Further Information about the HCA and the 2024 HCA Nature Collection

HCA Boilerplate: The Human Cell Atlas (HCA)

The Human Cell Atlas (HCA) is an international collaborative consortium whose mission is to create comprehensive reference maps of all human cells—the fundamental units of life—as a basis for understanding human health and for diagnosing, monitoring, and treating disease. The HCA community is producing high quality Atlases of tissues, organs and systems, to create a milestone Atlas of the human body. More than 3,500 HCA members from over 100 countries are working together to achieve a diverse and accessible Atlas to benefit humanity across the world.

Discoveries are already informing medical applications from diagnoses to drug discovery, and the Human Cell Atlas will impact every aspect of biology and healthcare, ultimately leading to a new era of precision medicine. Website: https://www.humancellatlas.org

Current stage of HCA:

Human Cell Atlas researchers are using cutting-edge single cell and spatial genomics at massive scale, combined with powerful computing and artificial intelligence, to uncover the intricate details of how our genes and cells shape life. So far, they have profiled and characterised 100 million cells from thousands of individuals, resulting in more than 400 peer reviewed publications.

The community now has sufficient data to start building atlases. HCA's 18 HCA Biological Networks have started to create integrated Atlases for tissues, organs and systems across the human body. Initial HCA Lung, Retina and Brain Atlases are now available on the HCA Data Portal. The assembly of the first atlases mark a critical juncture for the HCA, analogous to the Golden Path of the Human Genome Project, which produced 'contigs' of overlapping DNA sequences.

HCA Nature Collection 2024:

A Collection of more than 40 papers in Nature and other Nature Portfolio journals is being released on 20 November 2024. These publications show the breadth and global progress towards the Atlas and cover three themes which are vital to the Atlas assembly.

The first theme is evidenced by the large number of studies that provide a deep dive into specific tissues and organs from healthy, adult tissue. This huge amount of work on individual tissues, organs or systems reveal major new biological discoveries and implications for disease. These papers show the diversity of approaches used, including single cell, spatial and other

multimodal data and highlight the importance of international collaborative science. They also reveal the power of large-scale integration to discover rare cell types and states.

The second theme of this collection spans prenatal and paediatric stages across many tissues. Mapping human development at the cellular level is vital to understand how different cell types and complex tissue architectures are formed. These studies increase our fundamental understanding of healthy development in time and in 3D space and provide blueprints and resources for creating therapeutics.

The third theme relates to the great technical challenges in collecting the vast amounts of data needed to create the Human Cell Atlas, and further big challenges in integrating the data and interrogating it. New computational and analysis methods are helping to overcome some of the limitations of earlier technologies, and highlight the importance of Machine Learning and Artificial Intelligence in creating the HCA.

In addition, papers on ethics and equity show the commitment of the HCA to creating an ethical, representative atlas that will benefit humanity worldwide.

These papers provide a crucial foundation for assembling an integrated Human Cell Atlas, revealing the huge-scale of open data that has been produced. They also highlight the methodological advances and biological and clinical insights gained so far.

HCA Atlases:

The research from this collection of papers will feed into the HCA Biological Network Atlases that are being created, and are the first taste of things to come.

The 18 Biological Network Atlases that are being assembled will then collectively form the first draft Human Cell Atlas (V1.0), This first draft HCA is being created over the next year or so and will be ready in 2025 / 2026. It will be a major scientific milestone, not only in terms of scale and number of integrated datasets, but also in terms of the multimodal nature, and the rigour of integrating all these to a central set of standards to enable cross-tissue analysis.

The HCA community is creating a draft atlas that can be used universally. An accepted resource, with a common language that all can access and use.

Using cutting-edge single cell and spatial genomics, HCA researchers are revealing which of the 20,000 genes in an individual cell are switched on, creating a unique “ID card” for each cell type and mapping the precise location of cells within organs and tissues.

Looking forward, the HCA is aiming for up to billions of cells across all organs and tissues to create a globally representative, Comprehensive Atlas, to transform biological knowledge and healthcare worldwide. The papers in this large collection are the first taste of things to come.

