NEXT-GENERATION SEQUENCING

Sample Landscape Study

November, 2025

IIPRD
An ISO 9001:2015 Certified Firm

Next-Generation Sequencing

Next-Generation Sequencing (NGS) is a high-throughput method that sequences millions of DNA or RNA fragments in parallel, offering far greater speed and lower cost per base than Sanger sequencing. After library preparation—typically fragmentation, end-repair/A-tailing, adaptor ligation, and optional amplification—different platforms use distinct chemistries such as sequencing-by-synthesis (Illumina), semiconductor detection (Ion Torrent), single-molecule real-time sequencing (PacBio), or nanopore electrical sensing (Oxford Nanopore). These systems vary in accuracy and read length, enabling applications such as whole-genome and exome sequencing, RNA-seq, targeted panels, epigenomics, and metagenomics. Library preparation choices affect coverage and bias, while long-read platforms can detect base modifications and full-length transcripts. Continued advances in chemistry and algorithms are improving accuracy, throughput, and cost, driving broad adoption in research and clinical genomics.

NGS Technology - Overview

These platforms vary in accuracy, read length, and throughput, enabling diverse applications including whole-genome and exome sequencing, transcriptomics (RNA-seq), epigenomics (e.g., bisulfite sequencing), targeted resequencing, and metagenomics—driving advances in research, clinical diagnostics, and biotechnology. Library preparation methods (e.g., enzymatic vs. mechanical fragmentation, PCR vs. PCR-free workflows) critically influence coverage uniformity, GC bias, and detection limits, while long-read platforms such as PacBio and Oxford Nanopore can directly detect base modifications and full-length transcript isoforms.

Semiconductor and nanopore systems also offer rapid, portable sequencing suitable for field or targeted applications, though data analysis must account for their platform-specific error profiles. Clinical NGS requires validated pipelines, stringent quality metrics, and standardized reference materials to ensure diagnostic accuracy. Ongoing innovations in sequencing chemistries, base-calling algorithms, and error-correction tools continue to improve accuracy, throughput, and affordability—expanding NGS applications across genomics, precision medicine, macromolecule analysis, and infectious disease surveillance.

Key Components

Sequencing Technology

It includes Sequencing by synthesis, Sequencing by ligation, Sequencing by Binding and Sequencing by Electrical Impedance.

Instrumentation & Hardware

Flow cell, Microfluidic chips, Detectors etc.

Data Analysis & Bioinformatics

Base-calling & Signal processing algorithms, Read alignment & variant calling, De novo assembly etc.

Quality Control & Reagents

Covers Internal standards & controls, Reagent kits (enzymes, beads) and Error-rate & Q-score improvement methods.

Automation and Sample-to-answer

Integrated Benchtop Systems and Robotics & Workflow Automation

Applications

Market Potential

The global next-generation sequencing (NGS) market is reported to be valued at ~ US $10.27 billion in 2024, projected to grow to US $12.51 billion in 2025 and reach around US $73.47 billion by 2034, implying a CAGR of ~ 21.74 % over the 2024-2034 period.

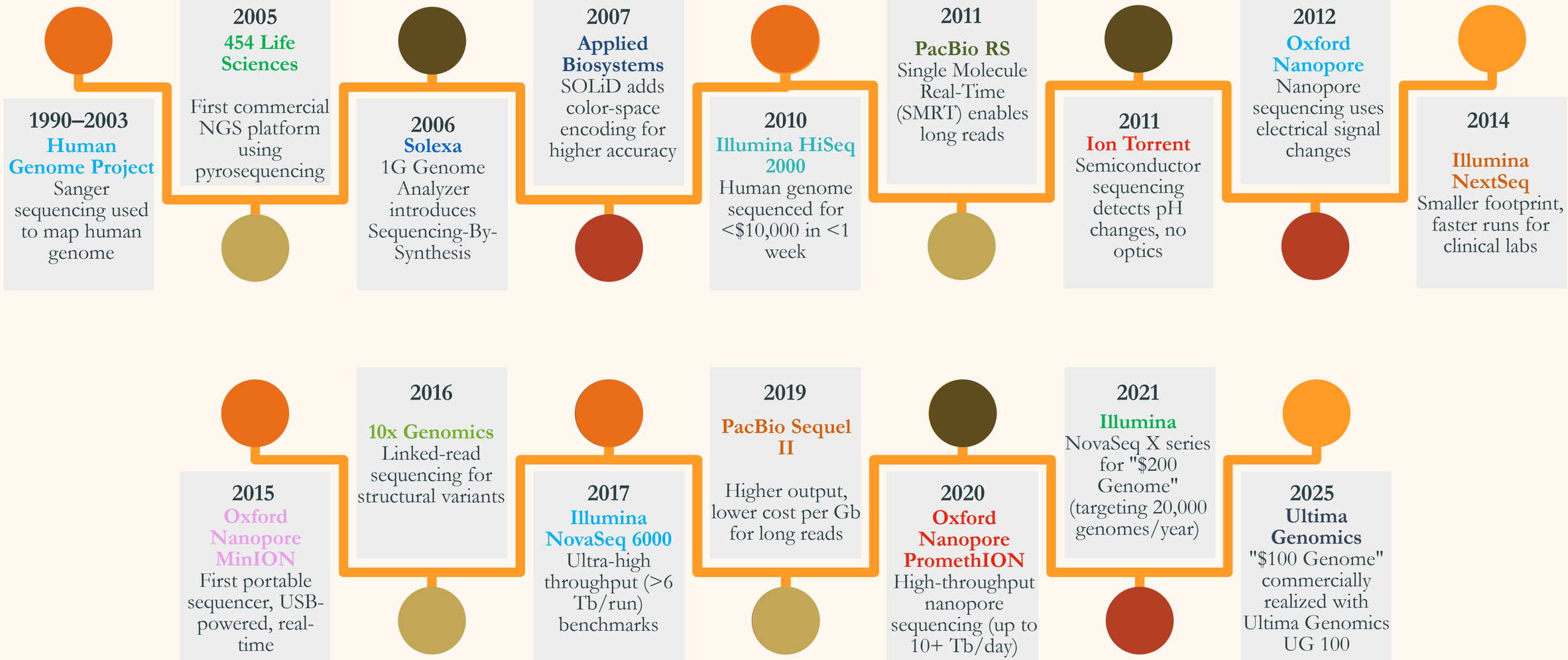
The expanding demand for advanced genomic research, rising applications of NGS in clinical diagnostics (especially oncology, infectious disease and rare disease testing), and ongoing technological improvements in sequencing platforms and bioinformatics workflows lowers cost-per-sample and expand throughput. Regional adoption trends-especially strong uptake in North America and accelerating investment in Asia-Pacific and Europe—are supporting market growth, as are emerging long-read and portable sequencing technologies that enable new use-cases and decentralized sequencing.

Declines in sequencing cost, improvements in library-preparation workflows, and more efficient analysis pipelines are further fueling uptake, while the need for validated clinical pipelines, regulatory compliance and data-interpretation infrastructure remain important constraints in the diagnostic segment.

References & Credits

- "Next Generation Sequencing Market Trends and New Era of Genetic Screening and Diagnosis", Towards Healthcare.
- "Next-Generation Sequencing Technology: Current Trends and Applications", Biology (Basel). 2023 Jul 13;12(7):997
- "The Global Market for Next-Generation Sequencing Tests Continues to Expand", Precis Med. 2018 Oct;4
- "Next Generation Sequencing Market (2025 - 2033)", Grand View Research.
- "Next-Generation Sequencing Market", MarketsandMarkets.

Key Milestones in Next-Generation Sequencing (NGS)



Study Objectives & Methodology

Comprehensive Patent Analysis

Perform detailed examination of granted patents and published applications pertaining to next-generation sequencing technologies across global jurisdictions.

Technology Categorization

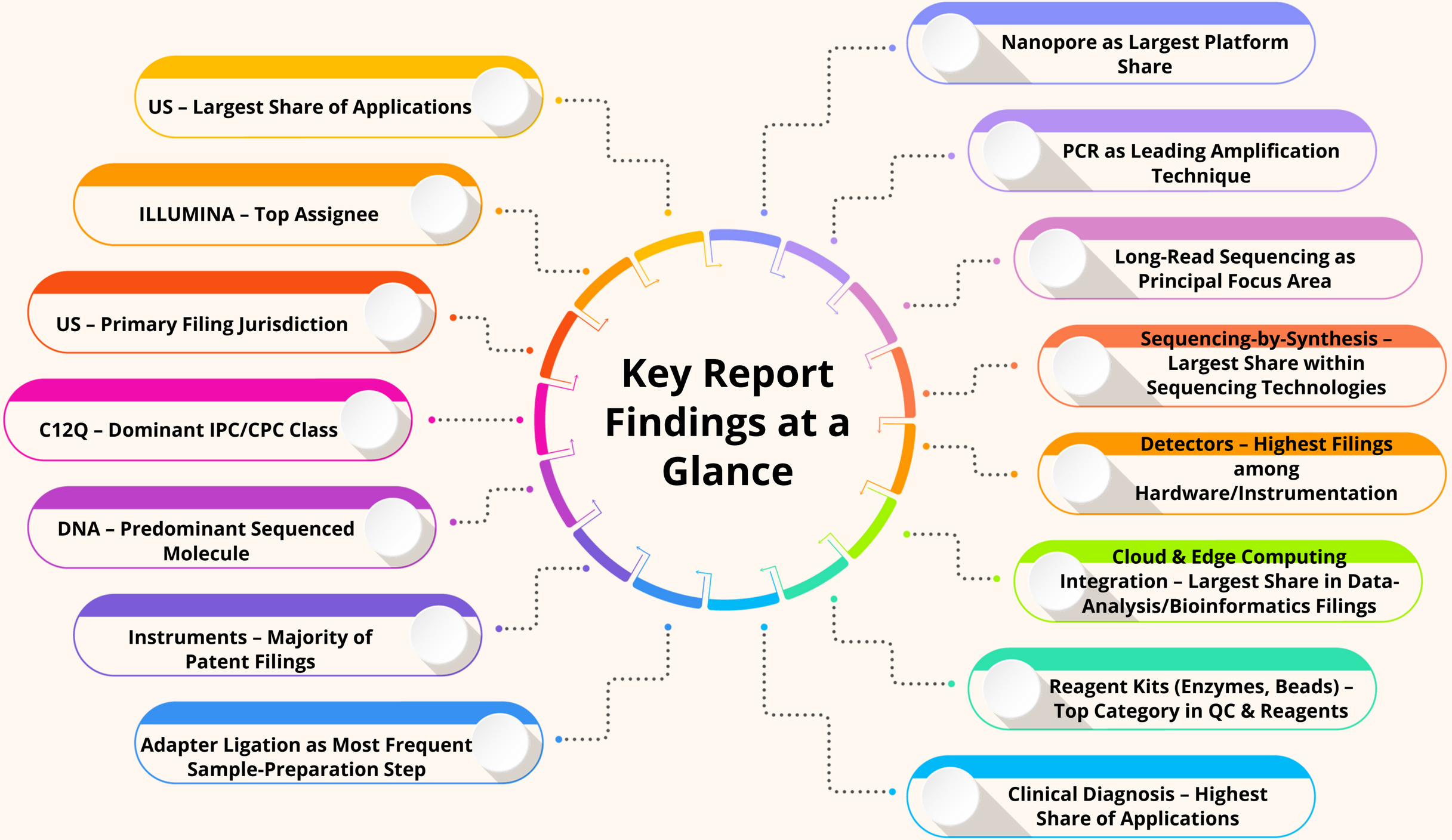
In-depth analysis of patents and applications to categorize innovations and understand strategic focusing areas of major applicants and emerging players.

Trend Visualization

Graphical representation of filing, publication, and technology trends extracted from comprehensive analysis of relevant patent data.

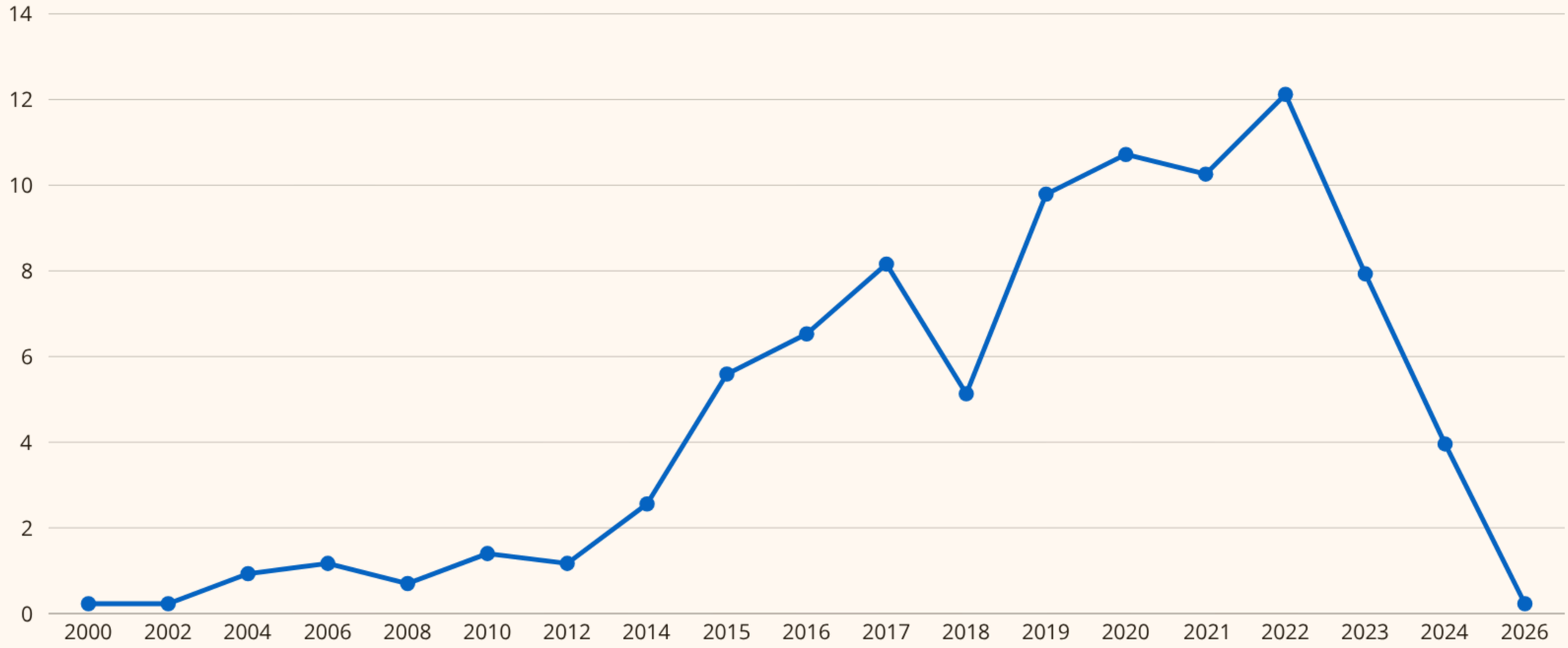
Database Mining

Systematic search using PatSeer and Questel Orbit databases, incorporating targeted keywords and International Patent Classifications across title, abstract, and claims fields.


Key Report Findings at a Glance
US – Largest Share of Applications
ILLUMINA – Top Assignee
US – Primary Filing Jurisdiction
C12Q – Dominant IPC/CPC Class
DNA – Predominant Sequenced Molecule
Instruments – Majority of Patent Filings
Adapter Ligation as Most Frequent Sample-Preparation Step
Nanopore as Largest Platform Share
PCR as Leading Amplification Technique
Long-Read Sequencing as Principal Focus Area
Sequencing-by-Synthesis – Largest Share within Sequencing Technologies
Detectors – Highest Filings among Hardware/Instrumentation
Cloud & Edge Computing Integration – Largest Share in Data-Analysis/Bioinformatics Filings
Reagent Kits (Enzymes, Beads) – Top Category in QC & Reagents
Clinical Diagnosis – Highest Share of Applications

Priority Year-Based Filing Trends

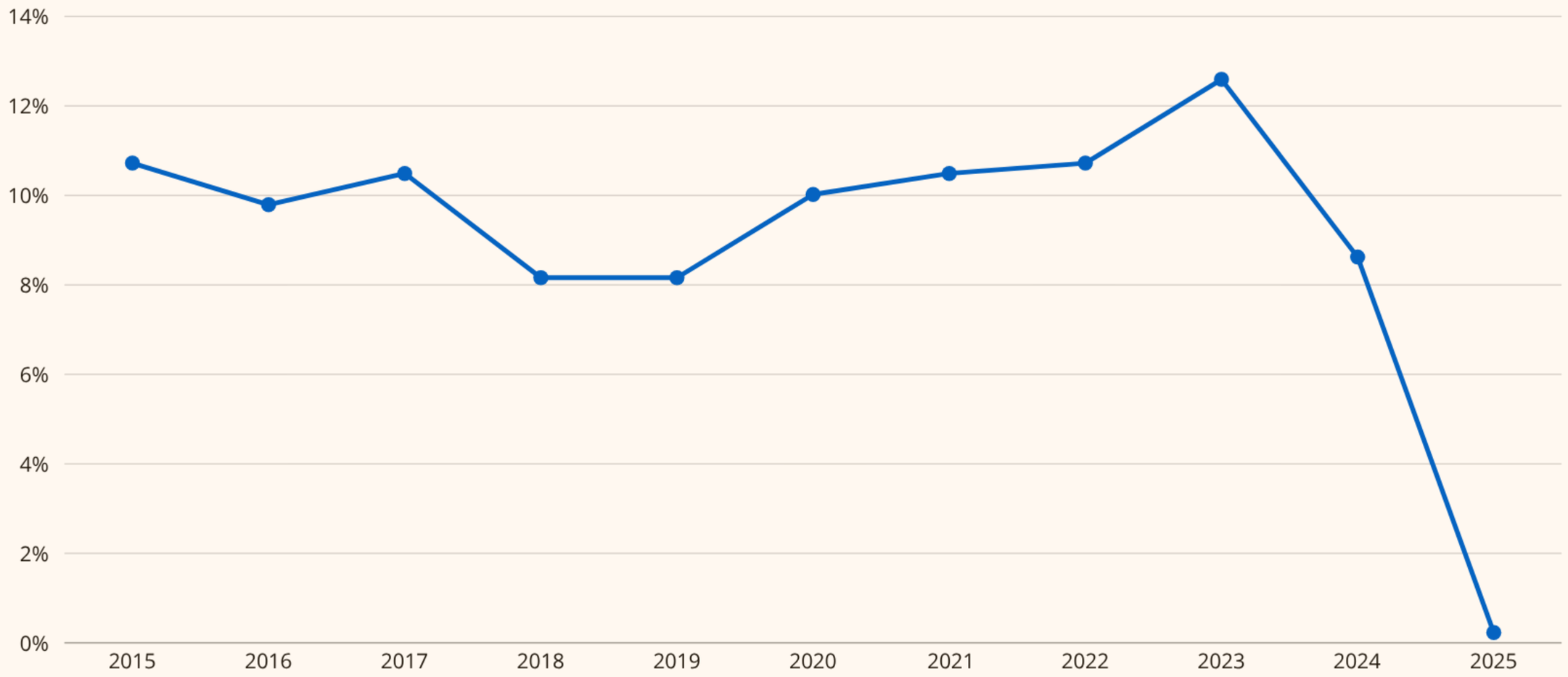
- The graph shows a steady rise in next generation sequencing patent application filing percentages from 2019 to a peak of 12.12% in 2022, reflecting heightened innovation and filing activity during this period. Filings appear lower in 2023–2024. However, the 2025 data is incomplete and likely to rise.



