

### SAMPLE LANDSCAPE STUDY

## Spatial Omics

December, 2024



## **INTRODUCTION (1/2)**





#### **Spatial Omics**

Spatial omics is a rapidly evolving field that integrates molecular biology with spatial information, allowing researchers to study the spatial organization of biological molecules like RNA, DNA, proteins, and metabolites within tissues or cells. By combining advanced imaging techniques and molecular analysis, spatial omics provides insights into how biological processes are organized in their native environments, offering unprecedented detail at cellular and subcellular levels. This approach is transforming our understanding of complex biological systems, particularly in areas like disease pathology, developmental biology, and personalized medicine, by revealing spatial patterns that traditional methods might miss.



#### **Spatial Omics Types**

**Spatial Transcriptomics**: Focuses on the spatial distribution of RNA transcripts, providing a detailed view of gene expression patterns across different tissue regions. This technique helps identify how specific genes contribute to tissue structure and function, particularly in disease contexts such as cancer.

**Spatial Genomics**: Maps the location of DNA sequences within tissues or cells, offering insights into genomic organization, chromosomal architecture, and how genetic variations may influence local cellular environments.

**Spatial Proteomics**: Involves mapping proteins within tissues, providing critical information on protein localization, post-translational modifications, and protein interactions. This is key for understanding cellular mechanisms and signaling pathways.

**Spatial Metabolomics**: Maps the distribution of metabolites, the small molecules produced by cellular processes, within tissues. It is essential for understanding metabolic pathways and how they are influenced by tissue structure and function

**Spatial Epigenomics**: Focuses on epigenetic modifications, such as DNA methylation or histone modification, within the spatial context of tissues, giving insights into gene regulation and tissue-specific expression patterns



## **INTRODUCTION (2/2)**



### MARKET POTENTIAL

The global spatial OMICS market size was estimated at USD 380.4 million in 2023 and is projected to grow to USD 906.13 million by 2033, rising at a compound annual growth rate (CAGR) of 9.50% from 2024 to 2033. Global advancements in sequencing technology, the growing incidence of genetic disorders, and increased funding for OMICS research are some of the reasons propelling the market.



#### **REFERENCES & CREDITS**

- 1. https://genomebiology.biomedcentral.com/articles/10.1186/s13059-022-02824-6
- https://www.towardshealthcare.com/insights/spatial-omics-marketsizing#:~:text=The%20global%20spatial%20OMICS%20market,9.50%25%20from%20 2024%20to%202033.



## **OBJECTIVES**

## SEARCH METHODOLOGY



- To perform a detailed analysis of granted patents and published applications pertaining to spatial omics.
- In-depth analysis of patents/applications, to categorize them and to understand focusing areas of applicants.
- Graphical representation of trends (Filing, Publication, etc.) from the mined data of relevant patents/applications.



The first step is to create and define a patent set that will serve as the basis of the study. Patent databases like PatSeer/Questel Orbit were used as our data sources. The search was carried out in the Abstract, Title, and Claims fields of patent specifications by incorporation of Keywords and International Patent Classes.



### SUMMARY

- This report explores the global landscape of patents/ patent applications pertaining to spatial omics.
- $\blacktriangleright$  A set of 200+ patent families were analyzed pertaining to spatial omics.
- Spatial omics research is rapidly advancing, with the highest number of patents/applications focused on spatial transcriptomics, highlighting a strong interest in mapping RNA transcripts within tissues. Spatial proteomics and genomics are also gaining attention, along with emerging areas like epigenomics, metabolomics, and multi-omics.
- Key technologies include RNA-Seq and imaging, while computational approaches like machine learning and pathway analysis are dominant in data interpretation.
- Tissue samples, including formalin-fixed paraffin-embedded (FFPE) and single-cell, are commonly utilized in research. Spatial omics applications are broad, with a strong emphasis on diagnostics, single-cell analysis, gene expression profiling, and biomarker discovery. Disease focus is primarily on cancer, followed by infectious, cardiovascular, and neurological disorders, reflecting the growing role of spatial omics in diverse biomedical fields.

### **KEY REPORT FINDINGS**



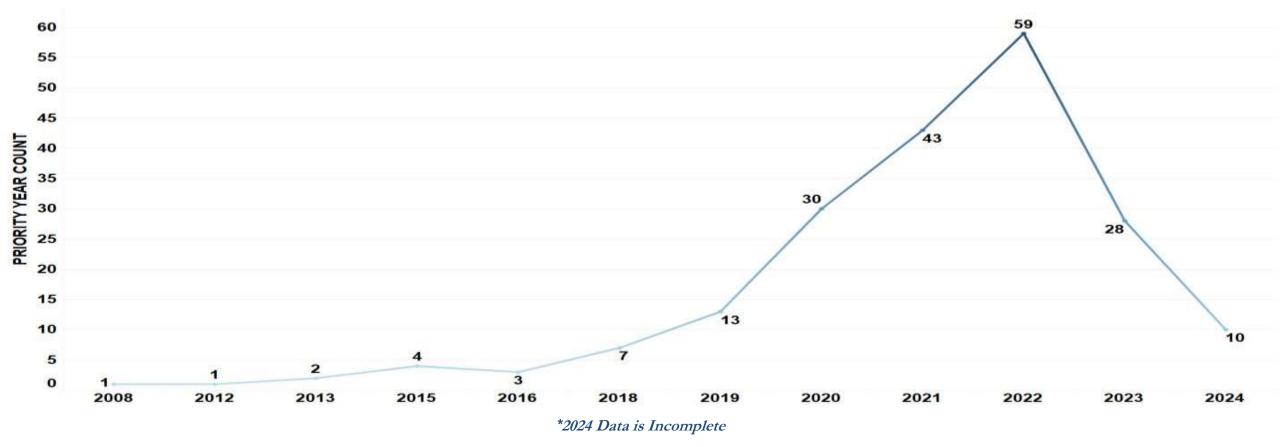
10X Genomics is the top global innovator in this domain with 18 patent families followed by Broad Institute with 11 patent families.



- ▶ United States (121 patent applications) is the largest filing destination.
- Spatial omics patents primarily focus on spatial transcriptomics, with growing interest in proteomics, genomics, and multi-omics.
- RNA-Seq and imaging technologies dominate spatial omics innovations, while machine learning is critical for data analysis.
- Tissue samples are frequently used in research, enabling resolution from the single-cell level down to subcellular details.
- Applications span diagnostics, gene expression profiling, and biomarker discovery, with a major focus on cancer and other diseases like cardiovascular and neurological disorders.

