiome - Applications

Disease	Taxonomy	Trend
COPD	<i>Haemophilus</i> ↑ <i>Moraxella</i> ↑ <i>Streptococcus</i> ↑ <i>Gemella</i> ↑ <i>Granulicatella</i> ↑ <i>Campylobacter</i> ↑ <i>Prevotella</i> ↓ <i>Candida</i> ↑	
Asthma	<i>Haemophilus</i> ↑ <i>Moraxella</i> ↑ <i>Gemella</i> ↑ <i>Porphyromonas</i> ↑ <i>Mogibacteriaceae</i> ↓ <i>Aspergillus</i> ↑ <i>Epstein-Barr virus</i> ↑ <i>Cytomegalovirus</i> ↑	
Bronchiectasis	<i>Pseudomonas</i> ↑ <i>Haemophilus</i> ↑ <i>Veillonella</i> ↑ <i>Stenotrophomonas</i> ↑ <i>Enterobacteriaceae</i> ↑ <i>Aspergillus</i> ↑ <i>Cryptococcus</i> ↑ <i>Penicillium</i> ↑	
Cystic fibrosis	<i>Pseudomonas</i> ↑ <i>Haemophilus</i> ↑ <i>Stenotrophomonas</i> ↑ <i>Staphylococcus</i> ↑ <i>Penicillium</i> ↑ <i>Scedosporium</i> ↑	
Idiopathic pulmonary fibrosis	<i>Haemophilus</i> ↑ <i>Streptococcus</i> ↑ <i>Staphylococcus</i> ↑ <i>Veillonella</i> ↑ <i>Stenotrophomonas</i> ↑ <i>Campylobacter</i> ↑	
Pneumonia	<i>Haemophilus</i> ↑ <i>Acinetobacter</i> ↑ <i>Klebsiella</i> ↑ <i>Streptococcus</i> ↑ <i>Staphylococcus</i> ↑ <i>Veillonella</i> ↓ <i>Leptotrichia</i> ↓	
Sepsis/ARDS	<i>Enterobacteriaceae</i> ↑ <i>Bacteroides</i> ↑ <i>Lachnospiraceae</i> ↑ <i>Prevotella</i> ↑ <i>Fusobacterium</i> ↑ <i>Staphylococcus</i> ↑ <i>Pseudomonadaceae</i> ↑	
COVID-19	<i>Mycoplasma</i> ↑ <i>Burkholderia</i> ↑ <i>Staphylococcus</i> ↑ <i>Streptococcus</i> ↑ <i>Stenotrophomonas</i> ↑ <i>Enterobacteriaceae</i> ↑ <i>Anelloviridae</i> ↑ <i>Redondoviridae</i> ↑	
Lung cancer	<i>Veillonella</i> ↑ <i>Megasphaera</i> ↑ <i>Granulicatella</i> ↑ <i>Streptococcus</i> ↑ <i>Abiotrophia</i> ↑ <i>Acidovorax</i> ↑ HPV ↑	
Lung transplant ation-related	<i>Pseudomonas</i> ↑ <i>Staphylococcus</i> ↑ <i>Stenotrophomonas</i> ↑ <i>Corynebacterium</i> ↑ <i>Candida</i> ↑ <i>Aspergillus</i> ↑ <i>Anelloviridae</i> ↑	
HIV	<i>Prevotella</i> ↑ <i>Veillonella</i> ↑ <i>Tropheryma</i> ↑ <i>Streptococcus</i> ↑ <i>Flavobacterium</i> ↓ <i>Pneumocystis</i> ↑	
Tuberculosis	<i>Mycobacterium</i> ↑ <i>Porphyromonas</i> ↑ <i>Cupriavidus</i> ↑ <i>Streptococcus</i> ↑ <i>Prevotella</i> ↓ <i>Candida</i> ↑ <i>Aspergillus</i> ↑	

Disease

- Chronic lung diseases
- Acute lung diseases
- Other lung diseases

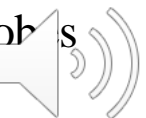
Taxonomy

- Proteobacteria
- Firmicutes
- Bacteroidetes
- Actinobacteria
- Fusobacteria
- Others
- Fungi
- Virus