2025 Data is Incomplete

Filing Year-based Trend Analysis

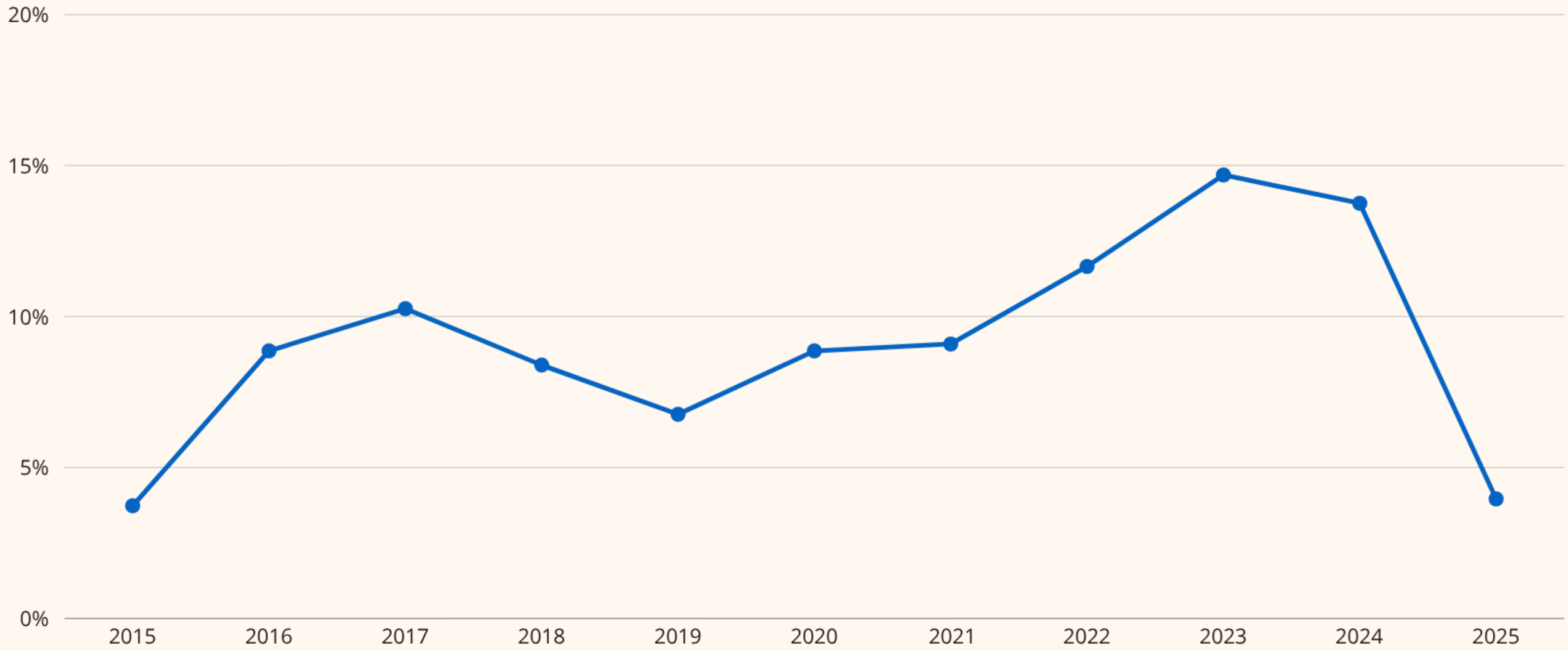
- Application filing trends show a surge in next generation sequencing-related patent application from 2020 to 2023, with filings for 2025 possibly still being recorded, suggesting the trend may continue to increase.



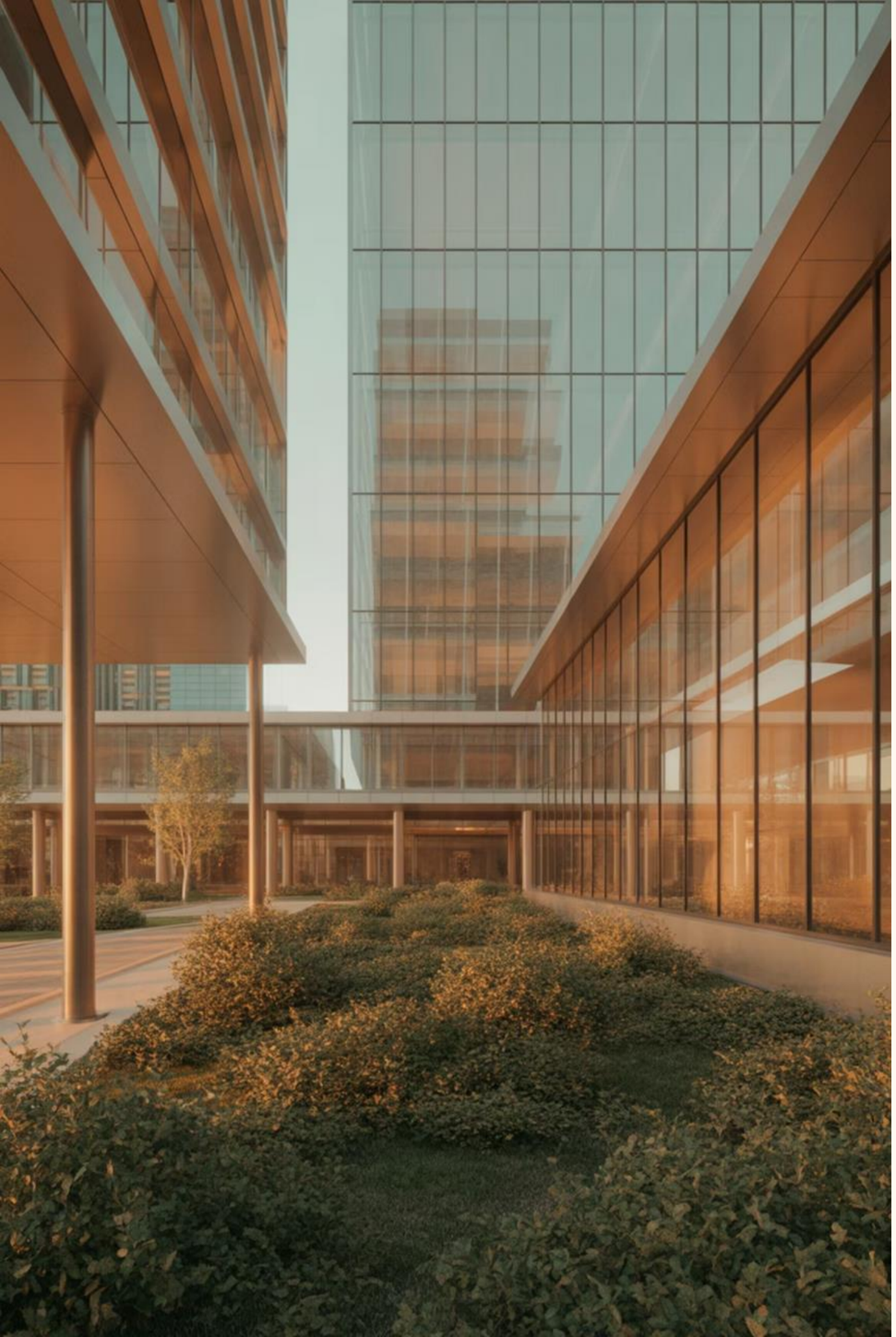
2025 Data is Incomplete

Publication Year-based Trend Analysis

- The publication trends show a sharp rise in next generation sequencing-related patent publications starting in 2020, with a significant increase continuing into 2022 and 2023. However, the 2025 data still being recorded.



2025 Data is Incomplete



Major Assignees and Market Leaders

Illumina, Roche, and BGI hold the largest percentages of patents and patent publications in the next-generation sequencing domain, demonstrating their dominant market positions and sustained commitment to innovation.

1

Illumina

Market leader with comprehensive portfolio spanning sequencing chemistry, instruments, and software platforms

2

Roche

Strong position in clinical diagnostics with focus on companion diagnostics and oncology applications

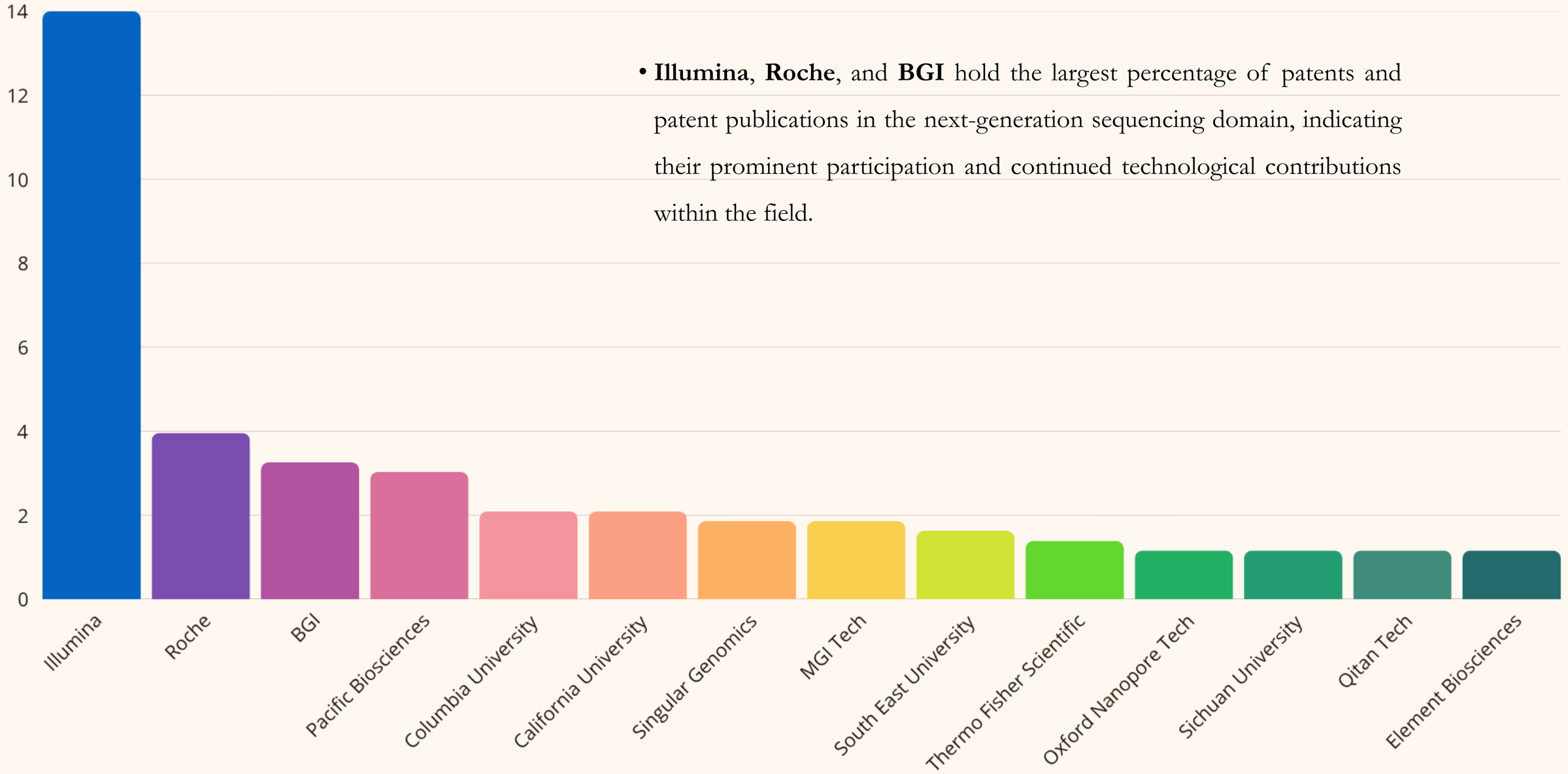
3

BGI

Rapidly growing Chinese competitor with emphasis on cost-effective sequencing and automation

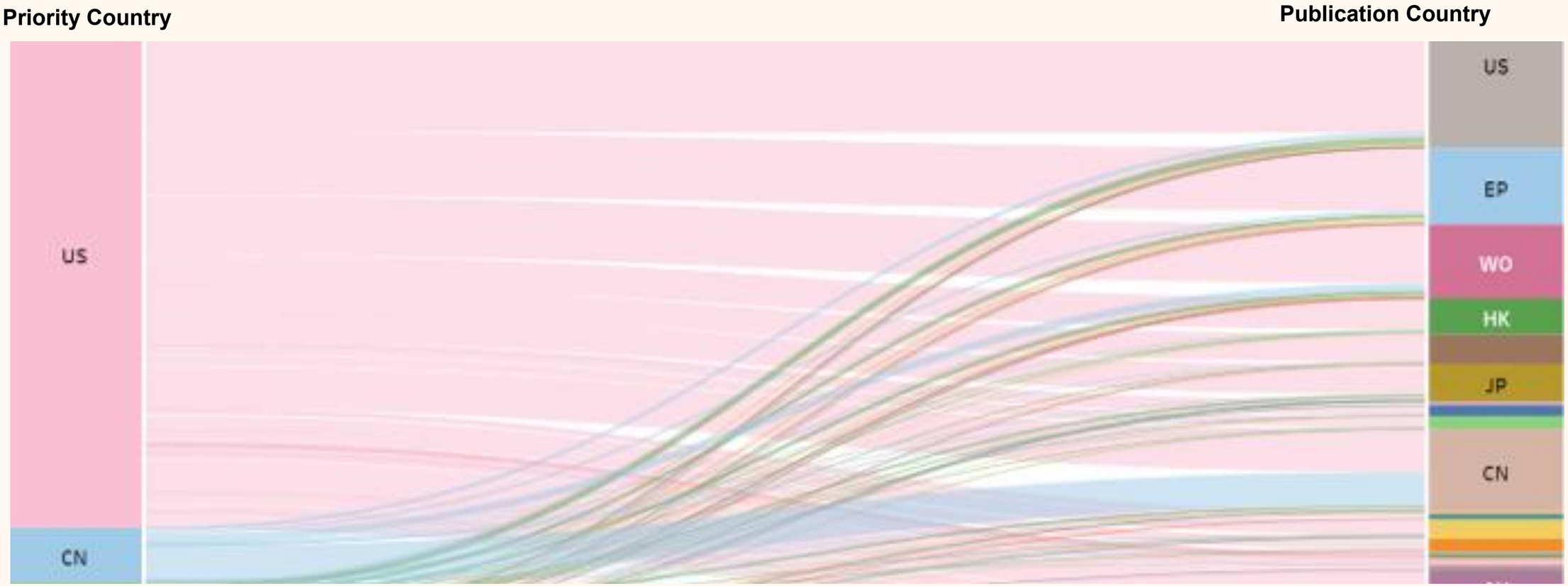
These assignees' patent portfolios reflect not only their current market dominance but also their strategic vision for future NGS applications, from research tools to point-of-care diagnostics.

Major Assignees (Based On Representative Member Per Family)



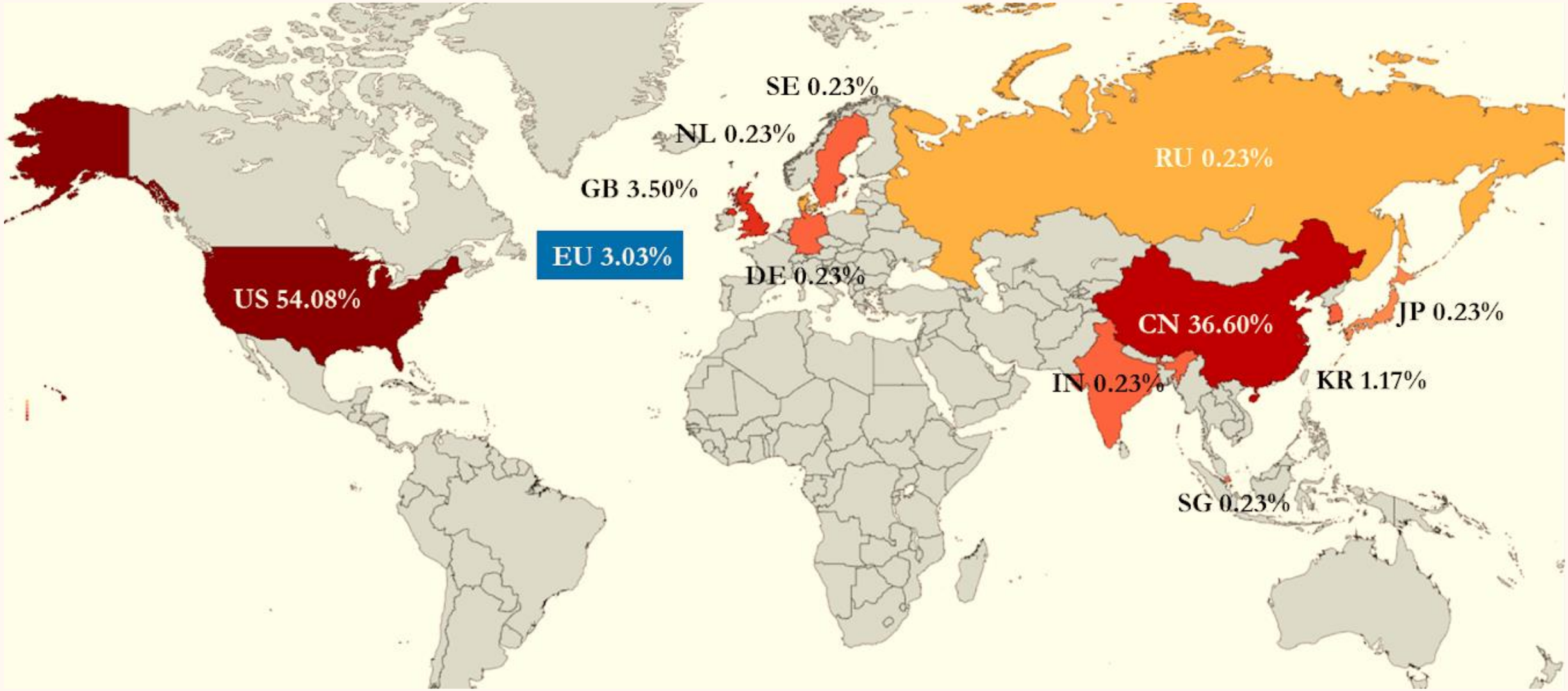
- **Illumina**, **Roche**, and **BGI** hold the largest percentage of patents and patent publications in the next-generation sequencing domain, indicating their prominent participation and continued technological contributions within the field.

Next Generation Sequencing Patent Trends



- **Graph Showing Patent Priority Vs. Publication Country:** Major flows highlight the global reach of patents originating from key markets such as the **US** and **CN**. Among patent families claiming the **US** as the priority country, the highest proportions of subsequent filings are in **EP** and **CN**. Conversely, among families claiming **CN** as the priority country, the highest proportions of subsequent filings are in the **US** and **EP**.