### PRIORITY YEAR-BASED TREND ANALYSIS

### ANALYSIS BASED ON REPRESENTATIVE MEMBER PER INPADOC FAMILY



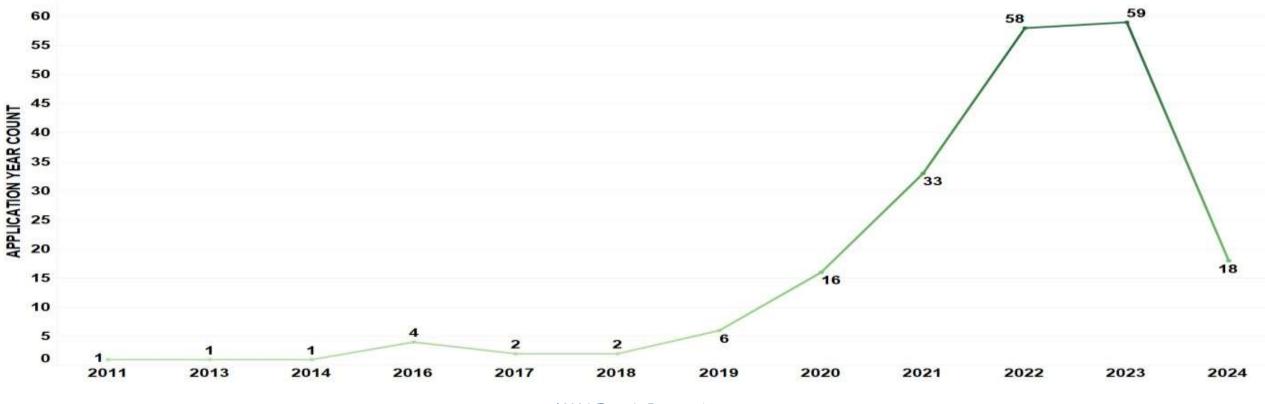
The graph shows a steady increase in spatial omics patent/publication counts from 2019 to a peak of 59 in 2022, reflecting rapid innovation and growing interest in the field. However, the 2024 data is incomplete and likely to rise.



## A.

### FILING YEAR-BASED TREND ANALYSIS

### ANALYSIS BASED ON REPRESENTATIVE MEMBER PER INPADOC FAMILY

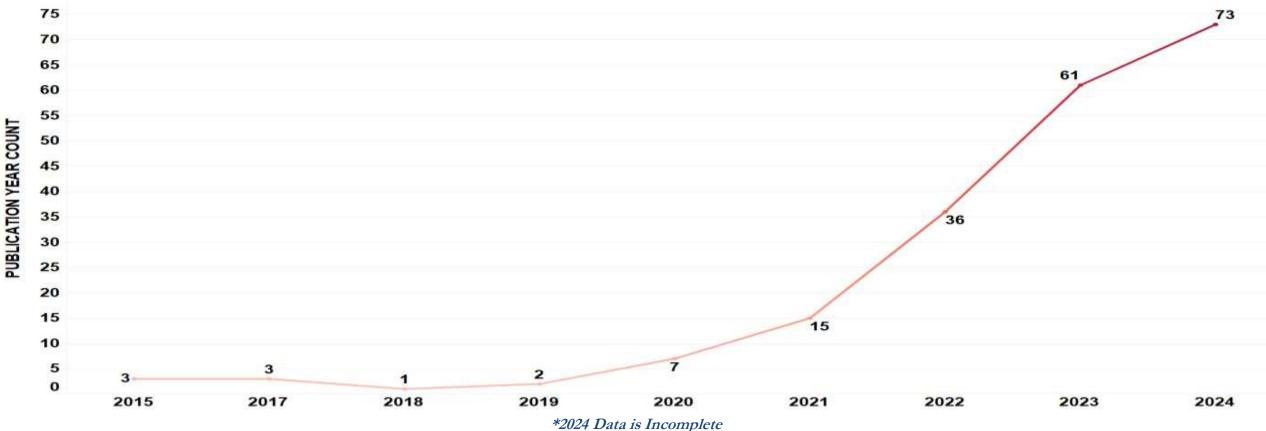


#### \*2024 Data is Incomplete

Application trends show a surge in spatial omics-related patents/publications from 2021 to 2023, with filings for 2023-2024 possibly still being recorded, suggesting the trend may continue to increase.

### PUBLICATION YEAR-BASED TREND ANALYSIS

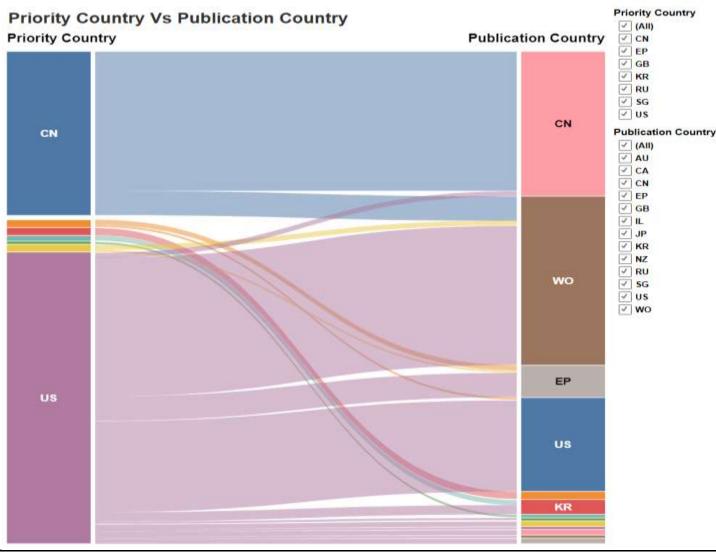




The publication trends show a sharp rise in spatial omics-related patents/publications starting in 2021, with a significant increase continuing into 2022 and 2023. However, the 2024 data still being updated, suggesting that the upward trend could continue throughout the year.



