

ORIGINAL RESEARCH ARTICLE

The future of three-dimensional printing in healthcare: A competitive technology intelligence-based scientometric and patent landscape of three-dimensional bioprinting

Supplementary File

Table S1. Search strategies and analytical settings

Item	Scientific publications	Patent families
Database	Web of Science Core Collection	The Lens
Search field	Topic (TS)	Title, abstract, and claims
Coverage period	January 1, 2021–December 31, 2025	January 1, 2021–December 31, 2025
Analytical unit	Unique publication record	Unique simple patent family
Unique identifier	Web of Science accession number (UT)	Lens family record/simple family member set
Final validated corpus	6,916 records	732 simple patent families
Annual date field	Publication year	Publication year
Classification restriction	None reported	IPC: A61*, B33Y*, C12M*, or C12N*
Language/document-type filters	No additional filters reported	No additional filters reported
Validation result	6,916 unique UTs; no missing or duplicate UTs; no 2026 records	732 unique Lens identifiers and 732 unique simple-family member sets; no 2026 records

Note: The primary quantitative analysis focused on three-dimensional (3D) bioprinting and tissue engineering. Fiber-based fabrication and 3D-printed oral drug delivery were included as complementary quantitative and contextual domains, drawing on previously published CTI studies to support the broader interpretation of healthcare-related 3D printing technologies.

Table S2. Exact executed topic query

Platform	Query
Web of Science	TS=((bioprint* OR "bio-print*" OR biofabricat* OR "bio-fabricat*" OR bioink* OR "bio-ink*" OR "cell print*" OR "cell-print*" OR cellprint* OR "cell-laden construct*" OR "cell laden construct*" OR "cell-laden scaffold*" OR "cell laden scaffold*" OR "living tissue print*" OR "tissue print*" OR "organ print*" OR "in situ bioprint*" OR "in-situ bioprint*" OR "in vivo bioprint*" OR "scaffold-free bioprint*" OR "scaffold based bioprint*") AND ("tissue engineer*" OR "regenerative medicine" OR "regenerative engineer*" OR "tissue regenerat*" OR scaffold* OR organoid* OR spheroid* OR "cell aggregate*" OR "tissue construct*" OR "tissue model*" OR "organ model*" OR "disease model*" OR "organ-on-a-chip" OR "organ on a chip" OR "tissue-on-a-chip" OR "tissue on a chip" OR biomedic* OR "cancer model*" OR biomanufact* OR hydrogel*)) NOT TS=(stereoscopic* OR "oxidation product*" OR "streaming interactive" OR nanoweb OR "nano web" OR "nano-web" OR "non halogen" OR "non-halogen" OR (food* NEAR/2 additive*) OR (feed* NEAR/2 additive*) OR (liquid* NEAR/2 additive*) OR "media access control" OR "multi-wafer 3D CAM cell" OR "3-sigma" OR "three sigma" OR "3 sigma" OR "three-sigma" OR (rheolog* NEAR/1 additive*) OR (vibration NEAR/1 isolator*) OR toilet OR paper OR transistor* OR "light emitting" OR diode OR "solar cell" OR spectrophotom* OR spectroscop*)

(Cont'd...)

Table S2. (Continued)