Geographical Distribution of Patent Filings



International Patent Classification Analysis

Analysis of International Patent Classification (IPC) codes reveals the technical focus areas within NGS patent applications. The dominant classifications center on:

C12Q (Measuring or Testing Processes)

The most prevalent classification, covering enzymatic methods and nucleic acid analysis techniques

G01N (Investigating Materials)

Significant representation in instrument design, detection methods, and analytical systems

C12N (Microorganisms, Enzymes)

Focus on polymerases, nucleic acid modifying enzymes, and biochemical reagents

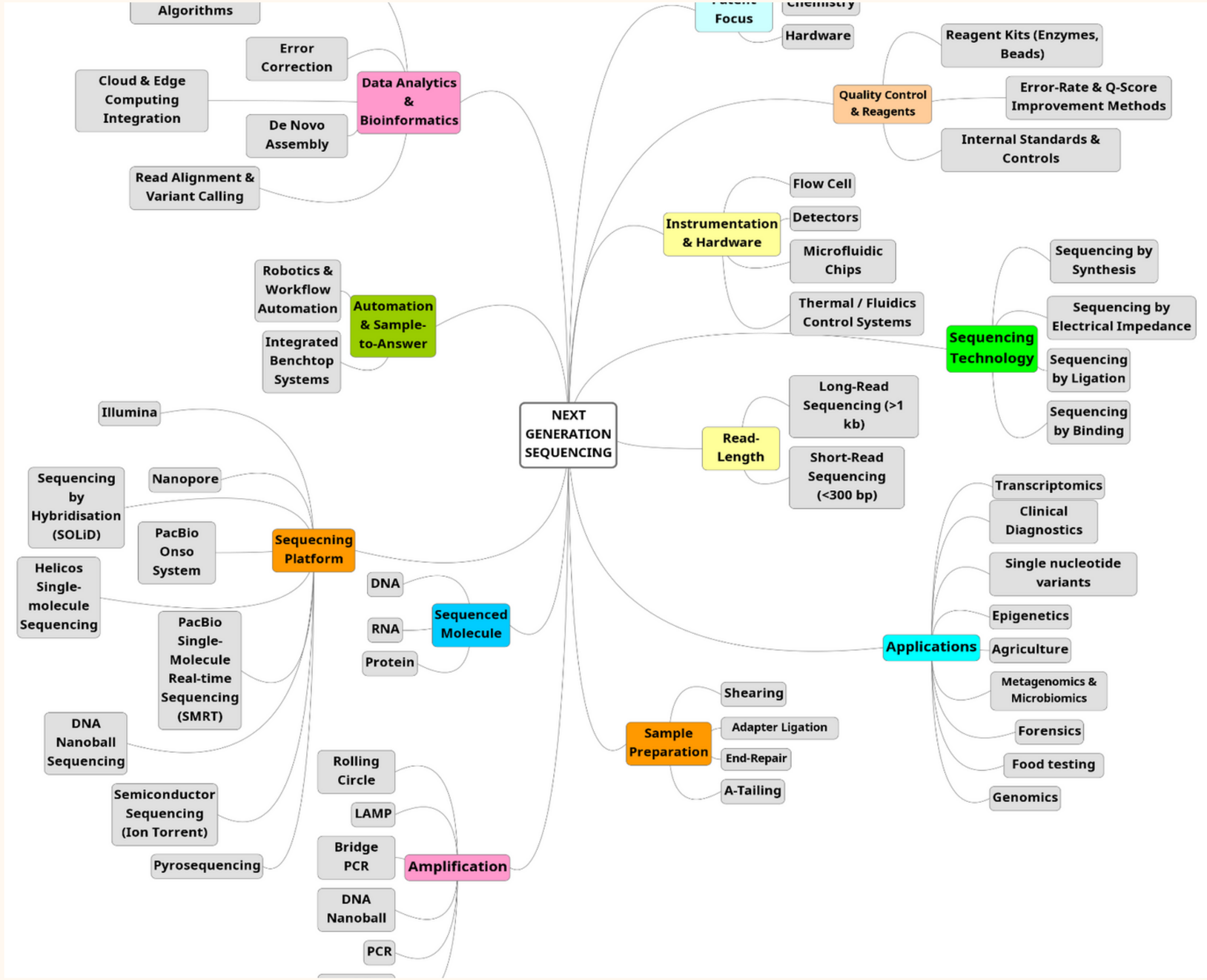
G16B (Bioinformatics)

Growing classification covering sequence analysis, data processing, and computational methods

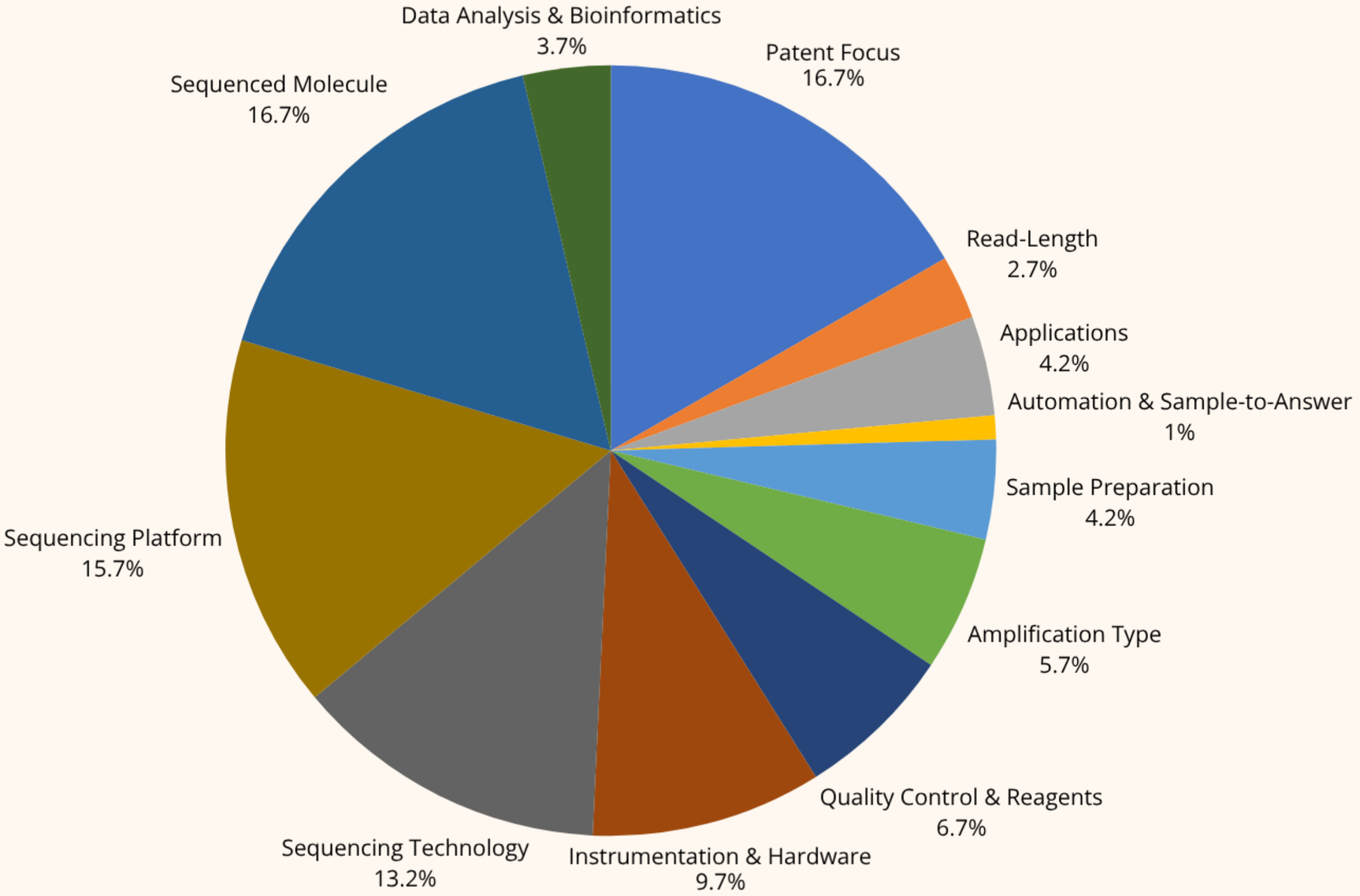
The IPC distribution demonstrates the **multidisciplinary nature of NGS innovation**, spanning chemistry, instrumentation, biology, and computer science.

Technology Taxonomy

- A comprehensive set of **400+ patent families** was analyzed in depth to map the innovation landscape and identify strategic focus areas across the NGS technology spectrum.
- The taxonomy spans **twelve major technology categories**: Sequencing Molecules, Patent Focus, Quality Control & Reagents, Instrumentation & Hardware, Read-Length, Sequencing Technology, Sample Preparation, Amplification, Sequencing Platform, Automation & Sample-to-Answer, Data Analytics & Bioinformatics, and Applications.
- This structured approach enables identification of white space opportunities, competitive clustering, and emerging innovation trends across the NGS value chain.

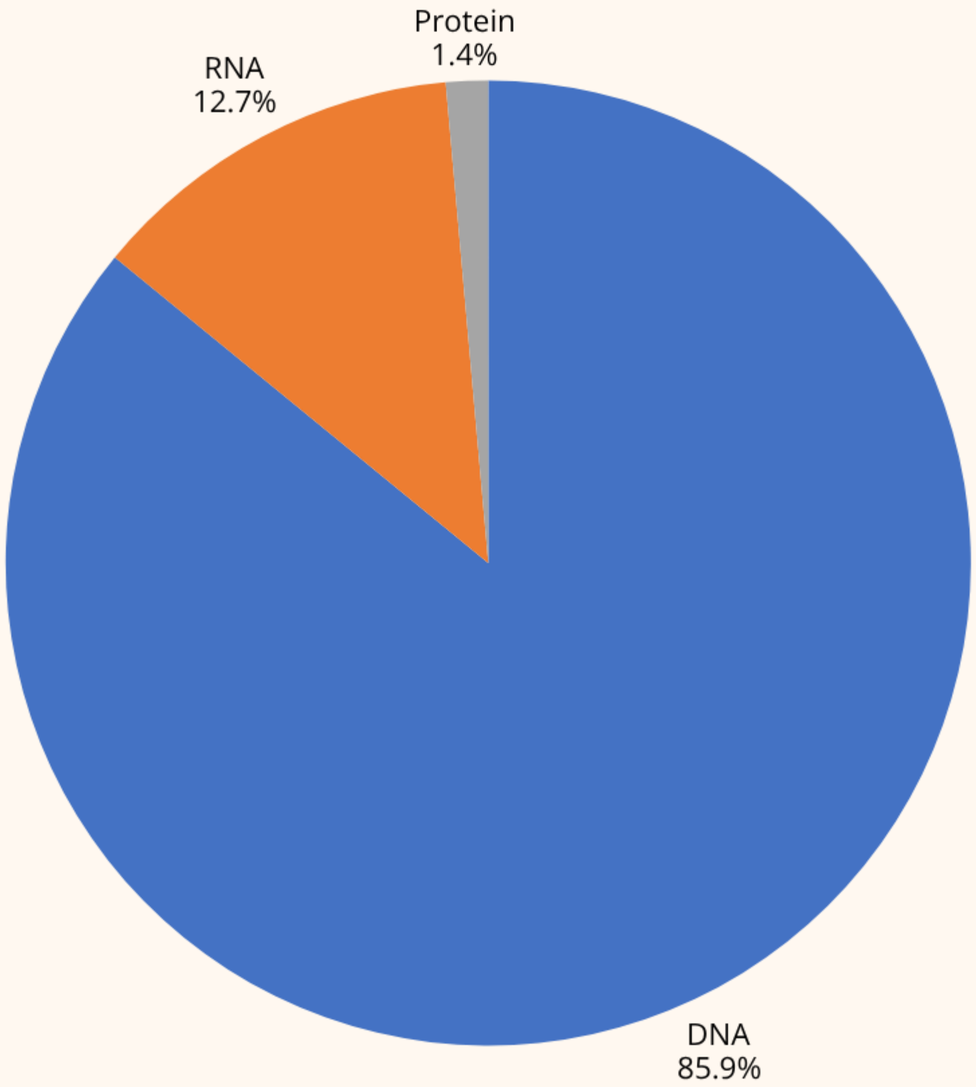


Patent Landscape Analysis Of Next Generation Sequencing



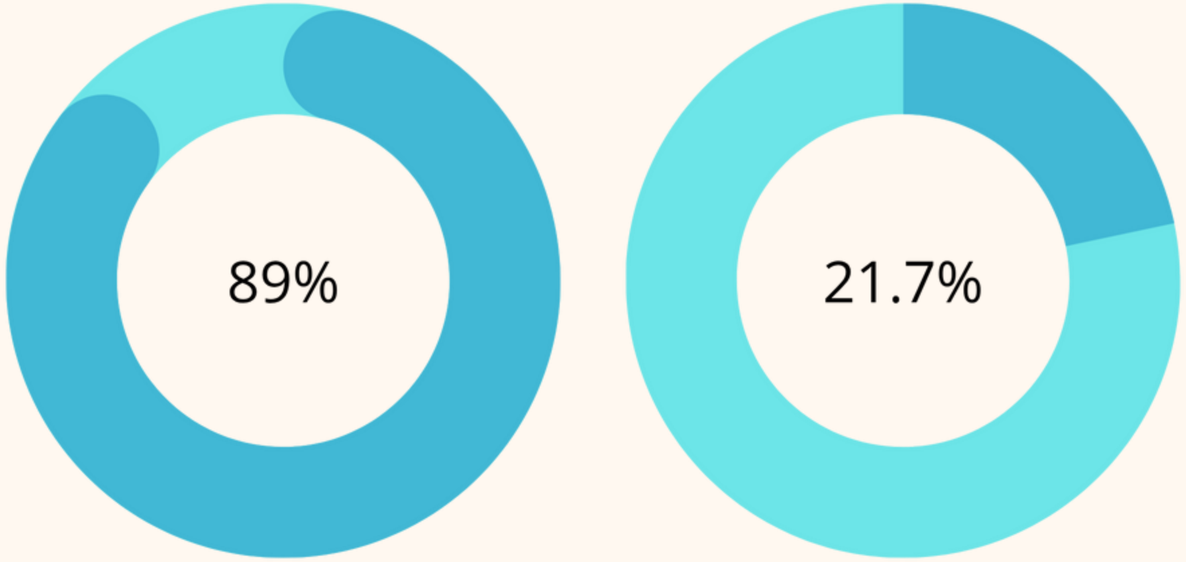
- A Visual Representation of Patent Activity Across Sequenced molecules, technologies, platform and applications.
- The chart highlights key areas of next generation sequencing research, with the largest focus on Sequenced Molecules types, Patent Focus areas and Sequencing Platform. Other significant areas include Sequencing Technology, Instrumentation & Hardware, Quality Control & Reagents, Amplification Type, Sample Preparation show moderate activity. The chart also emphasizes on Applications, Data Analysis & Bioinformatics, Read-Length, and Automation & Sample-to-Answer.

Dissection Of Patents/Applications Pertaining To ‘Sequenced Molecules Types’



The chart illustrates the distribution of patents/applications by molecule type. **DNA** accounts for the largest share of patents/applications, indicating it is the most frequently sequenced molecule using next-generation sequencing technologies.

Patent Focus Areas: Methodology vs. Instrumentation



Methodology (Protocol & Chemistry)

Instruments

Methodology (Protocol & Chemistry)

The **dominant focus** of NGS patents centers on protocols, chemistry innovations, and biochemical methods. This includes novel polymerases, base-calling approaches, library preparation techniques, and sequencing-by-synthesis improvements.

Companies prioritize protecting their unique chemical and enzymatic approaches, as these form the foundation of competitive differentiation and often carry stronger enforcement potential than instrument designs.

Instrumentation

Instrument-focused patents represent a smaller but strategically important segment, covering optical systems, flow cells, detection mechanisms, and automation hardware.

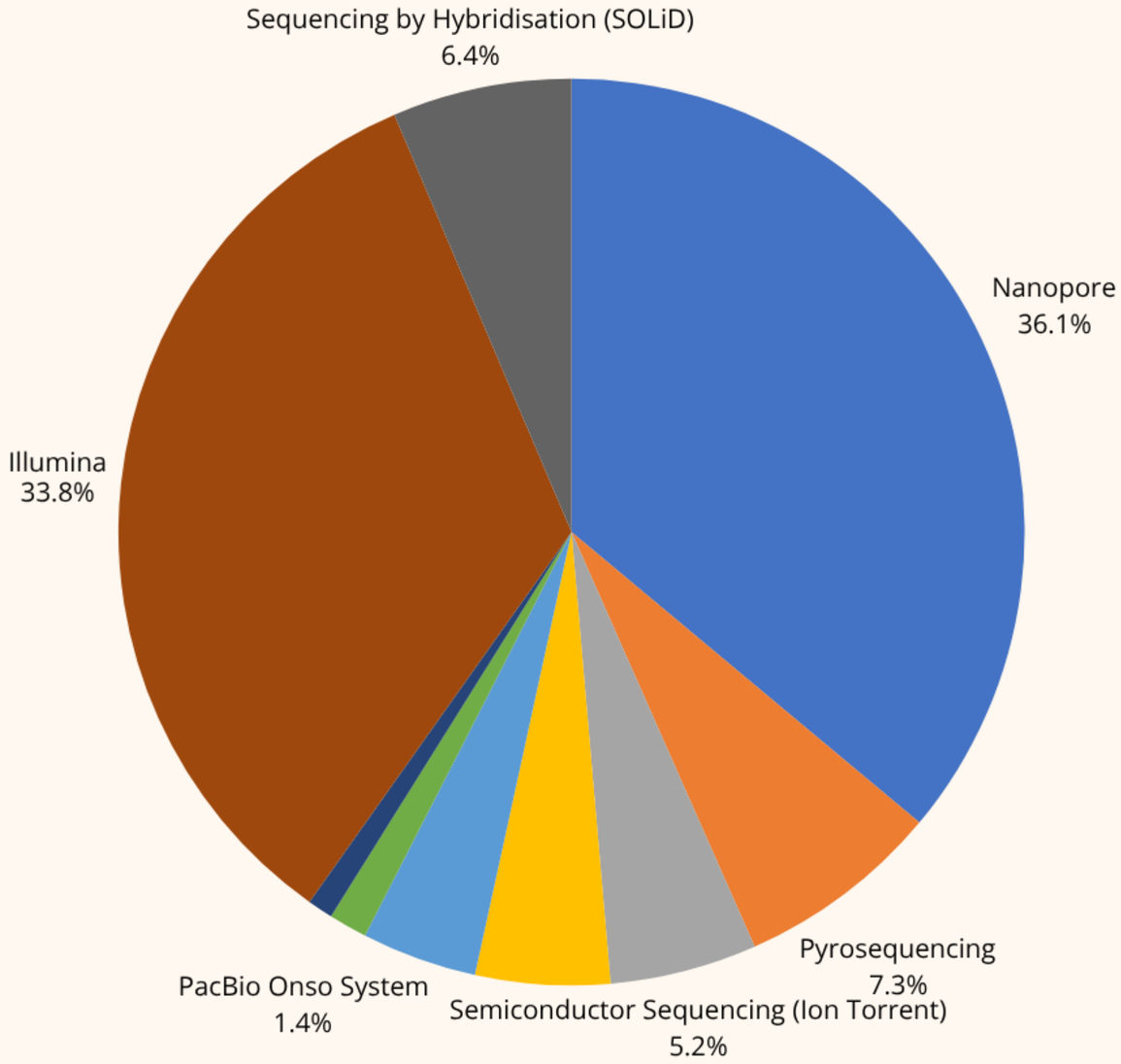
While fewer in number, instrument patents often have longer commercial lifecycles and can create significant barriers to entry for competitors attempting to develop compatible systems.

This distribution reflects a strategic reality: **chemistry and protocols are easier to protect and harder to design around**, making them preferred targets for patent protection compared to mechanical or electronic innovations that may face more design-around challenges.