### SPATIAL OMICS PATENT TRENDS

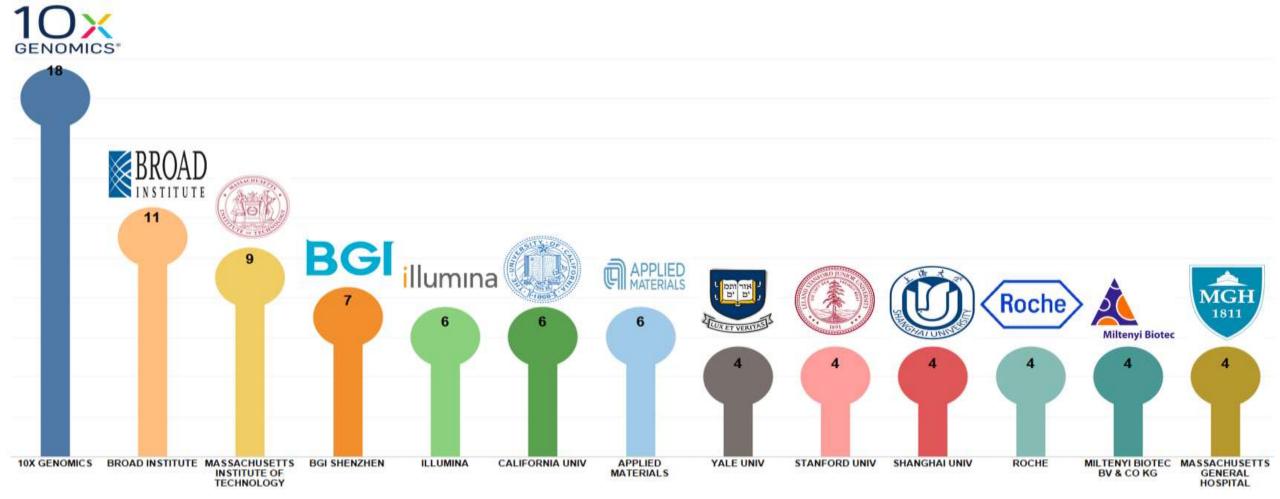


**Graph Showing Patent Priority Vs. Publication Country:** This visualizes the flow of patent applications from priority countries (initial filing location) to publication countries (subsequent jurisdictions for protection). Major flows highlight the global reach of patents originating from key markets such as the US and CN.





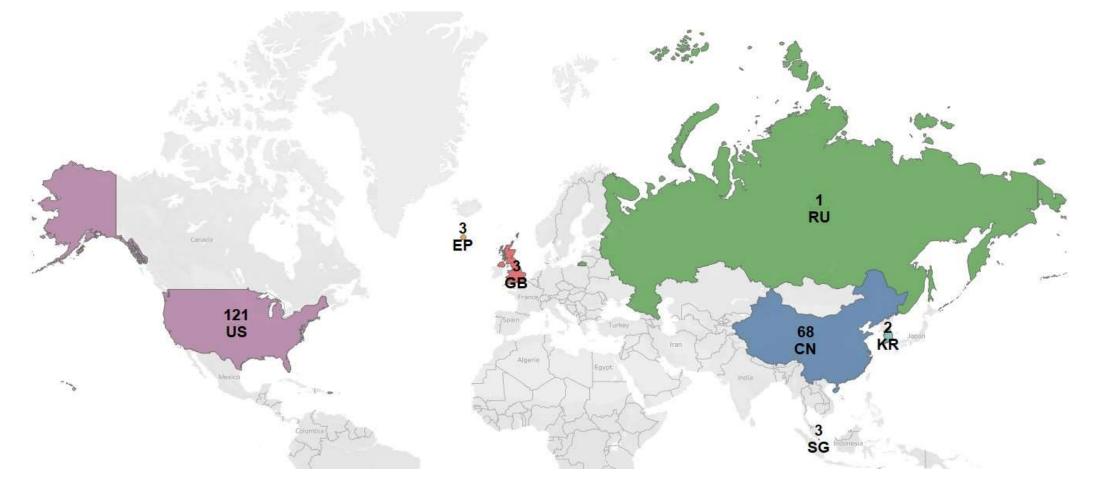
### MAJOR ASSIGNEES (BASED ON REPRESENTATIVE MEMBER PER FAMILY)



Based on the analysis, 10X Genomics, the Broad Institute, and MIT dominate the field, holding a significant number of patents. This indicates their leadership in driving innovation and technological advancements in this emerging area of spatial omics.



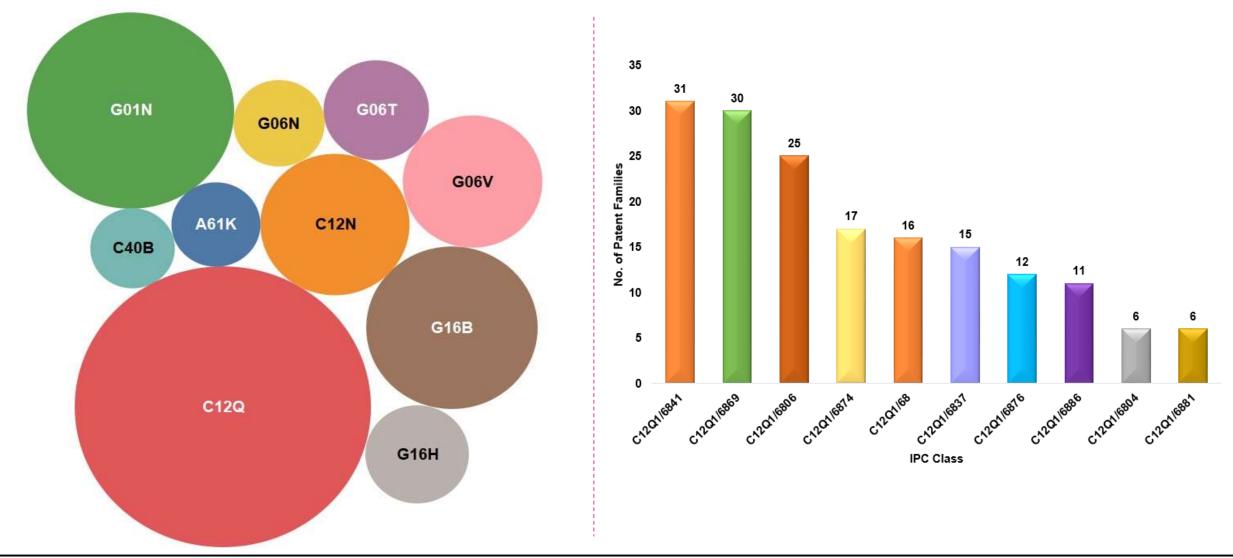
### GEOGRAPHICAL DISTRIBUTION OF PATENT APPLICATION FILINGS



Trend related to Geographical filing demonstrates that the maximum number of filings had their origin in the United States (US) with 121 patent families followed by China (CN) with 68 patent families.