Platform	Query
The Lens	(title:(bioprint* OR "bio-print*" OR biofabricat* OR "bio-fabricat*" OR bioink* OR "bio-ink*" OR "cell print*" OR "cell-print*" OR cellprint* OR "cell-laden construct*" OR "cell laden construct*" OR "cell-laden scaffold*" OR "cell laden scaffold*" OR "living tissue print*" OR "tissue print*" OR "organ print*" OR <i>in situ</i> bioprint* OR <i>in-situ</i> bioprint* OR <i>in vivo</i> bioprint* OR "scaffold-free bioprint*" OR "scaffold based bioprint*") OR abstract:(bioprint* OR "bio-print*" OR biofabricat* OR "bio-fabricat*" OR bioink* OR "bio-ink*" OR "cell print*" OR "cell-print*" OR cellprint* OR "cell-laden construct*" OR "cell laden construct*" OR "cell-laden scaffold*" OR "cell laden scaffold*" OR "living tissue print*" OR "tissue print*" OR "organ print*" OR <i>in situ</i> bioprint* OR <i>in-situ</i> bioprint* OR <i>in vivo</i> bioprint* OR "scaffold-free bioprint*" OR "scaffold based bioprint*")) OR claim:(bioprint* OR "bio-print*" OR biofabricat* OR "bio-fabricat*" OR bioink* OR "bio-ink*" OR "cell print*" OR "cell-print*" OR cellprint* OR "cell-laden construct*" OR "cell laden construct*" OR "cell-laden scaffold*" OR "cell laden scaffold*" OR "living tissue print*" OR "tissue print*" OR "organ print*" OR <i>in situ</i> bioprint* OR <i>in-situ</i> bioprint* OR <i>in vivo</i> bioprint* OR "scaffold-free bioprint*" OR "scaffold based bioprint*")) AND (title:(tissue engineer* OR "regenerative medicine" OR "regenerative engineer*" OR "tissue regenerat*" OR scaffold* OR organoid* OR spheroid* OR "cell aggregate*" OR "tissue construct*" OR "tissue model*" OR "organ model*" OR "disease model*" OR "organ-on-a-chip" OR "organ on a chip" OR "tissue-on-a-chip" OR "tissue on a chip" OR biomedic* OR "cancer model*" OR biomanufact* OR hydrogel*) OR abstract:(tissue engineer* OR "regenerative medicine" OR "regenerative engineer*" OR "tissue regenerat*" OR scaffold* OR organoid* OR spheroid* OR "cell aggregate*" OR "tissue construct*" OR "tissue model*" OR "organ model*" OR "disease model*" OR "organ-on-a-chip" OR "organ on a chip" OR "tissue-on-a-chip" OR "tissue on a chip" OR biomedic* OR "cancer model*" OR biomanufact* OR hydrogel*) OR claim:(tissue engineer* OR "regenerative medicine" OR "regenerative engineer*" OR "tissue regenerat*" OR scaffold* OR organoid* OR spheroid* OR "cell aggregate*" OR "tissue construct*" OR "tissue model*" OR "organ model*" OR "disease model*" OR "organ-on-a-chip" OR "organ on a chip" OR "tissue-on-a-chip" OR "tissue on a chip" OR biomedic* OR "cancer model*" OR biomanufact* OR hydrogel*)) AND (class_ipcr.symbol:(A61*) OR class_ipcr.symbol:(B33Y*) OR class_ipcr.symbol:(C12M*) OR class_ipcr.symbol:(C12N*))

Table S3. Validated annual activity and counting rules

Publication year	Web of Science publications	The Lens simple patent families
2021	1,061	98
2022	1,292	146
2023	1,430	137
2024	1,428	158
2025	1,705	193
Total	6,916	732

Note: Annual counts were recalculated directly from the final record-level files. Publications were counted once by unique Web of Science accession number. Patents were counted once per unique simple patent family. Both series use publication year.

Table S4. Calculation and interpretation notes

Item	Definition/note
Endpoint change	$[(\text{count in 2025} - \text{count in 2021}) / \text{count in 2021}] \times 100$
Scientific publications	1,061 to 1,705: +60.7%
Simple patent families	98 to 193: +96.9%
Interpretation	These are endpoint changes within the retrieved datasets, not compound annual growth rates and not direct measures of commercialization
Patent year limitation	Patent publication may occur after filing; recent years may be affected by publication delay and database right truncation
Non-exclusive indicators	Document types and countries/regions can be assigned more than once per scientific record. Patent applicants, jurisdictions, and IPC classes can be assigned more than once per family; these categories are therefore non-exclusive
Scope sensitivity	Because bioprinting terminology can appear in adjacent applications, some records near the boundaries of the defined technological scope may remain in the dataset

Table S5. Data validation and consistency summary

Dataset	Check	Result
Scientific records	Rows in final file	6,916
Scientific records	Unique WoS accession numbers	6,916
Scientific records	Missing/duplicate accession numbers	0/0
Scientific records	Records assigned to 2026	0
Patent families	Rows in final file	732
Patent families	Unique Lens identifiers	732
Patent families	Unique simple family member sets	732
Patent families	Records assigned to 2026	0