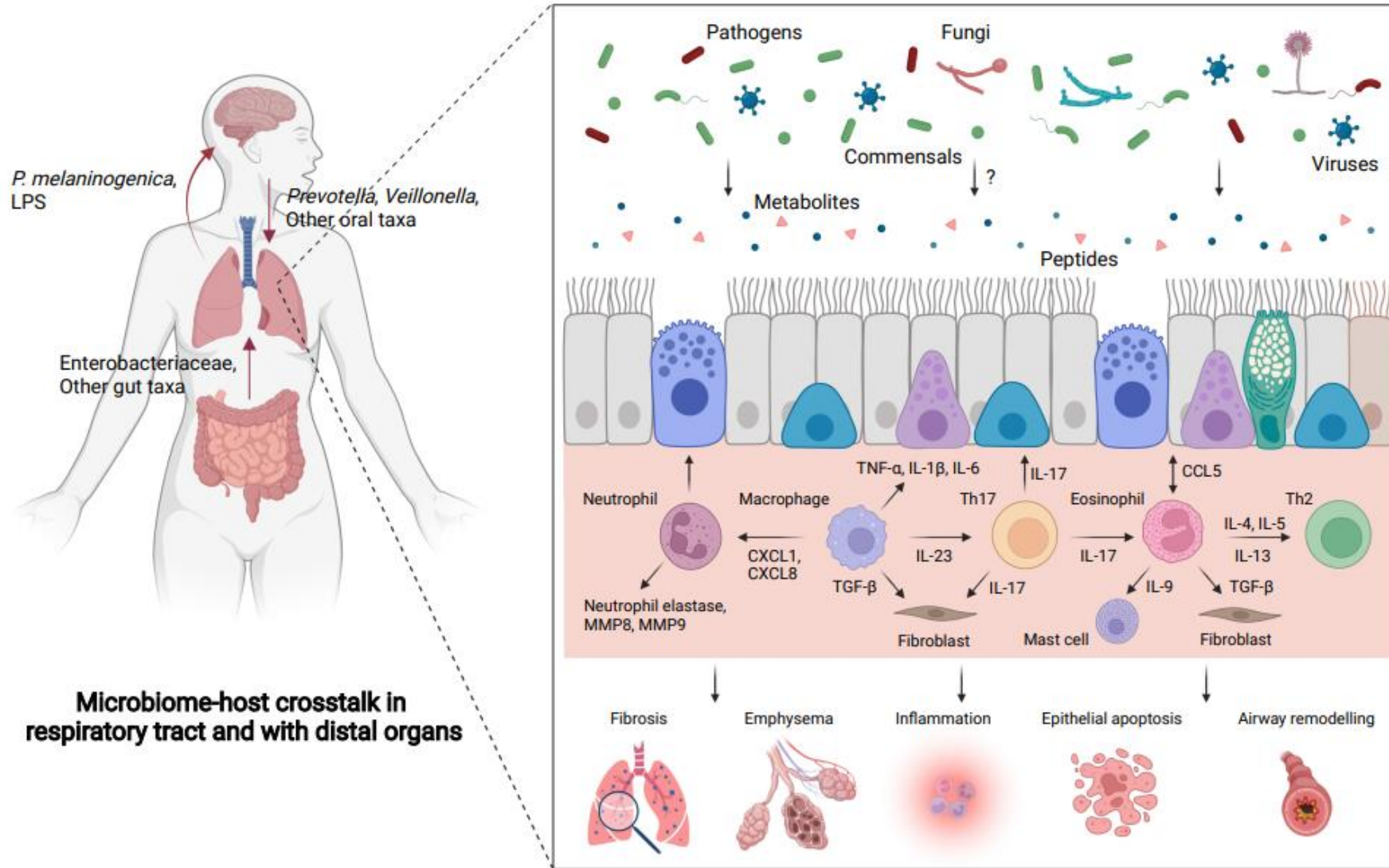
Trend

- ↑ Positive association with disease
- ↑ Positive association with neutrophilic subtype
- ↑ Positive association with eosinophilic subtype
- ↓ Negative association with disease

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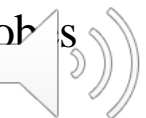


Lung Microbiome - Mechanisms



Microbiome-host crosstalk in respiratory tract and with distal organs

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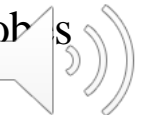
Lung Microbiome - Challenges

Challenges

- Oral contamination
- Low microbial-to-host ratio
- Disease heterogeneity
- Microbiome-host interaction
- Microbiome manipulation
- Culturability

Possible solutions

- Sample quality control
- Oral sample cross-comparison
- Pre-sequencing host cell depletion
- High depth 'Holo-biome' sequencing
- Microbiome-pheno/endotype relations
- 'Microbial-host' multi-omic landscape
- Standard procedure for respiratory microbiome manipulation
- Culturomics



iMeta: Integrated meta-omics to change the understanding of the biology and environment



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