### INTERNATIONAL PATENT CLASSIFICATION-BASED TREND (1/2)





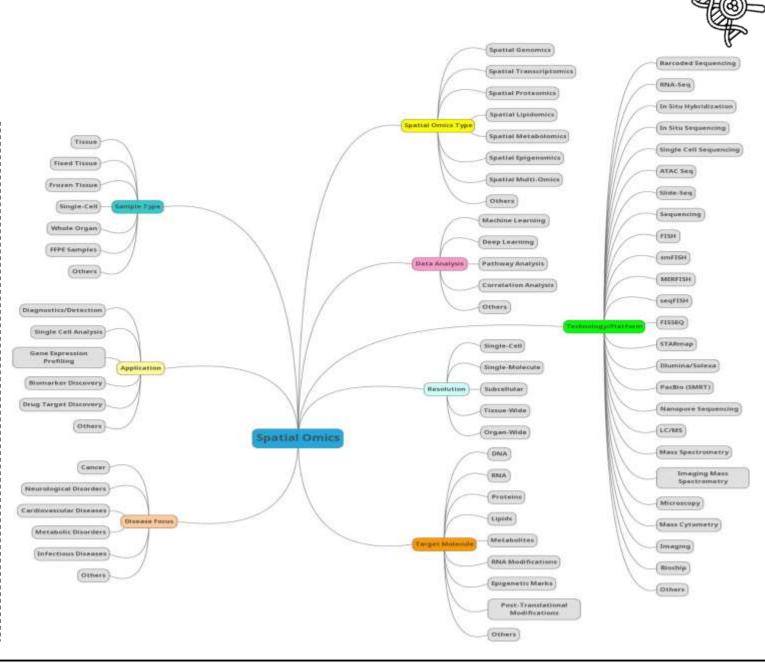
### INTERNATIONAL PATENT CLASSIFICATION-BASED TREND (2/2)

IPC	DEFINITION
C12Q	MEASURING OR TESTING PROCESSES INVOLVING ENZYMES, NUCLEIC ACIDS OR MICROORGANISMS; COMPOSITIONS OR TEST PAPERS THEREFOR; PROCESSES OF PREPARING SUCH COMPOSITIONS; CONDITION-RESPONSIVE CONTROL IN MICROBIOLOGICAL OR ENZYMOLOGICAL PROCESSES
G01N	INVESTIGATING OR ANALYSING MATERIALS BY DETERMINING THEIR CHEMICAL OR PHYSICAL PROPERTIES
G16B	BIOINFORMATICS, i.e. INFORMATION AND COMMUNICATION TECHNOLOGY [ICT] SPECIALLY ADAPTED FOR GENETIC OR PROTEIN-RELATED DATA PROCESSING IN COMPUTATIONAL MOLECULAR BIOLOGY
C12N	MICROORGANISMS OR ENZYMES; COMPOSITIONS THEREOF; PROPAGATING, PRESERVING, OR MAINTAINING MICROORGANISMS; MUTATION OR GENETIC ENGINEERING; CULTURE MEDIA
G06V	IMAGE OR VIDEO RECOGNITION OR UNDERSTANDING
G06T	IMAGE DATA PROCESSING OR GENERATION, IN GENERAL
G06N	COMPUTING ARRANGEMENTS BASED ON SPECIFIC COMPUTATIONAL MODELS
G16H	HEALTHCARE INFORMATICS, i.e. INFORMATION AND COMMUNICATION TECHNOLOGY [ICT] SPECIALLY ADAPTED FOR THE HANDLING OR PROCESSING OF MEDICAL OR HEALTHCARE DATA
A61K	PREPARATIONS FOR MEDICAL, DENTAL OR TOILETRY PURPOSES
C40B	COMBINATORIAL CHEMISTRY; LIBRARIES, e.g. CHEMICAL LIBRARIES



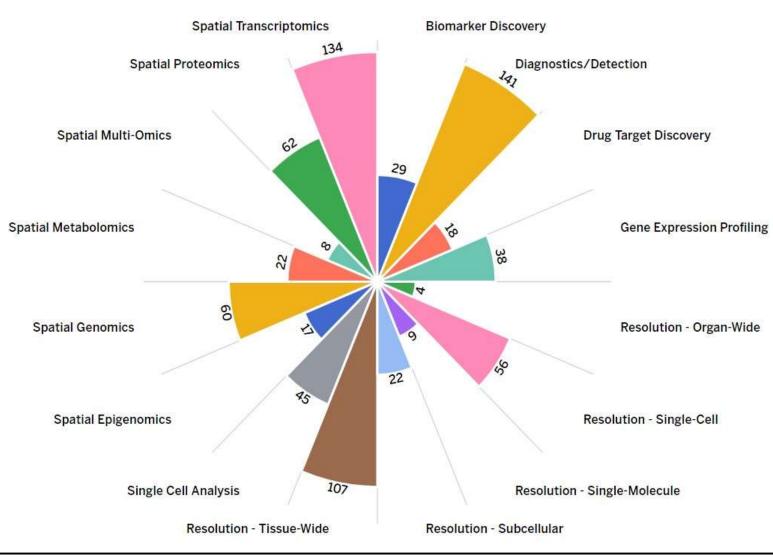
## TAXONOMY DEVELOPED FOR BUCKETING OF RELEVANT PATENT DOCUMENTS

- A set of 200+ patent families was analyzed in depth to identify the focus areas of the patents related to spatial omics.
- The mind map provides an overview of Spatial Omics, a field that integrates spatial context into the study of various biological molecules. It includes multiple omics types such as genomics, proteomics, and metabolomics, along with technologies like RNA-Seq and mass spectrometry for spatially resolved data collection. By analyzing different sample types, such as tissues and single cells, Spatial Omics helps in applications like diagnostics, biomarker discovery, and drug target identification.





### PATENT LANDSCAPE ANALYSIS OF SPATIAL OMICS



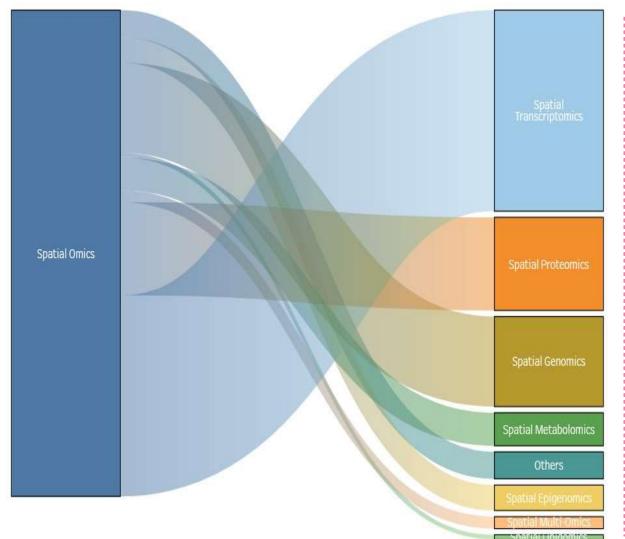
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- A Visual Representation of Patent Activity Across Spatial Omics Types, Resolution, and Applications.
- The chart highlights key areas of Spatial Omics research, with the largest focus on Diagnostics/Detection (141), Spatial Transcriptomic (134), and Resolution-Tissue Wide (107). Other significant areas include Single Cell Analysis (45) Spatial Genomics (60), and Spatial Proteomics (62), while emerging fields like Spatial Metabolomics and Epigenomics show moderate activity. The chart emphasizes the strong emphasis on diagnostics and tissue-wide resolution in Spatial Omics, as well as the growing importance of omics technologies in areas like biomarker discovery and drug target identification.