Dissection Of Patents/Applications Pertaining To Next Generation Sequencing ‘Sample Preparation’

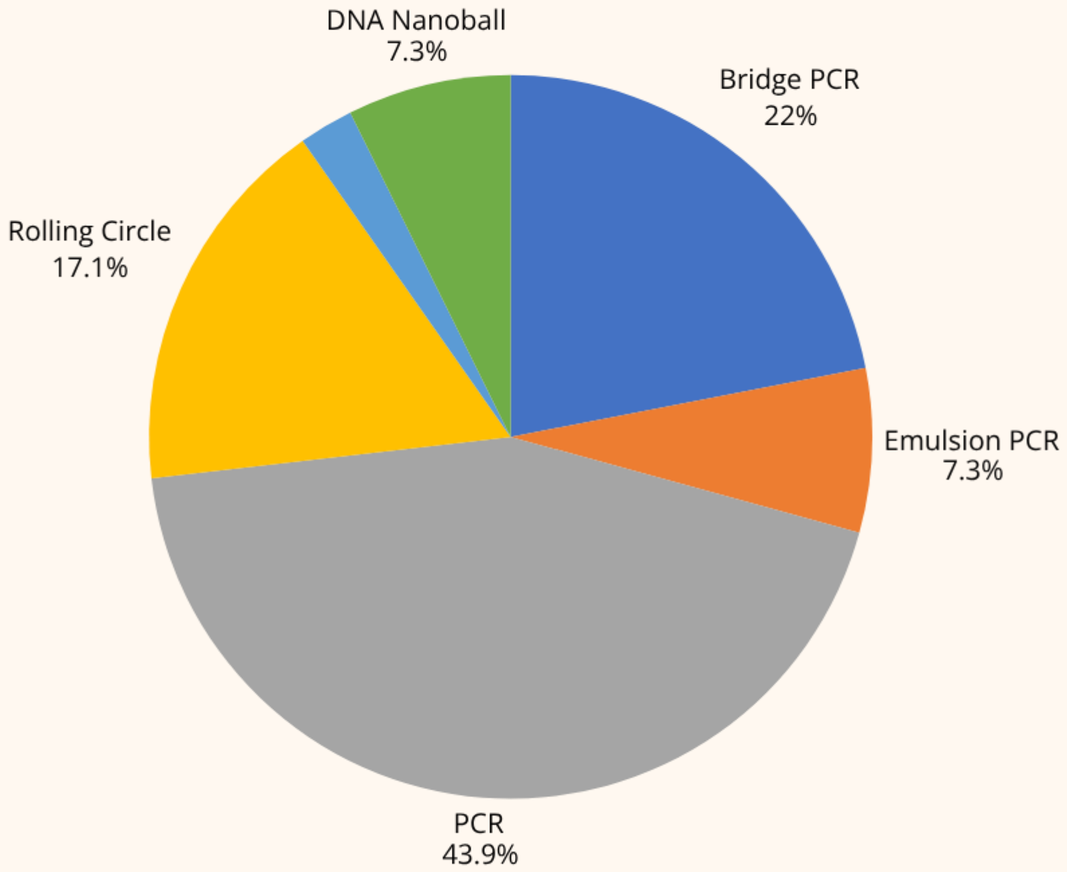
The chart presents a breakdown of patents and applications related to next generation sequencing sample preparation. The largest section of the map is dedicated to **Adaptor Ligation** method, indicating its significant role in next generation sequencing, followed by **End-Repair**, reflecting its growing prominence in next generation sequencing. **A-Tailing** and **Shearing** also represent notable shares, showing their importance in sample preparation for sequencing contexts.

Dissection Of Patents/Applications Pertaining To 'Sequencing Platform'



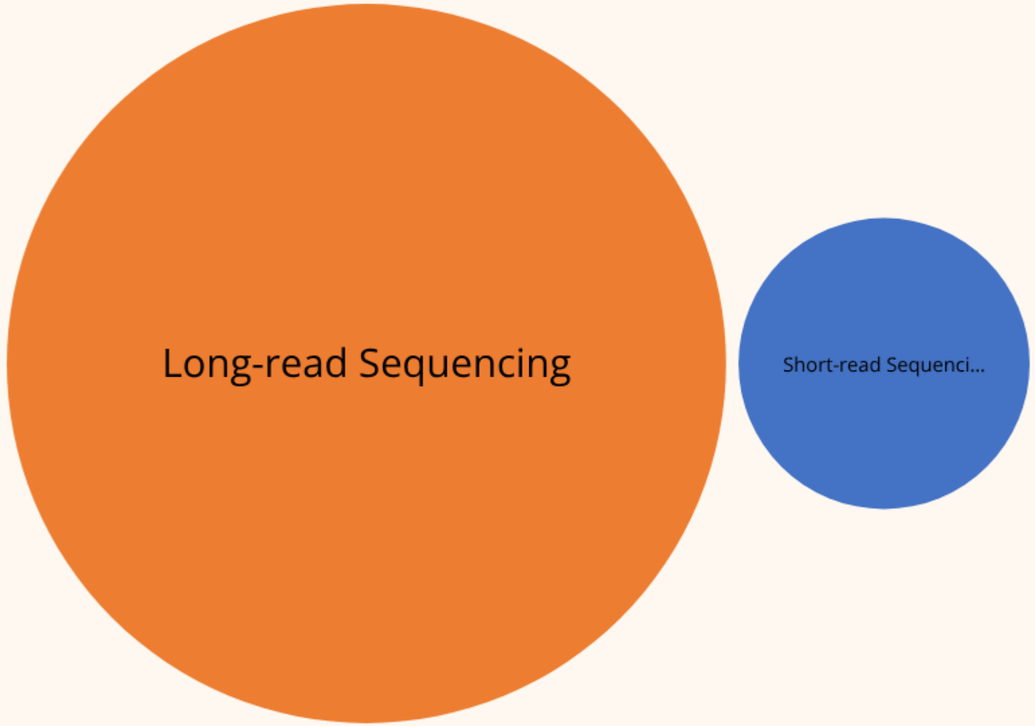
The graph provides a visual representation of the distribution of patents or applications related to Sequencing Platform in next generation sequencing research. **Nanopore** and **Illumina** emerges as the most frequently targeted platform followed by **Illumina, Pyrosequencing** and **Sequencing by Hybridization (SOLiD)**, highlighting their significance in next generation sequencing studies. While Semiconductor Sequencing (Ion Torrent), PacBio Single-Molecule Real-time Sequencing (SMRT), DNA Nanoball Sequencing, PacBio Onso System, Helicos Single-molecule Sequencing may be less frequently targeted, they are still emerging as valuable platforms in next-gen sequencing.

Dissection Of Patents/Applications Pertaining To 'Amplification Type'



The graph reveals that **PCR** is the largely utilized for amplification in next-gen sequencing along with **Bridge PCR** and **Rolling Circle** which are also utilized significantly for amplification.

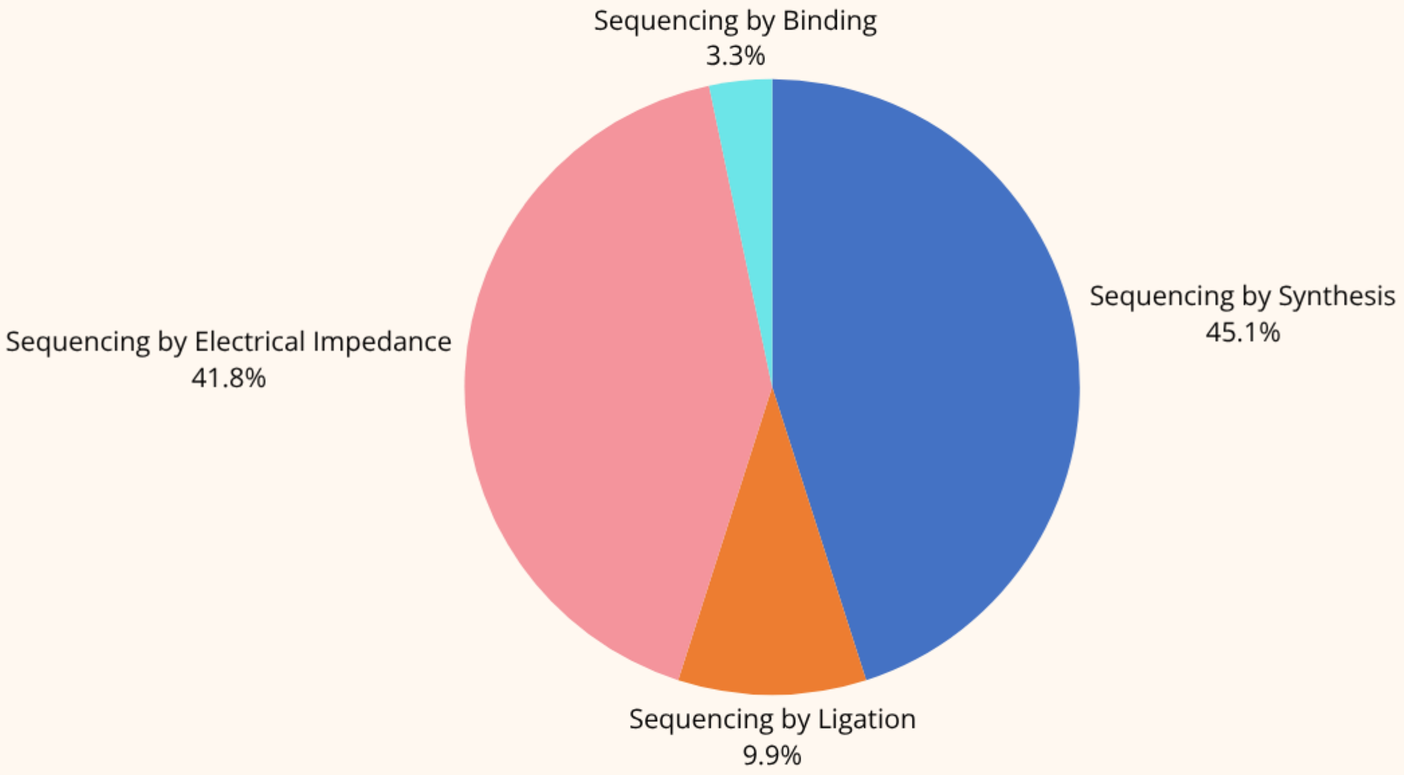
Dissection Of Patents/Applications Pertaining To 'Read Length'



2.33%	14.22%
Short-read	Long-read

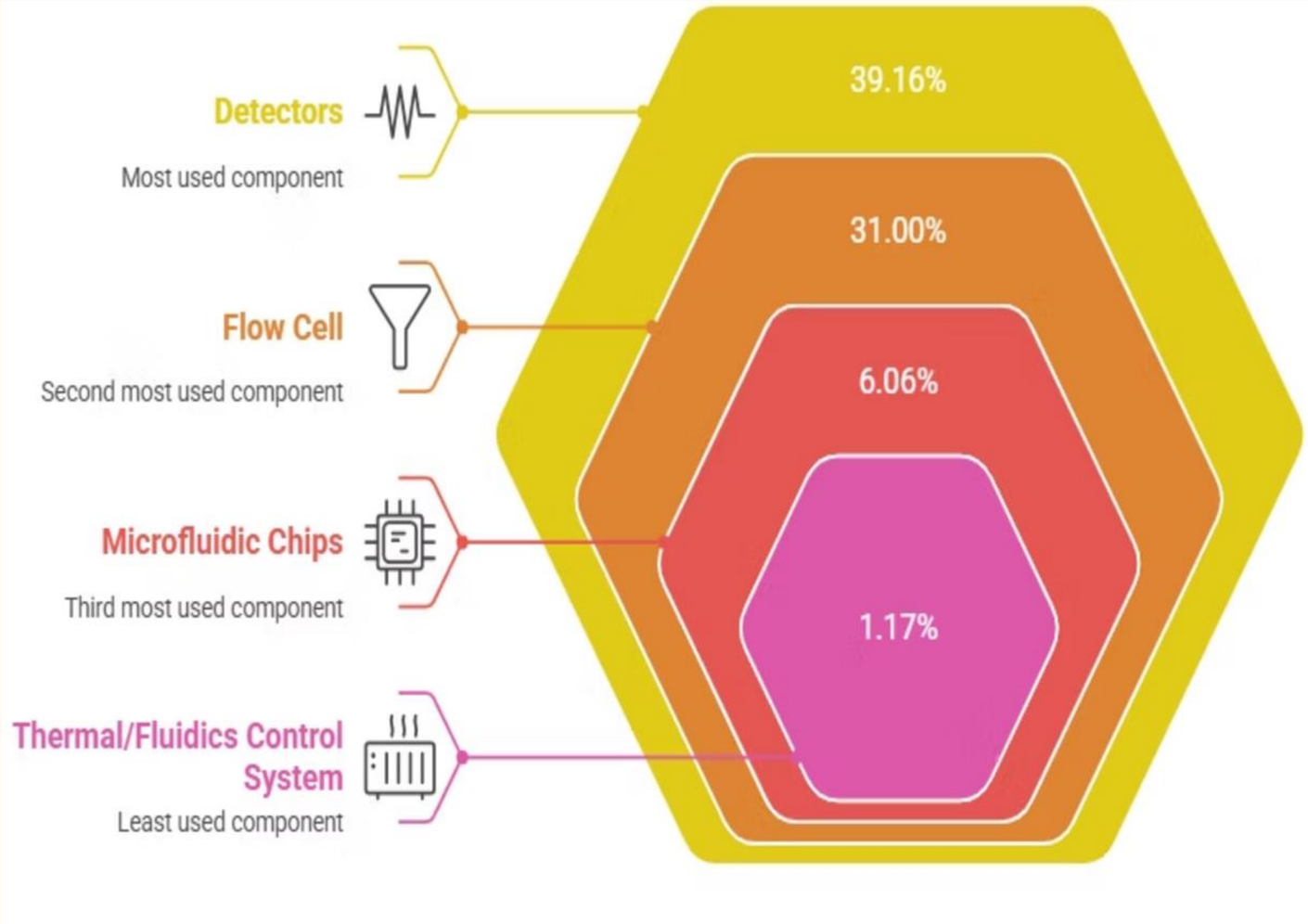
The graph highlights the Read- Length explored in next-gen sequencing research, with **Long-read Sequencing (>1 kb)** being the most common.

Dissection Of Patents/Applications Pertaining To 'Sequencing Technologies'



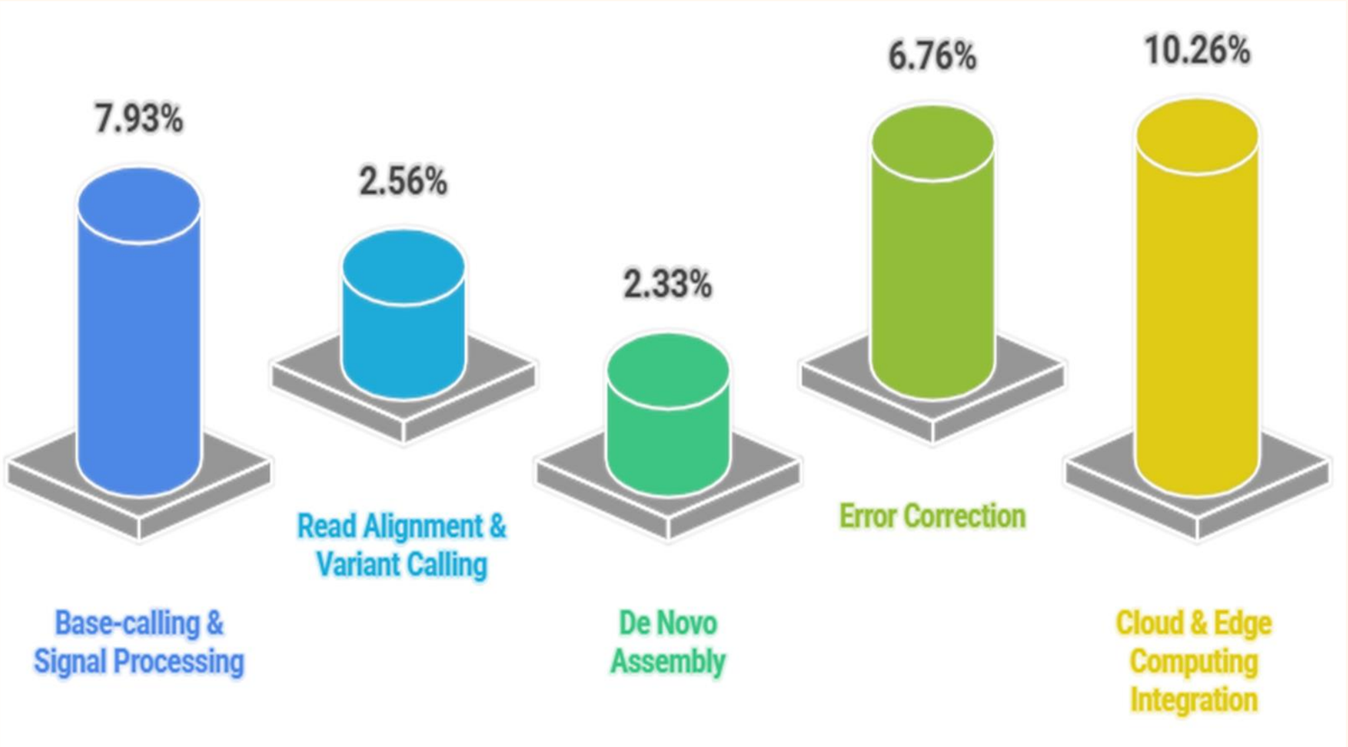
The chart shows the distribution of patent filings by sequencing technology in next-generation sequencing. **Sequencing-by-synthesis (41%)** represents the largest share of patents/applications, followed by **sequencing by electrical impedance (38%)**. **Sequencing-by-ligation (9%) and sequencing-by-binding (3%)** account for smaller shares. Together, **SBS and electrical-impedance** comprise **79%** of patents/applications, indicating a strong concentration of patenting activity in these two approaches.