Building a diverse and equitable Atlas:

HCA is committed to creating an open, ethical, equitable and representative atlas that should represent and benefit global humanity. This goal can only be achieved if researchers from communities around the world contribute to the effort by working within their local communities to explain the benefits and purpose of the HCA, and collecting and studying samples representing humans' incredible diversity. To assist this, the HCA Equity Working Group partners with local scientists to design and run virtual and in-person trainings, workshops, and roadshows. All HCA data is openly available worldwide through the HCA Data Portal.

The HCA scientific community includes members from every inhabited continent – they are essential for us to reach our goal of a representative atlas, which will help advance research and healthcare worldwide. HCA has regional networks in Africa, Asia, Latin America, and the Middle East, initiated and led by researchers in these areas, to help coordinate efforts, articulate priorities relevant to the populations they serve, and ensure that the atlas as a whole serves all parts of the world.

Impacts of HCA:

The collection of highly detailed maps will provide an unprecedented resource for studying health and disease. These comprehensive maps can be used as a guide book for specific organs, to understand how the cells come together to form tissues and talk to each other. The HCA can also act as a blueprint or recipe book for growing cells in the laboratory for research or therapeutics.

While our main focus is on the healthy body, the HCA will also serve as a reference guide book for understanding disease. With Biological Networks that focus on specific tissues or systems such as the heart, lung, skin and immune system, the HCA is already providing insights into COVID-19, cystic fibrosis, heart and lung diseases, cancer, and more. In addition, many diseases have their origin in early human development, and the 18 HCA Biological Networks include Reproductive and Developmental Networks, charting tissues comprehensively in space and time. These studies are helping to explain many aspects of human health and disease, from miscarriages and children's developmental disorders, through to cancer and ageing.

By driving new technologies for disease diagnosis, and enabling development of new treatments and advances in regenerative medicine, the HCA is likely to facilitate great transformations in healthcare, leading to a new era of personalised medicine. For example, HCA research is driving advances in disease modelling using mini organs (organoids), and on medical diagnostics for inflammatory bowel disease and cancer. New computational tools have highlighted potential new drug and cell targets, and understanding the developing immune system has provided critical information for engineering therapeutic T cells. HCA researchers are also tackling diseases with high unmet need in low- and middle-income settings, such as tuberculosis, and are ensuring human diversity is covered to enable progress towards equitable health care. See the recent perspective 'Impact of the Human Cell Atlas on medicine' to

understand how the HCA is transforming disease research, diagnostics and drug development.

Structure of the HCA:

The HCA is an independent, scientist-founded and led consortium that is governed by the HCA Organising Committee (OC) and supported by not-for-profit organisations based in the US and EU. Co-chaired by HCA co-founders Sarah Teichmann and Aviv Regev, with 35 members from 14 countries around the world, the OC meets regularly to set policies and determine the overall scientific direction of the HCA.

HCA Working Groups concentrate on Analysis, Ethics, Equity, Standards and Technology, and the HCA Data Ecosystem.

Funding:

The HCA is a grass-roots led, global and open scientific project that is supported by multiple funders from around the world. Such a large, global initiative needs diverse, collaborative funding, and the HCA community is grateful to all the funders for their generosity and support. Funders include the Canadian Institute for Advanced Research (CIFAR); the Chan Zuckerberg Initiative; the European Commission; Helmsley Charitable Trust; INSERM; the Klarman Family Foundation; Medical Research Council, UK; National Institutes of Health; Wellcome Trust; Wallenberg Foundation, and many others.

HCA Metrics – November 2024: at https://www.humancellatlas.org/learn-more/hca-metrics/

3,676 HCA members, from 1,910 institutes in 102 countries.
18 HCA Biological Networks of different tissues/organs.
More than 440 HCA publications (preprints and peer-reviewed), with over 22,600 citations.

Very lay summary of the HCA:
https://docs.google.com/document/d/1DX1JNFG33tKrCvuov58KnK75t54vBQcBmP1z-AXadfw/edit