## A.

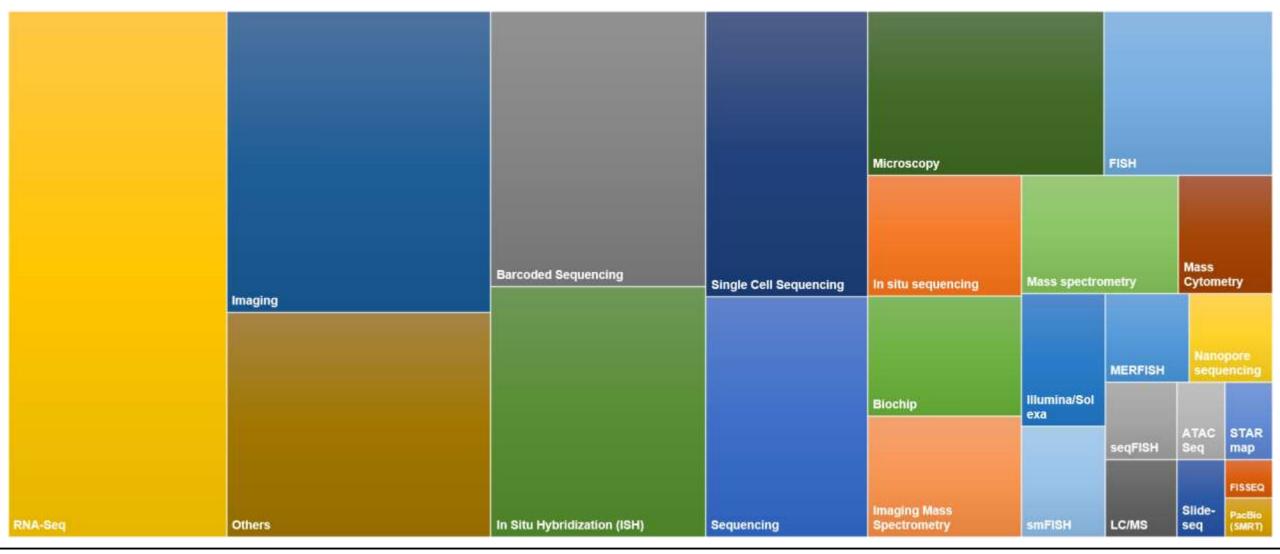
### DISSECTION OF PATENTS/APPLICATIONS PERTAINING TO 'SPATIAL OMICS TYPES'

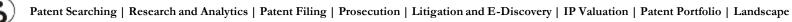


- The graph provides a visual representation of different types of spatial omics. It categorizes into specific areas such as spatial transcriptomics, proteomics, genomics, metabolomics, others, epigenomics, multi-omics, and lipidomics respectively.
- The graph reveals that spatial transcriptomics has the highest number of patents/applications, reflecting strong interest in mapping RNA transcripts within tissues. This is closely followed by spatial proteomics, which shows growing focus on protein distribution and its impact on cellular functions. Further, spatial genomics, epigenomics, metabolomics, lipidomics, and multi-omics are also gaining traction, indicating future growth as researchers explore the integration of various omics for more comprehensive biological insights.



### DISSECTION OF PATENTS/APPLICATIONS PERTAINING TO SPATIAL OMICS 'TECHNOLOGY/PLATFORM'







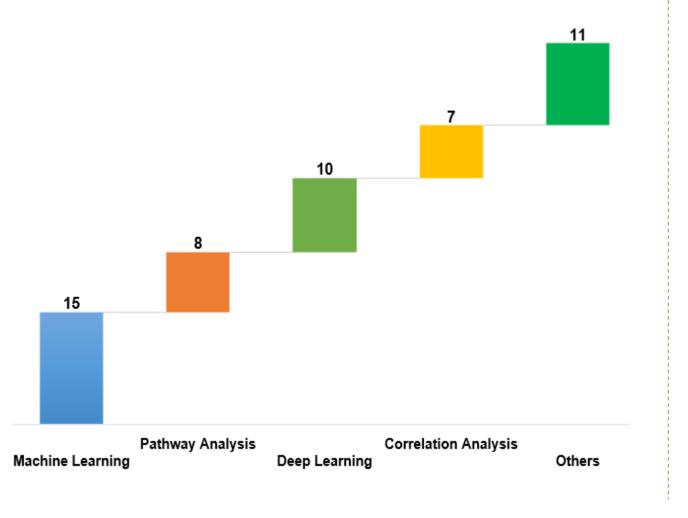
### DISSECTION OF PATENTS/APPLICATIONS PERTAINING TO SPATIAL OMICS 'TECHNOLOGY/PLATFORM'

- The tree map presents a breakdown of patents and applications related to spatial omics technologies and platforms. The largest section of the map is dedicated to RNA-Seq, indicating its significant role in spatial omics, followed by Imaging technologies, reflecting its growing prominence in capturing spatial data. Barcoded Sequencing and Single Cell Sequencing also represent substantial shares, showing their importance in identifying unique cell types and molecular features within spatial contexts.
- Other smaller but notable sections include Mass Spectrometry, In Situ Hybridization (ISH), and Microscopy, which contribute to diverse methods of spatial data acquisition. Advanced sequencing technologies like Nanopore Sequencing and Illumina/Solexa are also present, as are specific platforms such as MERFISH and FISSEQ, which focus on high-resolution spatial mapping. The chart emphasizes the broad and evolving landscape of technologies in the spatial omics domain.



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### DISSECTION OF PATENTS/APPLICATIONS PERTAINING TO 'DATA ANALYSIS'

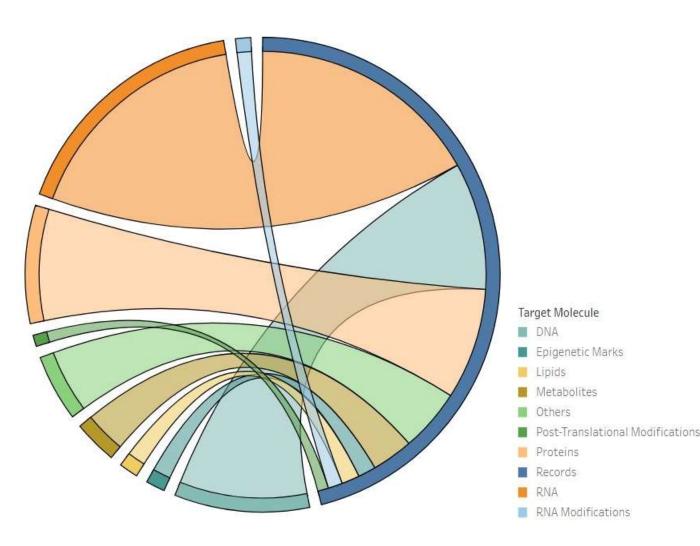


The graph reveals that Machine Learning is the dominant data analysis approach used in spatial omics analysis, with Pathway Analysis and Deep Learning also playing significant roles. This suggests a trend towards leveraging advanced computational methods to extract meaningful information from complex spatial data.