Dissection Of Patents/Applications Pertaining To 'Instrumentation And Hardware'



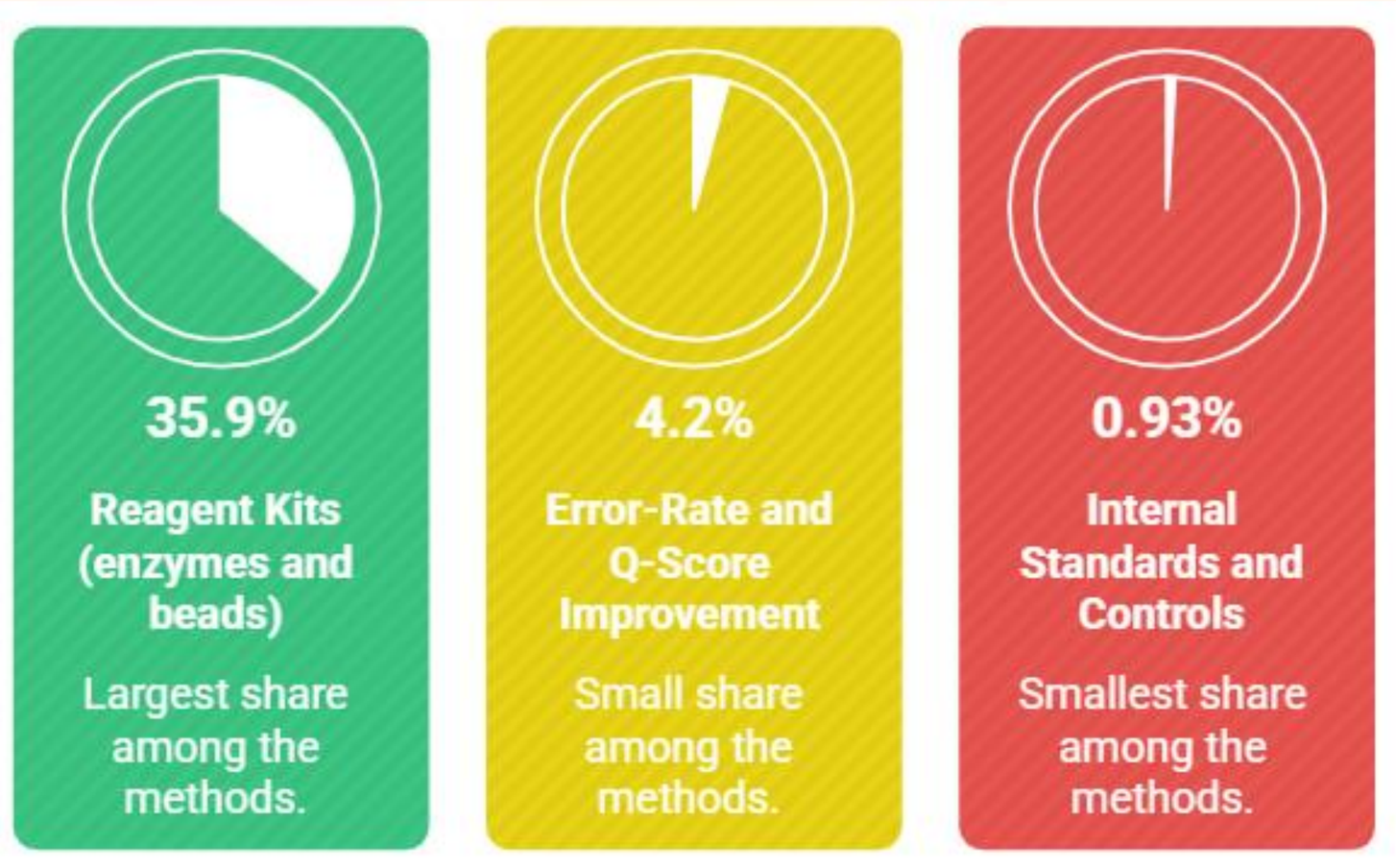
The graph shows the distribution of patent filings for instrumentation and hardware in next-generation sequencing. **Detectors (39.16%)** represent the largest share of patents/applications and encompass fluorescence, pH, and tunneling-current modalities. **Flow cells account for 31% of patents/applications**. Microfluidic chips and thermal/fluidic control systems make up smaller shares and appear less prevalent relative to detectors and flow cells.

Dissection Of Patents/Applications Pertaining To 'Data Analysis And Bioinformatics'



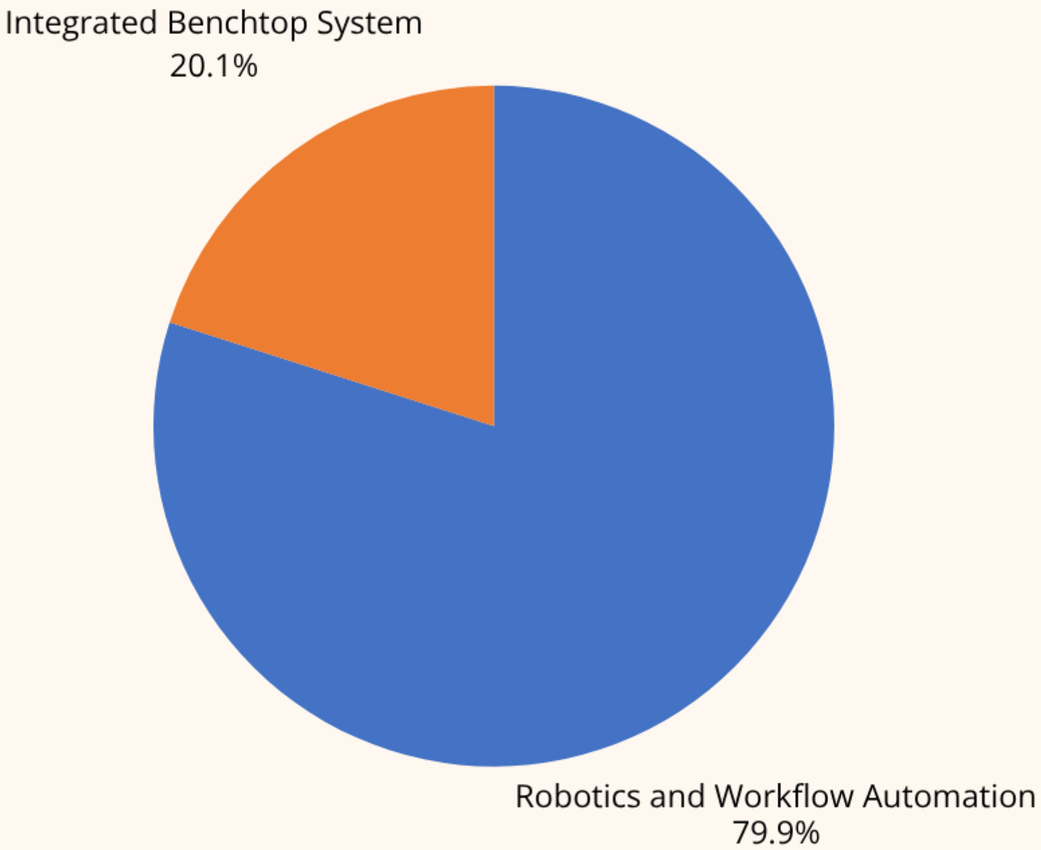
The graph reveals that **Cloud & Edge Computing Integration** is the primarily targeted in next-gen sequencing, followed by Base-calling & Signal Processing Algorithms and Error Correction.

Dissection Of Patents/Applications Pertaining To 'Quality Control And Reagents'



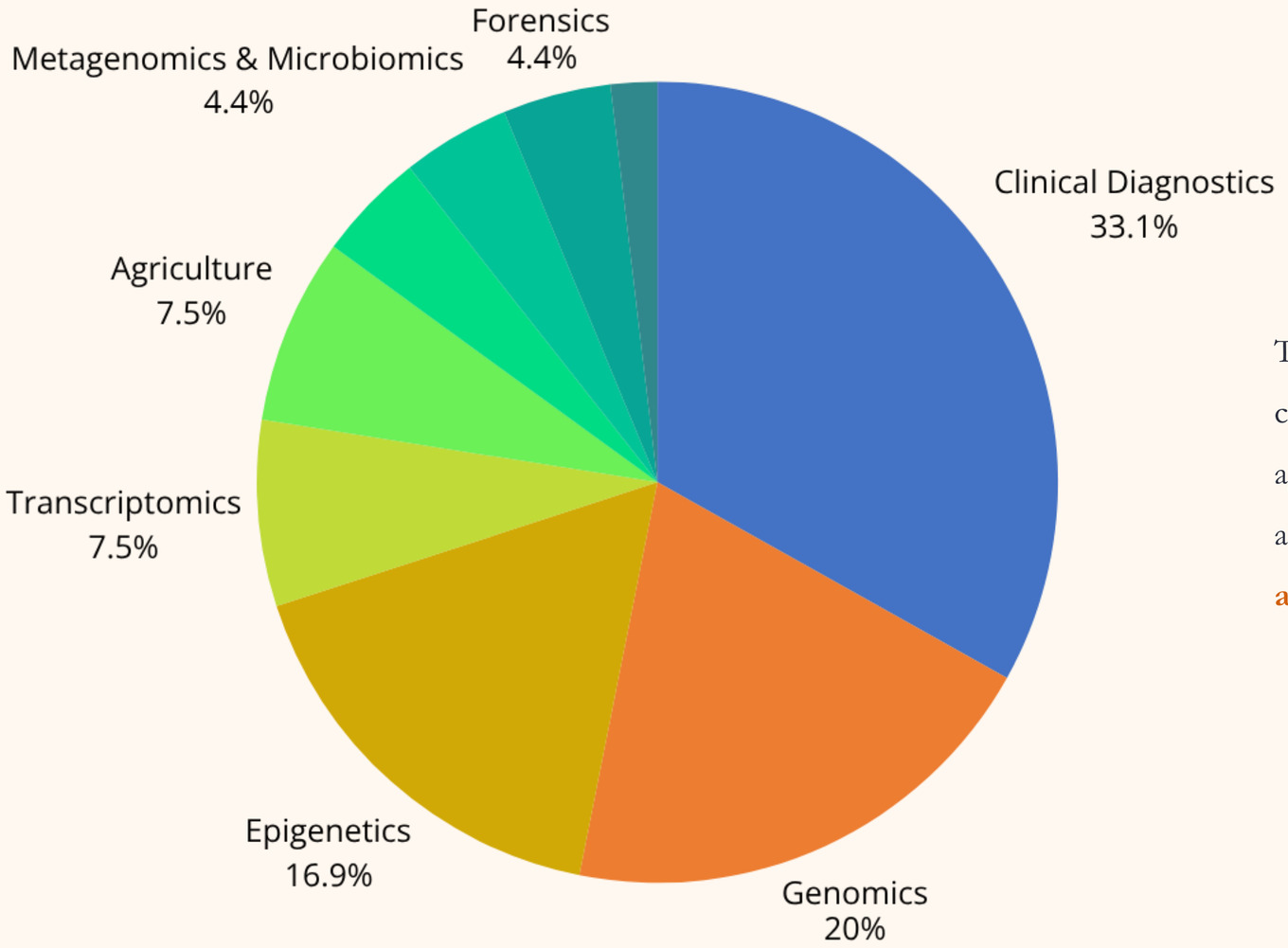
The graph highlights the distribution of key components used in Quality Control and Reagents within Next Generation Sequencing (NGS). It reveals that **Reagent Kits (enzymes and beads)** are by far the most widely used with **35.9%** of patents/applications, indicating their central role in quality control and reagents. In contrast, **Error-Rate and Q-Score Improvement Methods** are used far less frequently, with a proportion of **4.2%** patents/applications, suggesting they are not as widely implemented in standard workflows. **Internal Standards and Controls** appear to be the least utilized, with only **0.93%** patents/applications, highlighting a potential gap or an emerging area that may require more attention in the future.

Dissection Of Patents/Applications Pertaining To 'Automation & Sample To Answer'



The graph illustrates the application of Automation and Sample-to-Answer technologies in Next Generation Sequencing (NGS), categorized into two main areas: **Integrated Benchtop Systems and Robotics & Workflow Automation**. While **Robotics & Workflow Automation** demonstrates increased utilization within the field of NGS, the data suggests that these technologies are still not widely adopted across all areas.

Dissection Of Patents/Applications Pertaining To 'Applications'



The graph indicates that next-generation sequencing is primarily applied in clinical diagnostics, followed by genomics, epigenetics, transcriptomics, and agriculture. This distribution suggests a prioritization of clinical translation and diagnostic development within **NGS innovation, reflecting industry and research emphasis on patient-centric applications.**

PATENT PORTFOLIO ANALYSIS

Heat Map Analysis Represent Major Assignee's w.r.t. Sequencing Platform

	Pyrosequencing	Semiconductor Sequencing (Ion Torrent)	Illumina	Sequencing by Hybridisation (SOLiD)	DNA Nanoball Sequencing	Helicos Single-Molecule Sequencing	PacBio Onso System	PacBio Single-Molecule Real-Time Sequencing (SMRT)	Nanopore
Illumina	6.25	0	34.46	0	0	0	0	0	4.76
Roche	0	0	0	0	0	0	0	9.52	10.12
Bgi	0	0	1.35	7.14	22.22	0	0	4.76	4.76
Pacific Biosciences	0	0	0.68	0	0	0	83.33	28.57	4.76
Columbia Univ	6.25	4.35	0.68	0	0	0	0	0	1.79
California Univ	0	0	1.35	3.57	0	0	0	0	3.57
Singular Genomics	18.75	0	0.68	0	0	0	0	4.76	0
Mgi Tech	0	0	2.7	3.57	22.22	0	0	0	0
South East Univ	9.38	0	0	0	0	0	0	0	1.79
Thermo Fisher Scientific	0	4.35	3.38	0	0	0	0	0	0
Oxford Nanopore Tech	0	0	0	0	0	0	0	0	2.98
Sichuan Univ	6.25	0	0	0	0	0	0	0	1.79
Qitan Tech	0	0	0	0	0	0	0	0	2.98
Element Biosciences	3.13	4.35	0.68	3.57	27.78	0	0	4.76	0

Heat Map Analysis Represent Major Assignee's w.r.t. Sequencing Technology

	Sequencing by Synthesis	Sequencing by Ligation	Sequencing by Binding	Sequencing by Electrical Impedance
Illumina	30	25	0	4
Roche	7	0	7	2
BGI	1	5	0	4
Pacific Biosciences	4	0	36	3
Columbia Univ	5	0	0	2
California Univ	1	3	0	4
Singular Genomics	5	8	14	0
MGI Tech	2	8	0	1
South East Univ	1	0	0	2
Thermo Fisher Scientific	3	0	0	0
Oxford Nanopore Tech	0	0	0	3
Sichuan Univ	0	0	0	2
Qitan Tech	0	0	0	3
Element Biosciences	1	3	14	0

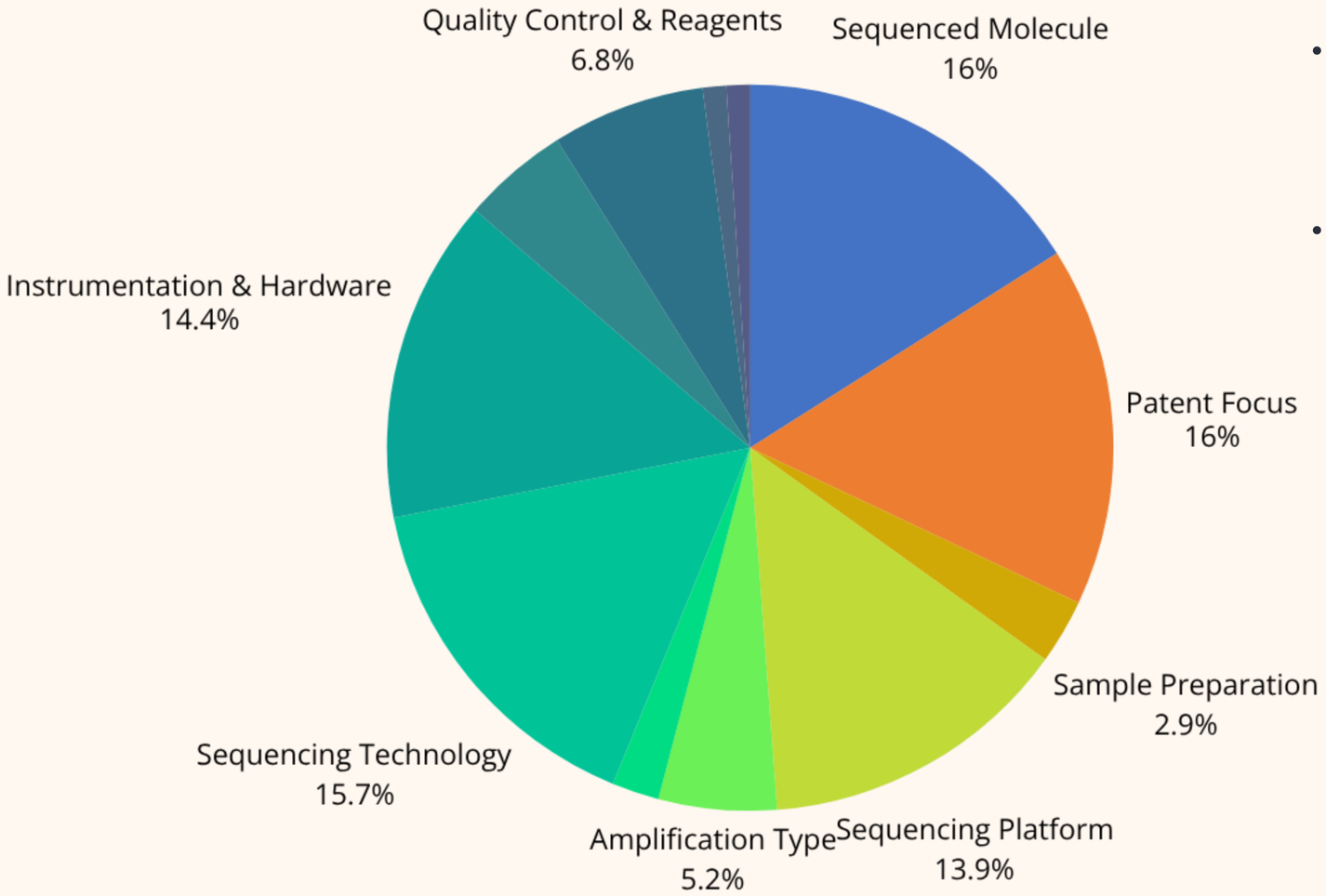
Heat Map Analysis Represent Major Assignee's w.r.t. Sequencing Platform

The heat map illustrates the distribution of patent or application counts across various Sequencing Platform for leading institutions and companies. **Illumina** dominates in **Sequencing with using Illumina as a platform** with 34.46%, highlighting their significant contribution to this field. The **Roche** and **BGI** also have a noticeable presence, particularly in **Nanopore**, with BGI showing diversified contributions across multiple fields, including DNA nanoball sequencing and Illumina whereas **Pacific Biosciences** uses PacBio Onso System largely and followed by it`s SMRT system.

Heat Map Analysis Represent Major Assignee's w.r.t. Sequencing Technology

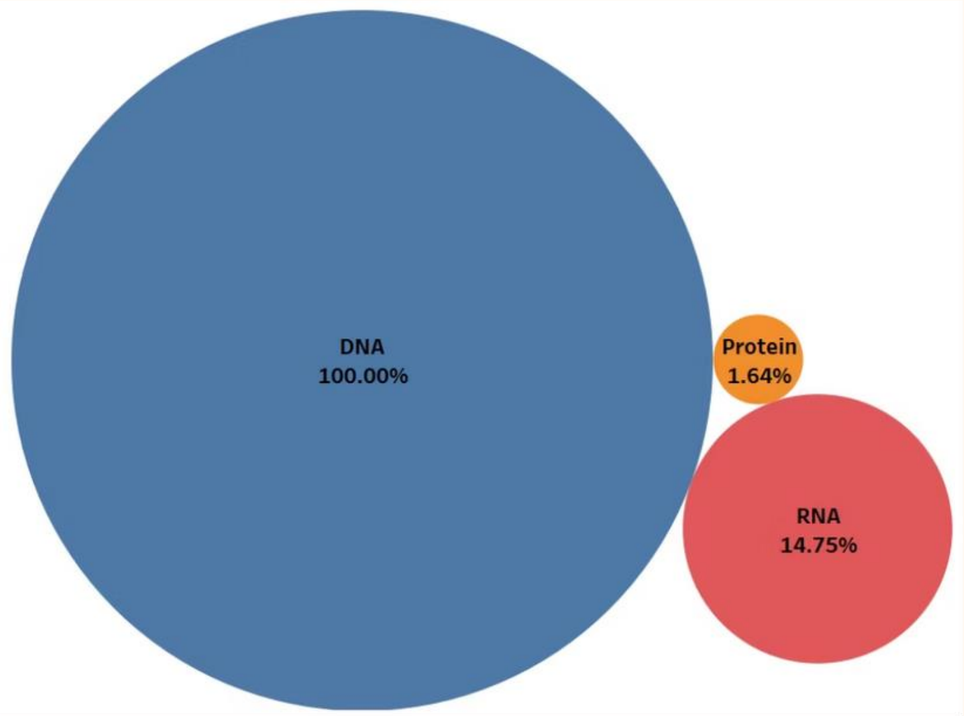
The heat map illustrates the distribution of patent or application counts across various Sequencing Technologies for leading institutes and companies. The technology **Sequencing by Synthesis** is predominately used largely across all key players. **Illumina** dominates in **Sequencing by Synthesis** with 30.46%. They also show strong involvement in **Sequencing by Ligation** and **Sequencing by Electrical Impedance**. The **Pacific Biosciences** also have a noticeable presence particularly in **Sequencing by Binding** and Sequencing by Electrical Impedance.