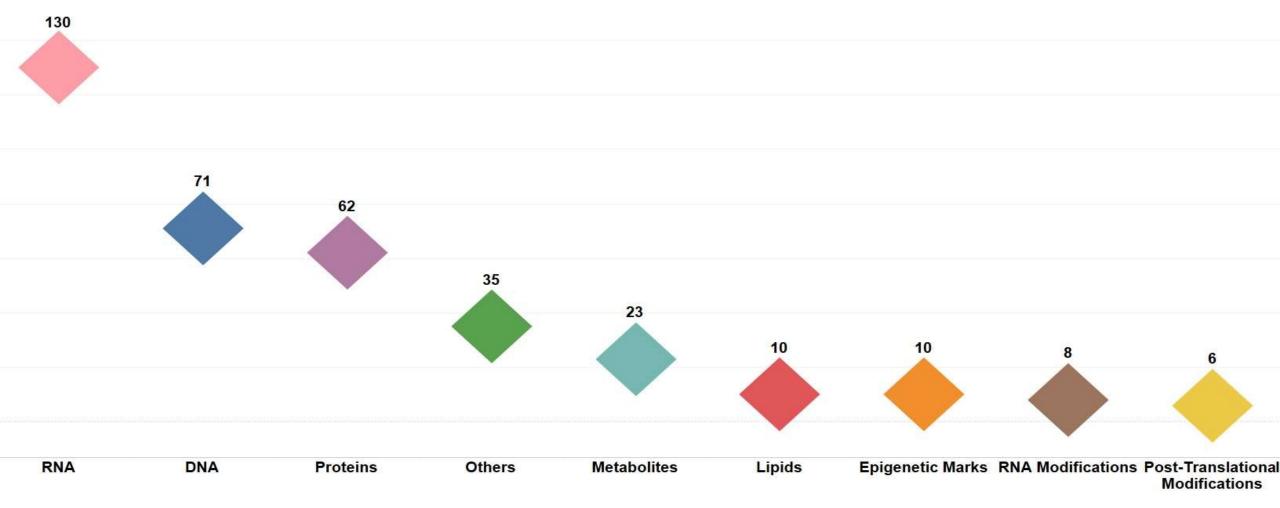
### DISSECTION OF PATENTS/APPLICATIONS PERTAINING TO 'TARGET MOLECULE' (1/2)



The graph provides a visual representation of the  $\succ$ distribution of patents or applications related to target molecules in spatial omics research. RNA emerges as the most frequently targeted molecule, followed by DNA and proteins, highlighting their significance in spatial omics studies. While metabolites, lipids, epigenetic marks, RNA modifications, and post-translational modifications may be less frequently targeted, they are still emerging as valuable targets in spatial omics research, offering unique insights into the complexity of biological systems.



### DISSECTION OF PATENTS/APPLICATIONS PERTAINING TO 'TARGET MOLECULE' (2/2)

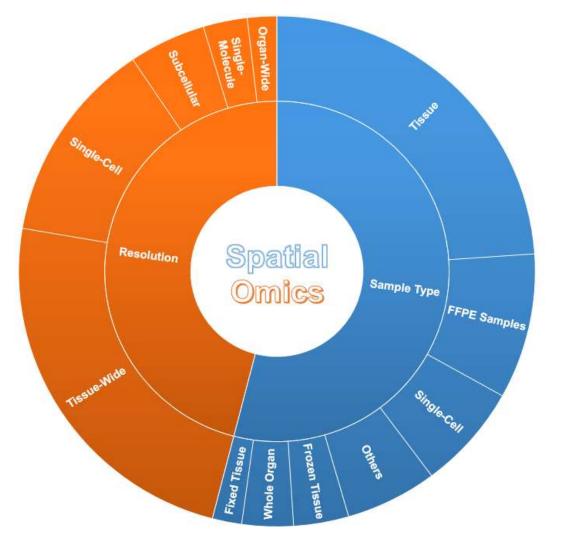


The graph reveals that RNA is the primary target molecule in spatial omics, followed by DNA and proteins. This suggests a strong focus on understanding these molecules' spatial distribution and interactions in biological systems.





### DISSECTION OF PATENTS/APPLICATIONS PERTAINING TO 'SAMPLE TYPE & RESOLUTION'

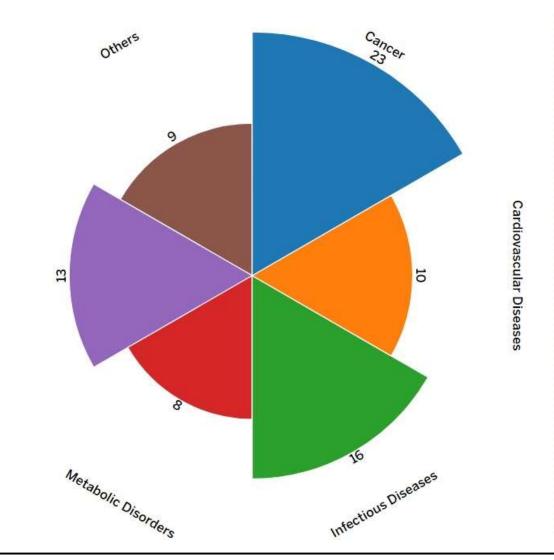


- The graph highlights the diverse resolutions explored in spatial omics research, with Single-Cell and Tissue-Wide studies being the most common, reflecting a strong focus on understanding biological processes at these scales. There is also increasing interest in Subcellular and Single-Molecule studies, which provide higher resolution insights into cellular and molecular interactions.
- The graph highlights the variety of sample types used in spatial omics research, with **Tissue samples** and **FFPE samples** being the most commonly studied, emphasizing the focus on understanding biological processes at these levels. Whole Organ and single cell studies are also gaining attention.





### DISSECTION OF PATENTS/APPLICATIONS PERTAINING TO 'DISEASE FOCUS'



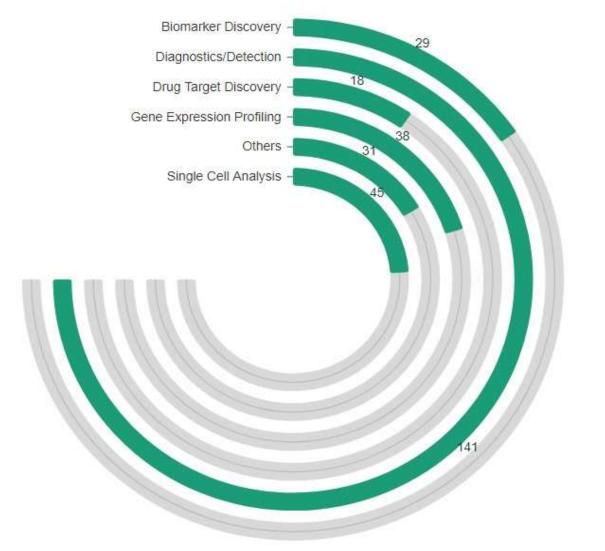
The chart illustrates the distribution of patents or applications related to disease focus in spatial omics research. **Cancer** is the most frequently studied disease, followed by infectious diseases and others. Cardiovascular diseases, neurological disorders, and metabolic disorders also represent significant areas of interest. This analysis suggests that spatial omics is being applied to a wide range of diseases, with a particular emphasis on cancer and infectious diseases.



Neurological Disorders



### DISSECTION OF PATENTS/APPLICATIONS PERTAINING TO 'APPLICATION'



The chart illustrates the distribution of patents or applications related to applications in spatial omics research. Diagnostics/Detection is the most frequently cited application, followed by Single-Cell Analysis, Gene Expression Profiling, and Others. Biomarker Discovery and Drug Target Discovery also represent significant areas of interest. This analysis suggests that spatial omics is being applied to a wide range of applications, with a particular emphasis on Diagnostics/Detection and Single-Cell Analysis.



## A.

## PATENT PORTFOLIO ANALYSIS

Heat Map Analysis Represent Major Assignee's w.r.t. Spatial Omics Types (1/2)

	Spatial Genomics	Spatial Transcriptomics	Spatial Proteomics	Spatial Metabolomics	Spatial Lipidomics	Spatial Epigenomics	Spatial Multi Omic	Others
10X GENOMICS	6	13	2					
BROAD INSTITUTE	4	5	2			2		1
MASSACHUSETTS INSTITUTE OF TECHNOLOGY	1	5	3					1
BGI SHENZHEN	1	2						4
ILLUMINA	2	6	2				1	
CALIFORNIA UNIV	4	5	2	1	1	1		
APPLIED MATERIALS	2	4						
YALE UNIV	3	2	2	2	2	2		
STANFORD UNIV	1	3	2	1		1		1
SHANGHAI UNIV	1	3	3			1		
ROCHE		4	2					
MILTENYI BIOTEC BV & CO KG	3	4	4	2			1	
MASSACHUSETTS GENERAL HOSPITAL	1	2	1	1		1		1



## PATENT PORTFOLIO ANALYSIS



### Heat Map Analysis Represent Major Assignee's w.r.t. Spatial Omics Types (2/2)

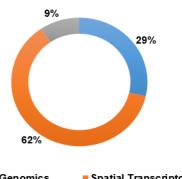
- The heat map illustrates the distribution of patent or application counts across various spatial omics categories for leading institutions and companies. 10X Genomics dominates in Spatial Transcriptomics with 13 patents, highlighting their significant contribution to this field. They also show strong involvement in Spatial Genomics and Spatial Proteomics. The Broad Institute and Illumina also have a noticeable presence, particularly in Spatial Transcriptomics, with Illumina showing diversified contributions across multiple fields, including Spatial Genomics and Spatial Proteomics.
- Institutions such as MIT, Yale University, and Stanford University exhibit research across multiple spatial omics domains, showing particular focus on Spatial Genomics and Spatial Metabolomics. Notably, BGI Shenzhen and Miltenyi Biotec display specific activity in Spatial Transcriptomics and Other Omics technologies. These insights reflect the diverse research and patenting activity across spatial omics, with several organizations prioritizing different segments of this rapidly advancing field.



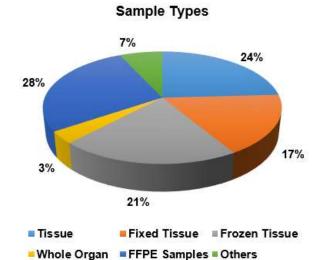
## PATENT PORTFOLIO ANALYSIS 10

### 10X GENOMICS (1/3)

### **Spatial Omics Types**



Spatial Genomics
Spatial Transcriptomics



The chart shows that spatial transcriptomics dominates with 62%, followed by spatial genomics at 29%, and spatial proteomics at 9%. This indicates a strong research focus on spatial transcriptomics and genomics.

This chart examines the type of

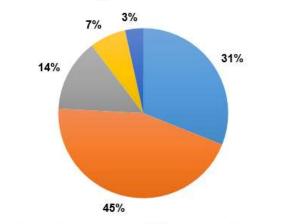
sample for the study of spatial

omics, emphasizing the dominance

of FFPE samples followed by tissue

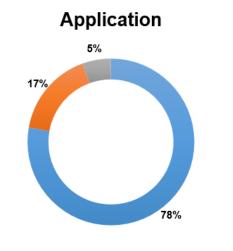
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samples.



**Target Molecule** 

DNA RNA Proteins Metabolites Others



Diagnostics/Detection = Others = Gene Expression Profiling

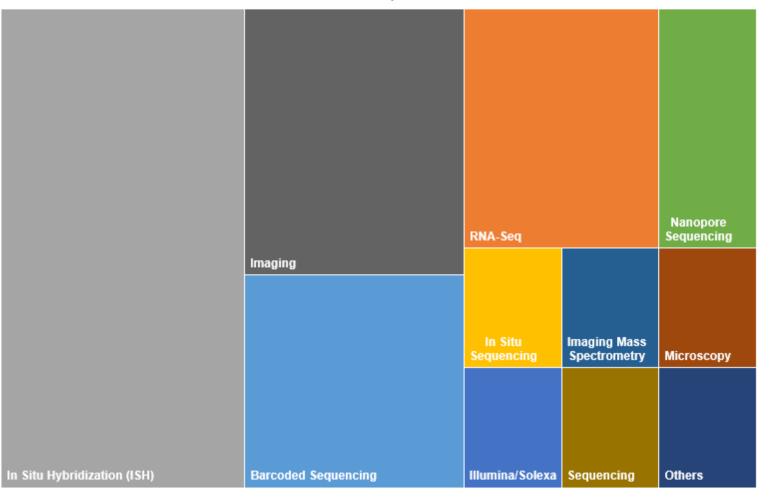
This chart showcases the preferred target molecule in the spatial omics studies, with RNA being the most frequently targeted.

The chart reveals that diagnostic and detection applications are the primary focus in spatial omics research.



### 10X GENOMICS (2/3)

**TECHNOLOGY/PLATFORM** 



The tree map presents a breakdown of patents applications related to spatial omics and technologies and platforms. The largest section the map is dedicated to In Situ of Hybridization, indicating its significant role in followed spatial omics, Imaging by technologies, reflecting its growing prominence in capturing spatial data. Barcoded Sequencing and RNA-Seq also represent substantial shares, showing their importance in identifying unique cell types and molecular features within spatial contexts.