ILLUMINA (1/6)



- A Visual Representation of Patent Activity involving Illumina across Sequenced molecules, technologies, platform and applications.
- The chart highlights key areas of next generation sequencing research, with the largest focus on **Sequenced Molecules types (100%), Patent Focus areas like Hardware or Protocol & Chemistry (100%), Sequencing Technology (98.36%)**, **Instrumentation & Hardware (90.16%)** and **Sequencing Platform (86.89%).** Other significant areas include Quality Control & Reagents (42.62%), Amplification Type (32.79%), Data Analysis & Bioinformatics (29.51%), Sample Preparation (18.03%) show moderate activity. The chart also emphasizes on Read-Length (13.11%), Automation & Sample-to-Answer (6.56%) and Applications (6.56%).

ILLUMINA (2/6)



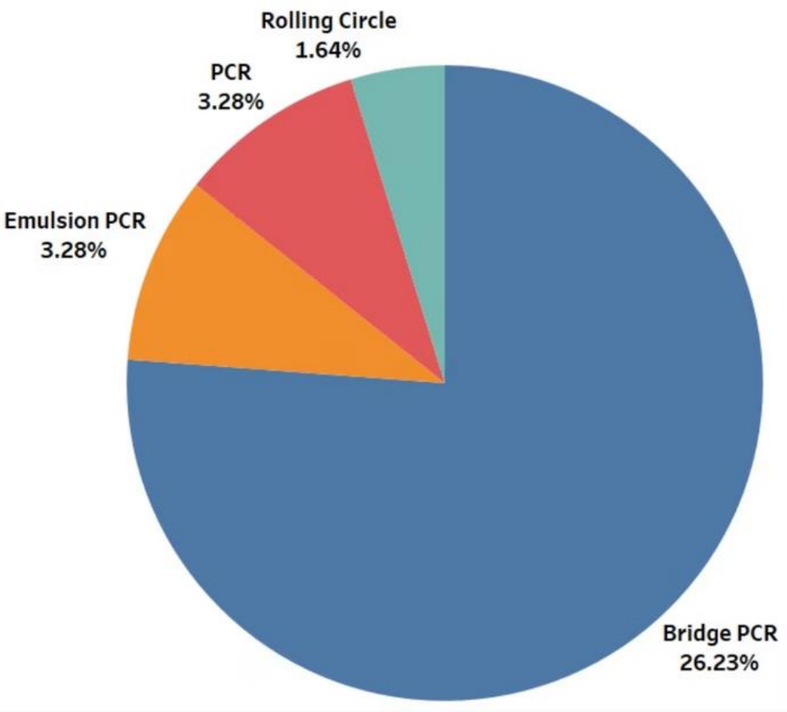
Protocol & Chemistry
95.08%

The chart visually categorizes different types of sequenced molecules into DNA, RNA, and protein. The chart shows that **DNA (100%)** has the highest number of patents or applications, indicating that it is the most frequently sequenced molecule used by **Illumina**. Other molecules includes **RNA (14.75%)** and **Protein (1.64%)**.

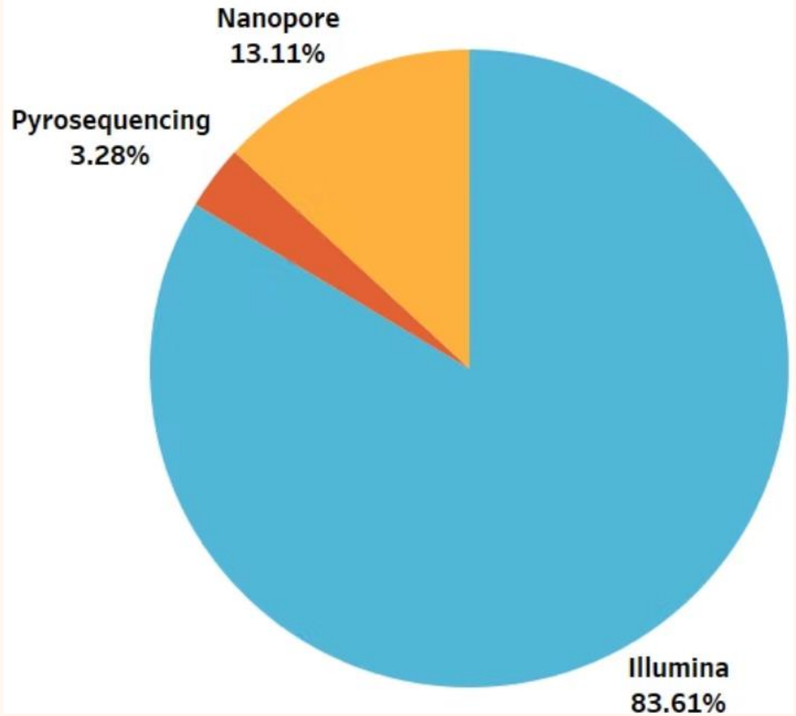
The chart depicts **Sample preparation** methods that includes **End-repair** and **A-tailing** each with 13.11%, and Adaptor ligation with 11.48% patents/applications .

The graph depicts **high number of the patents/ applications** related to Illumina focuses on **Methodology (Protocol & Chemistry)**.

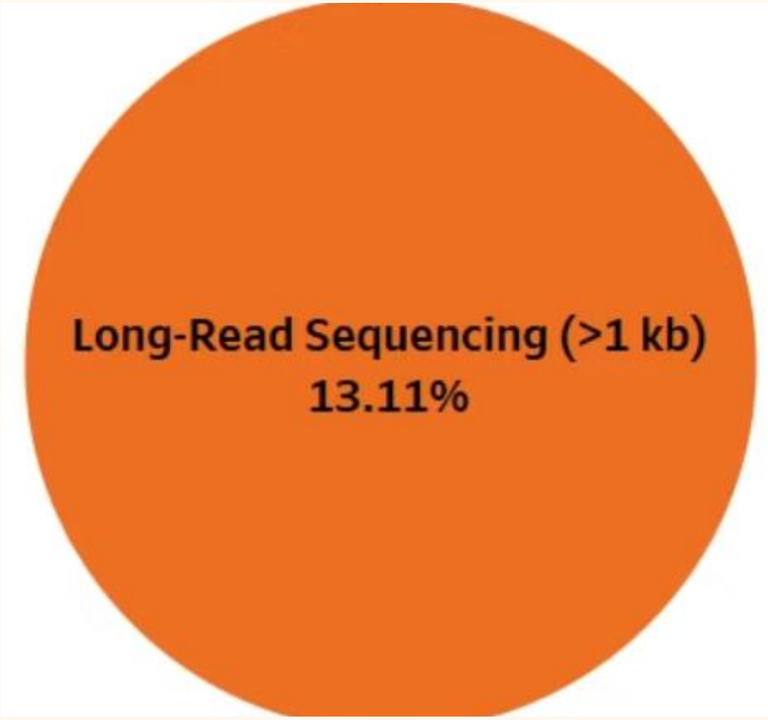
ILLUMINA (3/6)



The graph provides distribution of patent applications related to Sequencing Platform. **Illumina predominantly** uses its own platform for sequencing. Followed by **Nanopore** and **Pyrosequencing.**

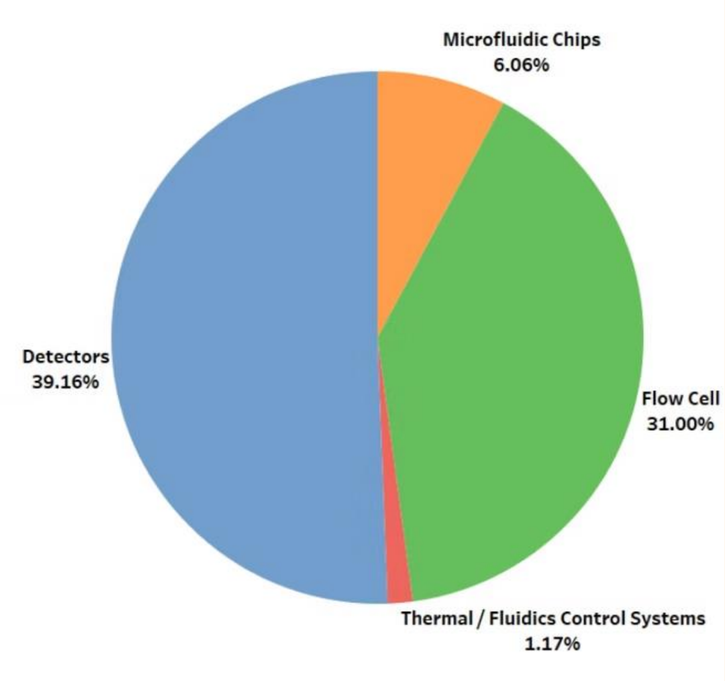


The graph highlights the Read- Length explored in next-gen sequencing research, with **Long-read Sequencing (>1kb)** being focused.

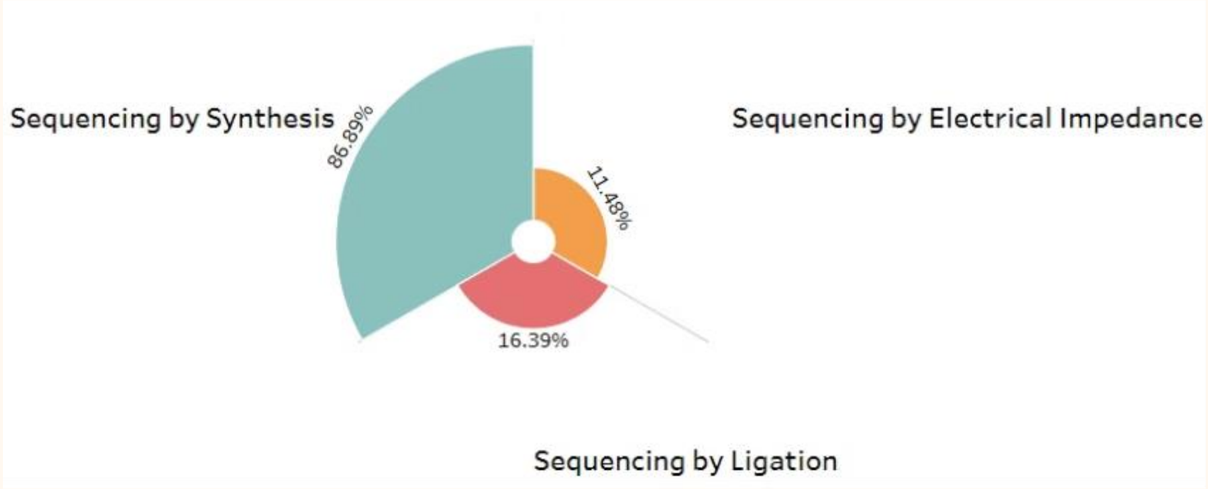


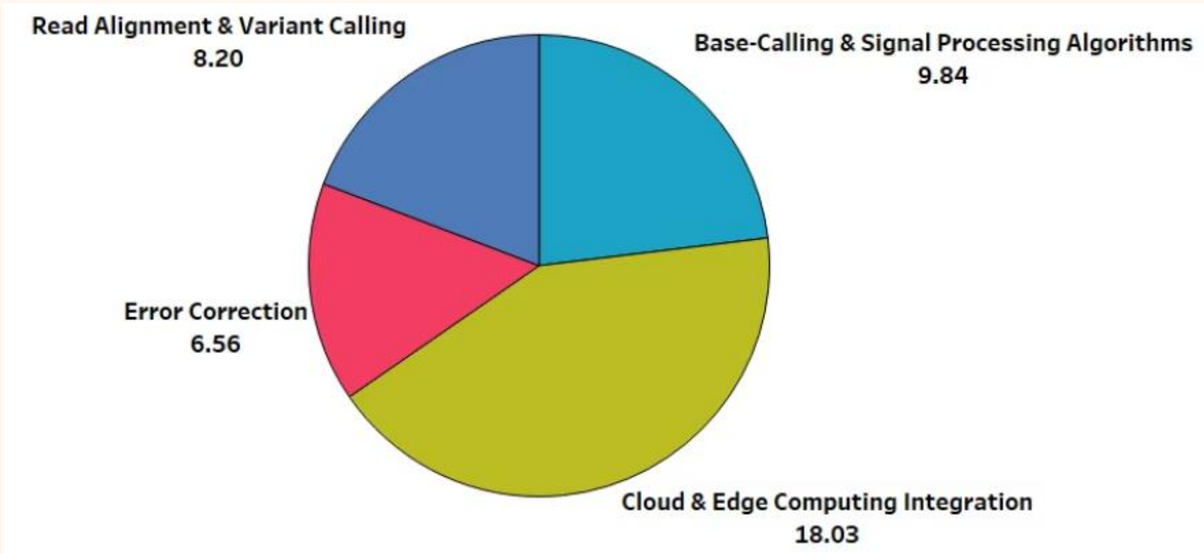
This chart examines the Amplification type with **Bridge PCR (26.23%), Emulsion PCR (3.28%), PCR (3.28%) and Rolling Circle (1.64%).**

ILLUMINA (4/6)



The graph provides distribution of patent applications related to Instrumentation and Hardware with **Detectors (39.16%)** primarily targeted followed by **Flow Cell (31%), Microfluidic Chips (6.06%)** and **Thermal/Fluidics control systems (1.17%).**

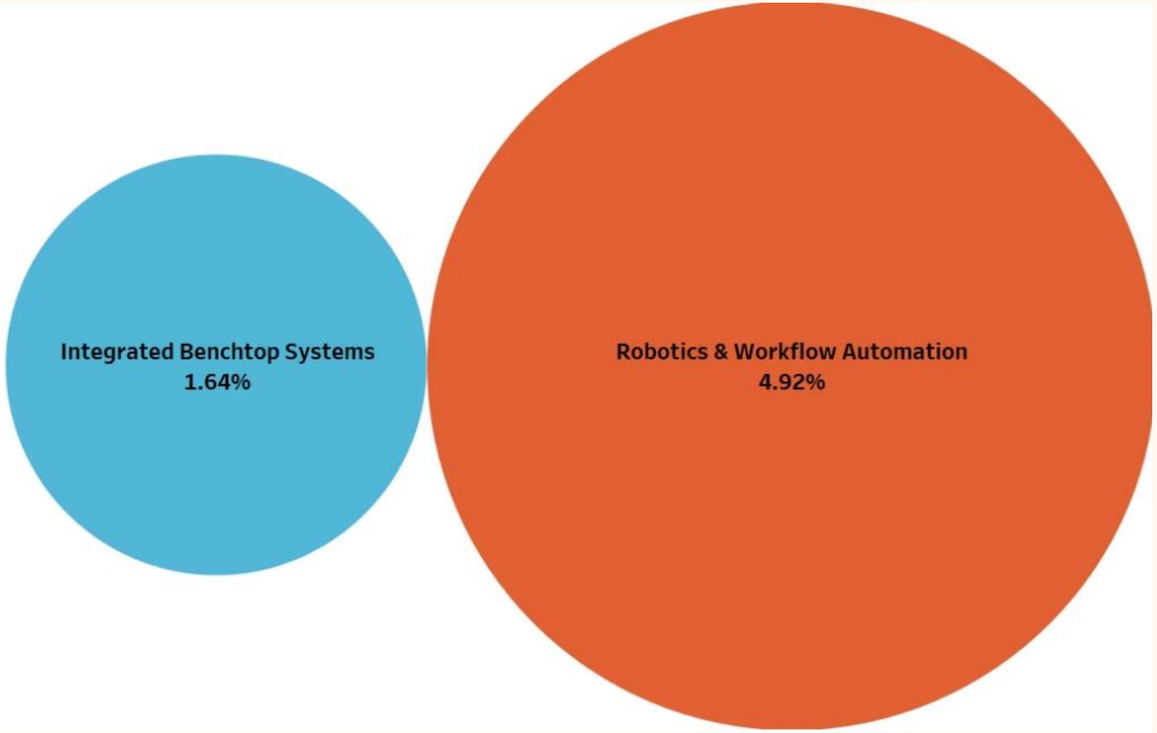




This chart examines the Sequencing technology largely targeted by Illumina which is **Sequencing by Synthesis (86.89%)** followed by **Sequencing by Ligation (16.39%)** and Sequencing by Electrical Impedance (11.48%).

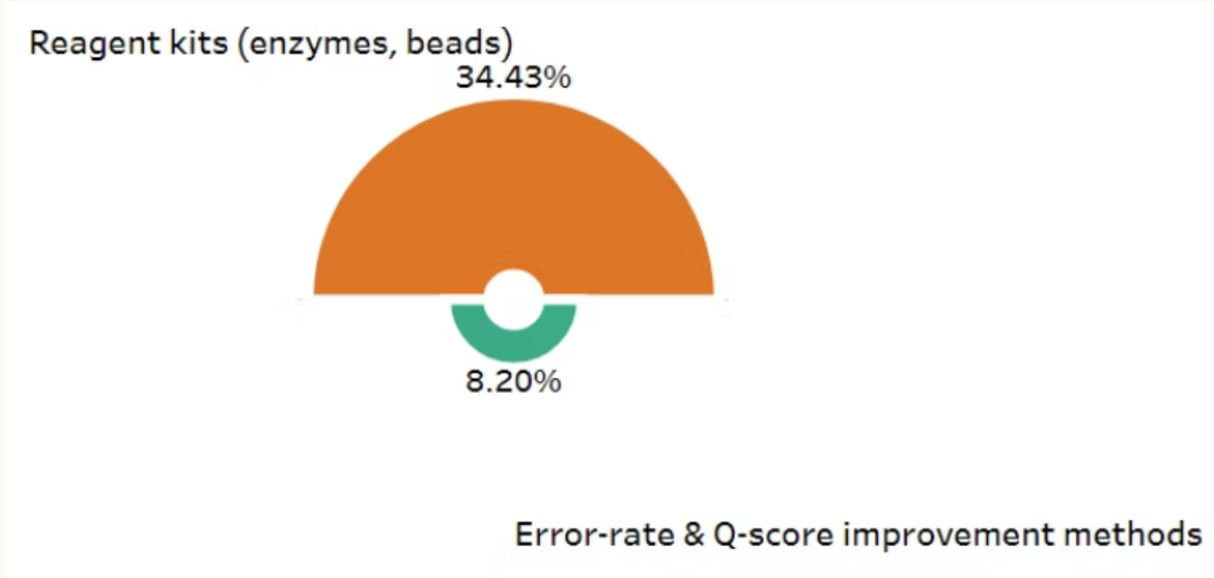
The graph highlights the Data Analysis & Bioinformatics with **Cloud & Edge computing integration** being focused on.

ILLUMINA (5/6)



This chart examines the Automation & Sample-To-Answer with **Robotics & Workflow Automation** being more targeted then Integrated benchtop systems.

The graph highlights the major Applications of the next-gen sequencing in the field of **Clinical Diagnostics and Epigenetics** for this assignee.