### 10X GENOMICS (3/3)

**KEY PATENTS** 

Patent No.	Key Features
<u>WO2024137826A1</u>	The patent application relates to a analysis of analytes and spatial gene expression wherein the analysing comprises spatial transcriptomics.
EP4352252A1	The patent application relates to the methods for spatial analysis using targeted probe silencing.
<u>WO2021225900A1</u>	The patent application relates to the method for determining the location of one or more analytes in a biological sample with electrophoresis analyte transfer modes.
<u>EP4151748A1</u>	The patent application related to the method for spatially tagging nucleic acids of a biological specimen



# PATENT PORTFOLIO ANALYSIS

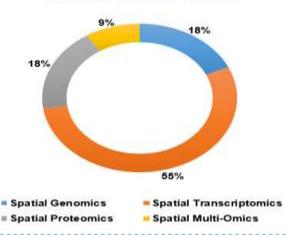
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### ILLUMINA (1/3)

#### **Spatial Omics Types**

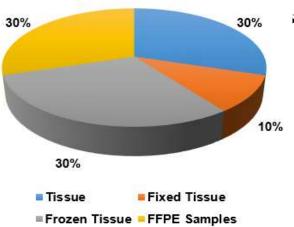


transcriptomics dominates with 55%, followed by spatial genomics at 18%, and spatial proteomics at 18%. This indicates a strong research focus on spatial transcriptomics and genomics.

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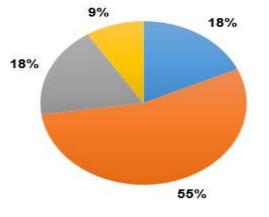
spatial

### Sample Types



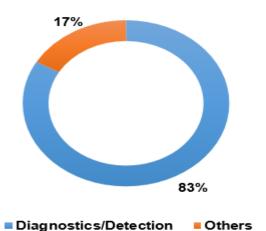
 This chart examines the type of sample for the study of spatial omics, emphasizing the dominance of tissue sample, frozen tissue, and FFPE samples

### Target Molecule



DNA RNA Proteins Others

### Application



This chart showcases the preferred target molecule in the spatial omics studies, with RNA being the most frequently targeted.

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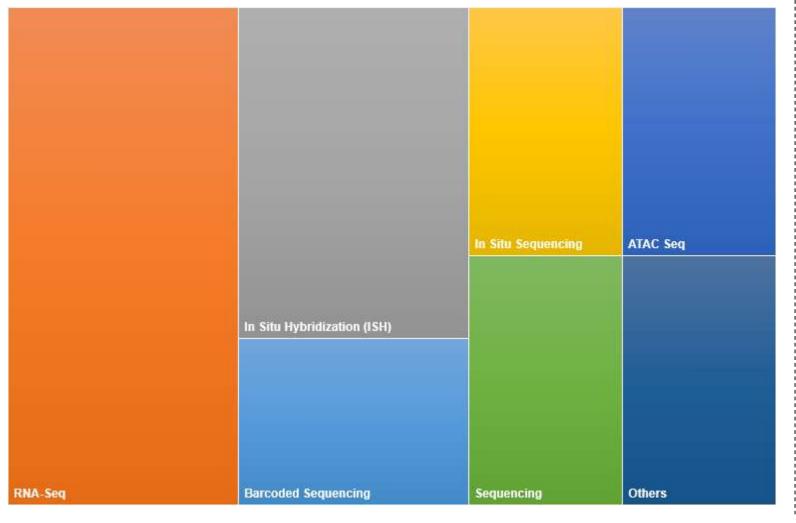
The chart reveals that diagnostic and detection applications are the primary focus in spatial omics research.



## PATENT PORTFOLIO ANALYSIS

### ILLUMINA (2/3)

TECHNOLOGY/PLATFORM



The tree map presents a breakdown of patents and applications related to spatial omics technologies and platforms. The largest section of the map is dedicated to **RNA-Seq**, indicating its significant role in spatial omics, followed by In Situ Hybridization, reflecting its growing prominence in capturing spatial data. Barcoded Sequencing and In Situ Sequencing also represent substantial shares, showing their importance in identifying unique cell types and molecular features within spatial contexts.

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### ILLUMINA (2/3)

#### **KEY PATENTS**

Patent No.	Key Features
<u>CA3176469A1</u>	The patent application relates to a method for spatial detection and analysis of nucleic acids in a tissue sample.
<u>EP4151748A1</u>	The patent application related to the method for spatially tagging nucleic acids of a biological specimen
<u>WO2023130019A2</u>	The patent application related to a spatial genomics Assay for Transposase- Accessible Chromatin with high- throughput sequencing (ATAC-Seq) method.
<u>WO2024138170A1</u>	The patent application relates to a method of preparing a spatial proteome and/or transcriptome sequencing library from a biological sample.



## **KEY PATENTS: COMPANIES VS INSTITUTIONS (1/3)**





## KEY PATENTS: COMPANIES VS INSTITUTIONS (2/3)



### **GRANTED PATENTS/PATENT APPLICATIONS – OTHER COMPANIES**

Patent No.	Key Features				
WO2024065585A1 BGI SHENZHEN	The patent application relates to a method for analyzing spatial omics information of a biological tissue sample using a biochip.				
US20220310202A1 APPLIED MATERIALS	The patent application relates to a spatial transcriptomics method using mFISH imaging.				
<mark>EP4257702A1</mark> MILTENYI BIOTEC BV & CO KG	The patent application relates to a method for obtaining the spatial location and sequence information of a target sequence in a sample comprising at least one RNA or single stranded DNA.				
CN112143784A BIOLAND LAB	The patent application related to spatial omics sequencing, single cell epitranscriptomics sequencing and positioning identification method.				



## KEY PATENTS: COMPANIES VS INSTITUTIONS (3/3)

### **GRANTED PATENTS/PATENT APPLICATIONS – UNIVERSITIES**

Patent No.	Key Features
<mark>US20220042097A1</mark> BROAD INSTITUTE, MASSACHUSETTS INSTITUTE OF TECHNOLOGY	The patent application relates to a method for spatial and/or temporal tissue profiling by depositing cell samples onto an addressable array or decoded bead array, capturing target molecules with spatial barcodes to link them with specific positions for in-situ analysis.
<u>WO2023043897A1</u> Chan Zuckerberg Biohub Inc, UNIV of California	The patent application relates to a method for obtaining both mass spectrographic measurements and spatial transcriptomic information from the tissue sample using cryosectioning, MALDI MS, and nucleic acid barcoding.
<u>WO2022147239A9</u> YALE UNIV	The patent application relates to a methods for producing a high resolution spatial epigenomic map of a biological sample
	The patent application relates to a method for spatially aligning single cells in tissue samples by analyzing transcriptomes and detecting genetic or spatial signatures to assess conditions such as cancer and predict therapy responses or disease progression.



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Sensitively Managing Sensible Intellectual Property

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