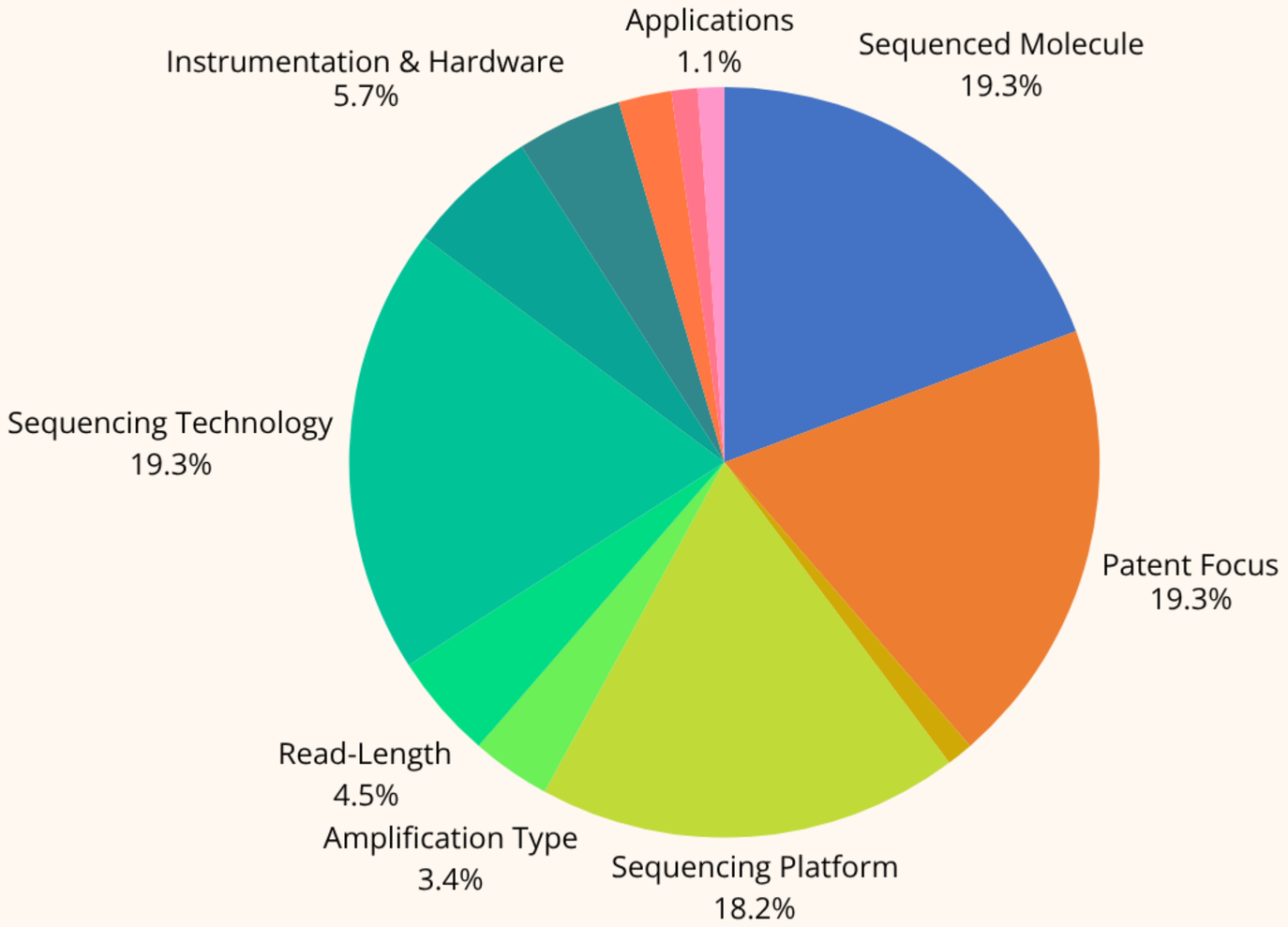
The graph provides a visual representation of the distribution of patents or applications related to Quality Control and **Reagents with Reagents Kits (enzymes, beads) (34.43%)** and **Error-rate & Q-Score improvements methods (8.20%)**.

ILLUMINA (6/6)

KEY PATENTS

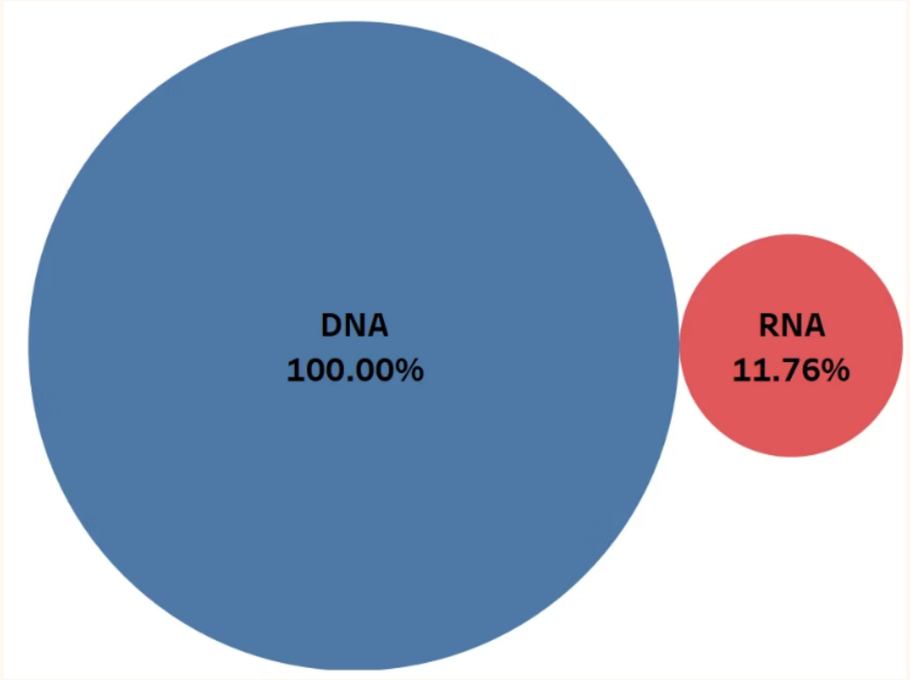
Patent No.	Key Features
WO2017030999A1	The patent application relates to a magnetic-based sequencing-by-synthesis (SBS) method using magnetically responsive sensors to detect nucleotide incorporation via magnetic particles.
WO2019136388A1	The patent application related to a sequencing device that performs base calling by analyzing overlapping signals from unevenly distributed nucleic acid clusters using pixel-based biosensors and signal processing.
US11293061B2	The patent application related to a high-throughput parallel DNA sequencing method using primer hybridization and labeled nucleotides with cleavable linkers for sequencing-by-synthesis.
US20180355348A1	The patent application relates to a method for generating a single-cell bisulfite sequencing library to determine DNA methylation status using dual indexing and nucleosome depletion.

ROCHE (1/5)



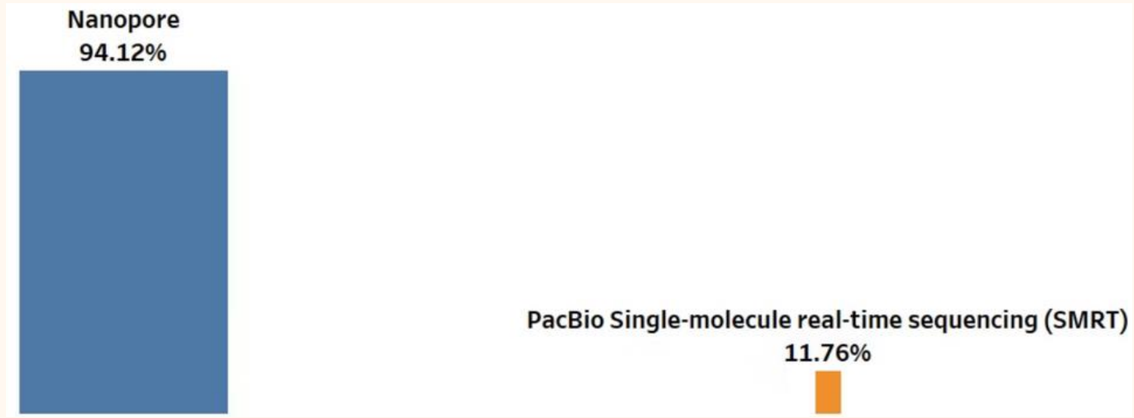
- A Visual Representation of Patent Activity involving **ROCHE** across Next-Generation Sequencing.
- The chart highlights key areas of next generation sequencing research, with the largest focus on **Sequenced Molecules types** (100%), **Patent Focus** areas like Hardware or Protocol & Chemistry (100%), **Sequencing Technology** (100%) and **Sequencing Platform** (94.12%). Other significant areas includes **Instrumentation & Hardware** (29.41%), **Read-Length** (23.53%), **Data Analysis & Bioinformatics** (23.53%), **Amplification type** (17.65%), **Quality Control & Reagents** (11.76%), Sample Preparation (5.88%), Automation & Sample-to-answer(5.88%) and Applications (5.88%).

ROCHE (2/5)

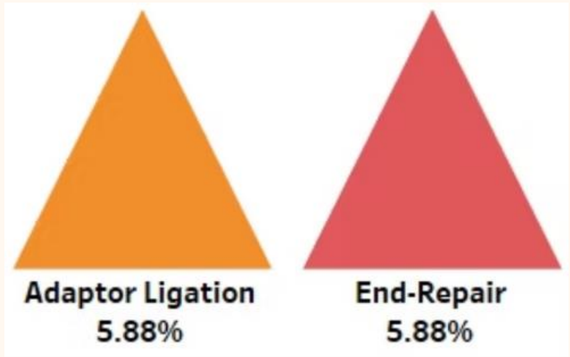


The chart displays the patents / applications covering type of molecules sequenced by Roche and **DNA** is mostly targeted.

The graph depicts that focus areas of patents/applications with **Methodology** (Protocol & Chemistry) is highly focused.



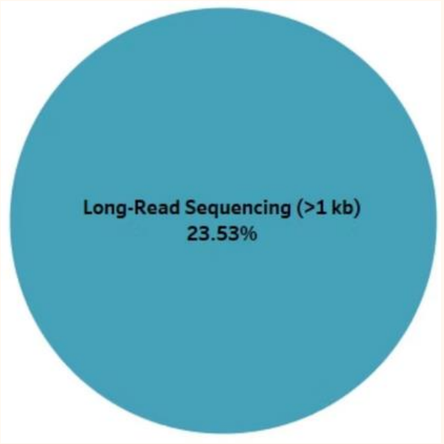
The graph highlights the Sample Preparation methods with both **Adaptor Ligation and End-Repair** with 5.88% patents/applications.



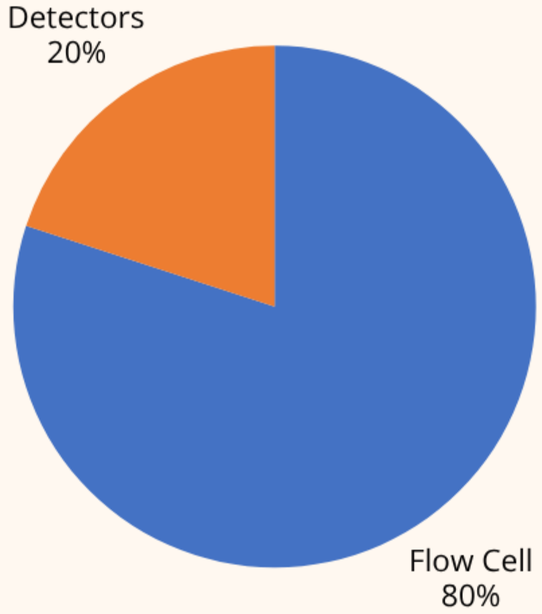
The graph is revealing the use of Sequencing Platform with **Nanopore** being primarily used with 94.12% patents/applications.

ROCHE (3/5)

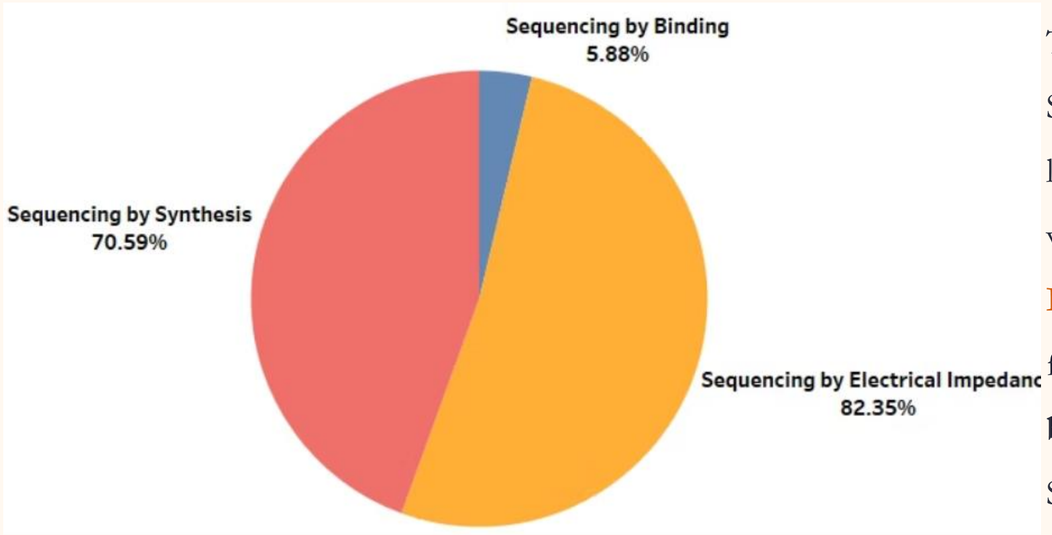
The graph provides a visual representation of the distribution of patents / applications related to Instrumentation and Hardware with **Flow Cell (23.53%)** primarily focused followed by **Detectors (5.88%).**



The graph highlights the Read- Length explored with **Long-read Sequencing (>1kb)** is being focused.



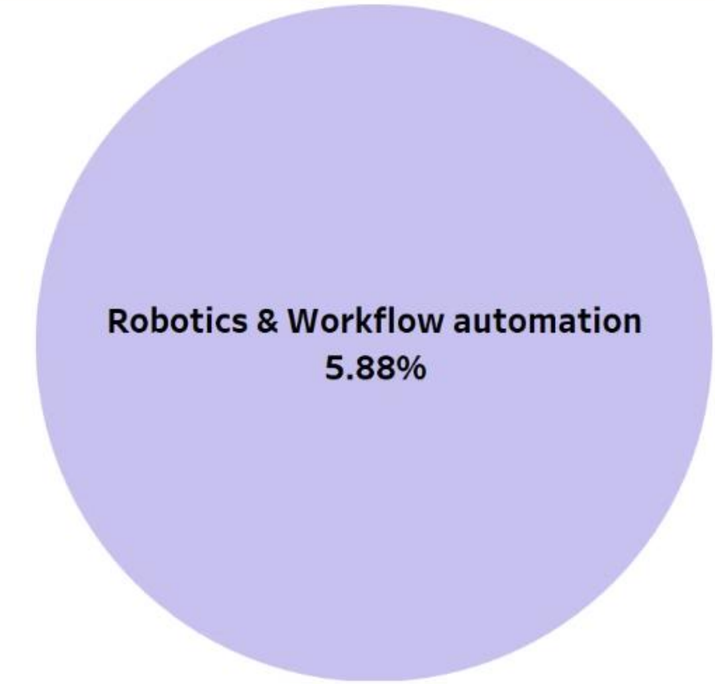
This chart examines the Amplification type with **Bridge PCR (11.76%)** and PCR (5.88%).



This chart examines the Sequencing technology largely targeted by Roche which is **Sequencing by Electrical Impedance** followed by **Sequencing by Synthesis** and Sequencing by binding.

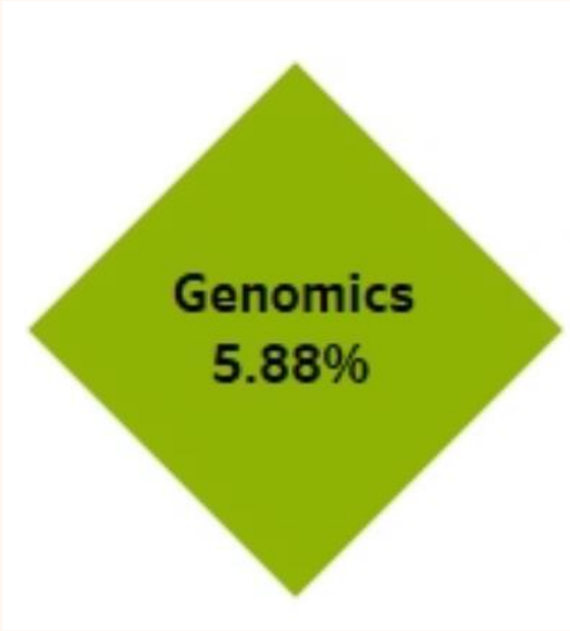
ROCHE (4/5)

The graph highlights the **Data Analysis & Bioinformatics** related to Next-generation sequencing.



This chart examines the Automation & Sample-To-Answer with **Robotics & Workflow Automation** being solely targeted.

The graph provides a visual representation of the distribution of patents or applications related to **Quality Control and Reagents with Reagents Kits (enzymes, beads) and Error-rate & Q-Score improvements methods** with 5.88% patents/applicatiosn each.



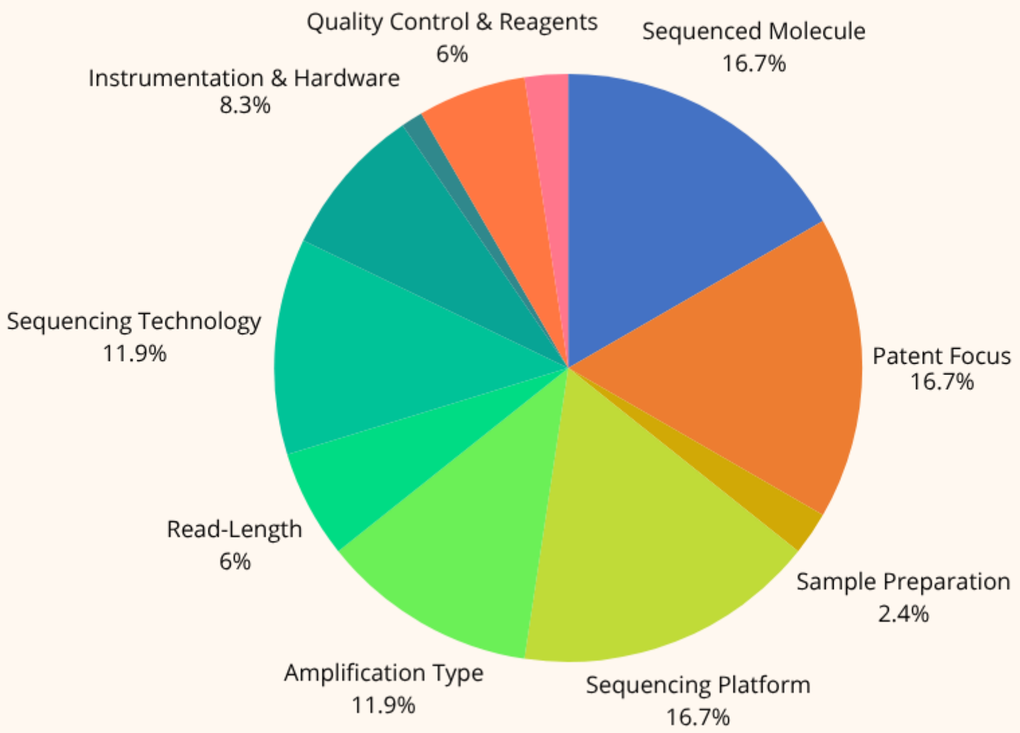
The graph highlights the Applications by Roche is in the field of **Genomics.**

ROCHE (5/5)

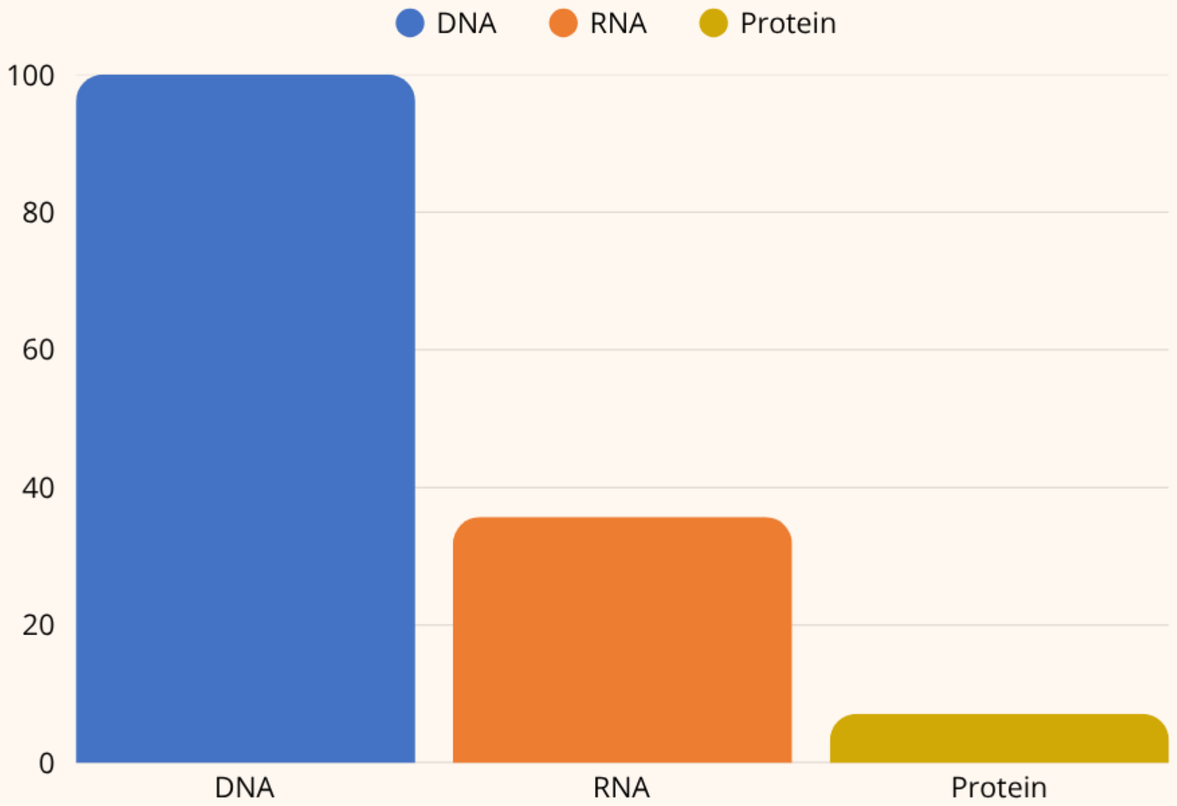
KEY PATENTS

Patent No.	Key Features
US9951385B1	The patent application relates to a nucleic acid sequencing or detection method using differential labeling of nucleotides across multiple mixtures to identify base types via signal patterns from polymerase-formed ternary complexes.
WO2016099673A1	The patent application relates to the method of analyzing a molecule in a Nanopore with varying stimulus.
WO2017125565A1	The patent application relates to the preparation of a nanopore-based sequencing complex by assembling a nanopore, sequencing enzyme, and nucleic acid polymer for real-time single-molecule DNA or RNA sequencing.
WO2020210370A1	The patent application related to the nucleic acid sequencing apparatus using a magnetic sensor array and a fluid chamber to detect magnetic signals during sequencing reactions.

BGI (1/5)

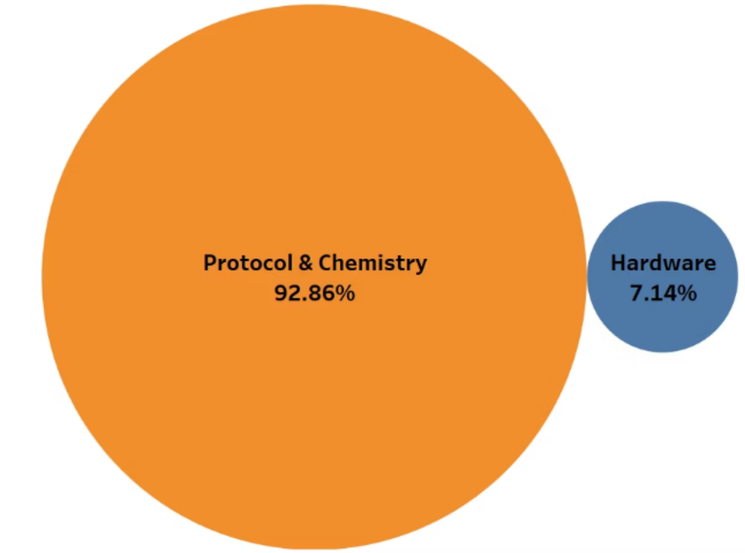


The chart highlights key areas of BGI interests, with the largest focus on **Sequenced Molecules types** (100%), **Patent Focus** areas like Hardware or Protocol & Chemistry (100%), **Sequencing Platform** (100%) and **Sequencing Technology** (71.43%). Other significant areas includes **Amplification Type** (71.43%), **Instrumentation & Hardware** (50%) and **Quality Control & Reagents** (35.71%) and **Read-Length** (35.71%).

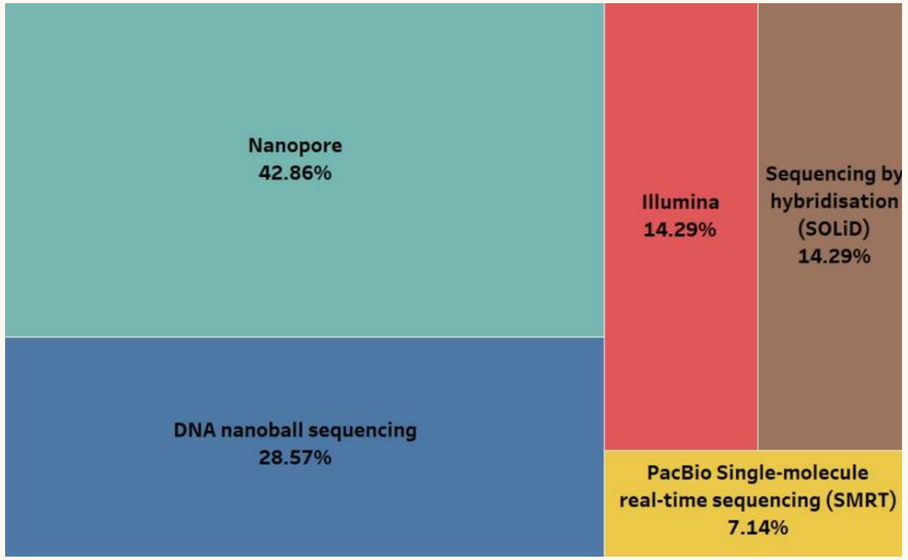


The chart displays the patents covering type of molecules sequenced by Roche where **DNA (100%)** is mostly targeted which is followed by **RNA (35.71%)** and **Protein (7.14%)**.

BGI (2/5)



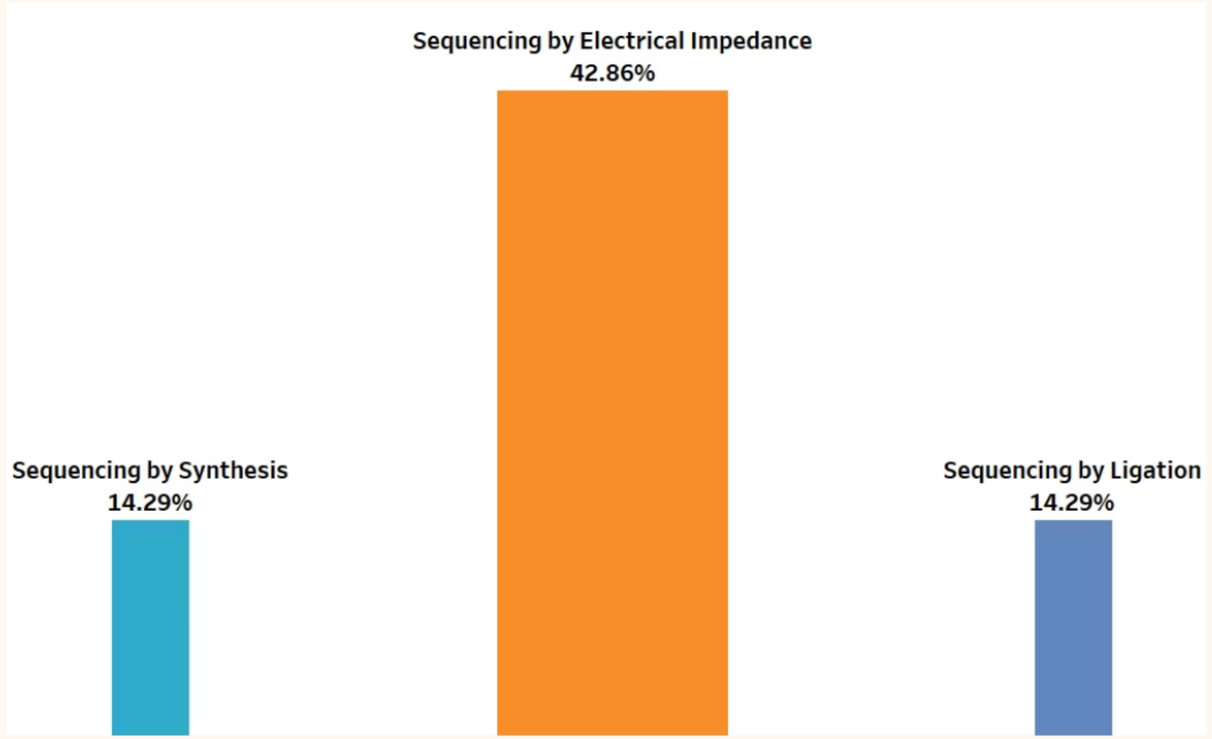
The graph highlights the Sample Preparation methods with both **Adaptor Ligation (14.26%) End-Repair and A-Tailing with 7.14% each.**



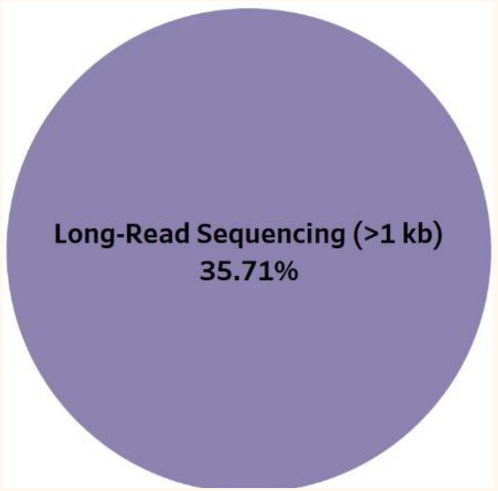
The graph is revealing the use of Sequencing Platform with **Nanopore (42.86%)** being primarily used followed by **DNA nanoball sequencing (28.57%).**

This chart examines the Amplification type with **Bridge PCR, DNA Nanoball, Rolling circle** being used largely.

BGI (3/5)



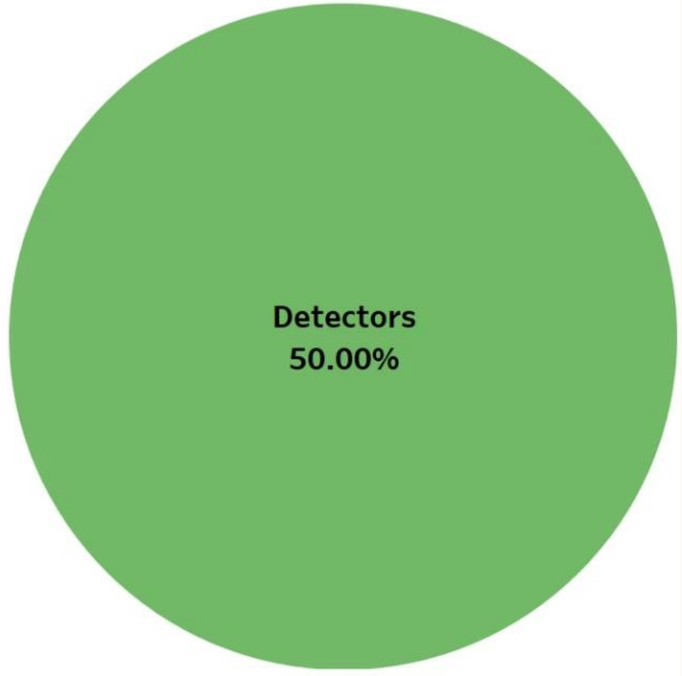
The graph highlights the **Data Analysis & Bioinformatics** related to Next-generation sequencing by BGI which is **Error Correction**.



The graph highlights the Read- Length explored in next-gen sequencing research, with **Long-read Sequencing (>1kb)** is being focused.

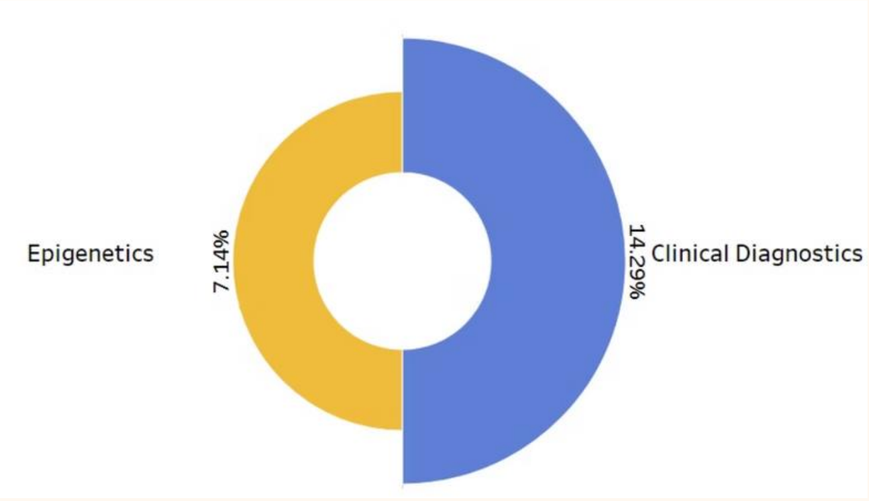
This chart examines the Sequencing technology largely targeted by BGI which is **Sequencing by Electrical Impedance (42.86%)** followed by Sequencing by Synthesis (14.29%) and Sequencing by Ligation (14.29%).

BGI (4/5)



The graph provides a visual representation of the distribution of patents or applications related to Instrumentation and Hardware with sole focus on **Detectors (50%)**.

The graph provides a visual representation of the distribution of patents or applications related to **Quality Control and Reagents.**



The graph highlights the Applications of the next-gen sequencing is in the field of **Clinical Diagnostics (14.29%)** and Epigenetics (7.14%).

BGI (5/5)

KEY PATENTS

Patent No.	Key Features
WO2020097607A1	The patent application relates to a method for detecting nucleotide incorporation during sequencing-by-synthesis using unlabeled reversible terminators and affinity-based detection with monoclonal antibodies.
WO2020113581A1	The patent application related to the nanopore sequencing method that combines rolling circle amplification with nanopore-based electrical signal detection to determine the base sequence of nucleic acid templates.
WO2019080725A1	The patent application related to a hybrid nucleic acid sequencing method combining probe ligation and reversible terminator nucleotide incorporation, enabling base identification through alternating detection and cleavage steps.
CN113166809A	The patent application relates to a DNA methylation detection method using stLFR technology with double-strand protection and bisulfite conversion for long-fragment methylation sequencing.

ASSIGNEE DISTRIBUTION: COMPANIES VS INSTITUTIONS

Industrial Players

Academic Players

KEY PATENTS: COMPANIES VS INSTITUTIONS (2/5)

GRANTED PATENTS/PATENT APPLICATIONS – OTHER COMPANIES

Patent No.	Key Features
US2017022553A1 **Pacific Biosciences**	The patent application relates to a method of sequencing by monitoring polymerase interactions with a primed template and unlabeled nucleotides forming ternary or binary complexes without nucleotide incorporation.
US2018258472A1 **Singular Genomics**	The patent application relates to a method of sequencing single-molecule, real-time nucleic acid sequencing-by-synthesis.
US2019088463A1 **MGI Tech**	The patent application relates to a method for fabricating sequencing flow cells by patterning a semiconductor wafer, attaching a cover wafer to form flow channels with differential surface regions, and singulating into individual dies.
US2016110499A1 **Thermo Fisher Scientific**	The patent application related to method for estimating numbers of nucleotide incorporations in nucleic acid sequencing-by-synthesis.

KEY PATENTS: COMPANIES VS INSTITUTIONS (3/5)

GRANTED PATENTS/PATENT APPLICATIONS – OTHER COMPANIES

Patent No.	Key Features
WO2017203269A1 **Oxford Nanopore Technologies**	The patent application relates to a new method of characterizing two or more target polynucleotides using a pore. The method involves sequentially attaching to a first polynucleotide one or more subsequent polynucleotides to form a concatenated polynucleotide.
CN113061531A **Qitan Tech**	The patent application relates to a chip structure, a chip assembly, a film forming method, a nanopore sequencing device and application.
WO2023230279A1 **Element Biosciences INC**	The patent application relates to a computer-implemented method for predicting quality of base calling in sequencing.

KEY PATENTS: COMPANIES VS INSTITUTIONS (4/5)

GRANTED PATENTS/PATENT APPLICATIONS – UNIVERSITIES

Patent No.	Key Features
WO2019104337A1 **Columbia University**	The patent application relates to a device comprising mRNA capture beads and optical barcodes housed in multiple chambers or microwells designed for reversible sealing.
US2016040230A1 **California University**	The patent application relates to a method for nucleic acid sequencing using a chip with multiple individually addressable nanopores to detect nucleic acid molecules and characterize their sequences via electrical signals processed by a coupled processor.
CN106978334A **SouthEast University**	The patent application relates to a DNA sequencing device based on light-induced dielectrophoresis technology and nanopores
CN111667883A **Sichuan University**	The patent application relates to a forensic medicine mixed DNA analysis method based on composite micro haplotype pyrophosphate sequencing atlas analysis.

KEY PATENTS: COMPANIES VS INSTITUTIONS (5/5)

GRANTED PATENTS/PATENT APPLICATIONS – UNIVERSITIES

Patent No.	Key Features
US10059990B2 **Harvard University**	The patent application relates to a method for in-situ sequencing of target nucleic acids present in a biological sample. The invention leverages the techniques for expansion microscopy (ExM) and fluorescent in situ sequencing (FISSEQ) in a new process referred to herein as “expansion sequencing” (ExSEQ).
CN110343612A **Shanghai University**	The patent application relates to a DNA Single-molecule Sequencing System and device based on multicolor fluorescence reversible terminator nucleotide.
CN110452817A **Guangdong University of Technology**	The patent application relates to a DNA sequencing device, which includes a three-dimensional nano-motion platform, a probe, a positioning fixture for clamping and fixing the probe, and a comprehensive sequencing layer.

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