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Organoid Electroporation

The NEPA21 is the only device on the market to approach Organoid Electroporation from the perspective of optimising delivered energy.

- The finer control over the delivered energy available with the NEPA21 offers specific and important advantages for organoid electroporation. As the thrust of NEPA21 protocols is to minimise delivered energy, this means that the targets are electroporated with less current (than competing device protocols).
- For particularly sensitive and delicate targets such as organoids, identifying and only delivering the required energy (and no more) to porate the membrane is of utmost importance for their viability post electroporation.
- The success of the NEPA21 for organoid electroporation is evident by the laboratories what have published with the NEPA21 system. Of note is the Organoid Group (previously Clever Group) at the Hubrecht Institute.
- The NEPA21 system is supported by a suite of over 250 different electrode configurations, which further enhance the applicability of the system and empower researchers with further experimental options and opportunities.
- With the NEPA21 system, the researcher can target both **Dissociated Organoids** (via the CU540 cuvette electrode) and **Whole Organoids** (via the CUY650P1 electrode).

The following two articles citing our NEPA21 system describe representative basic protocols:

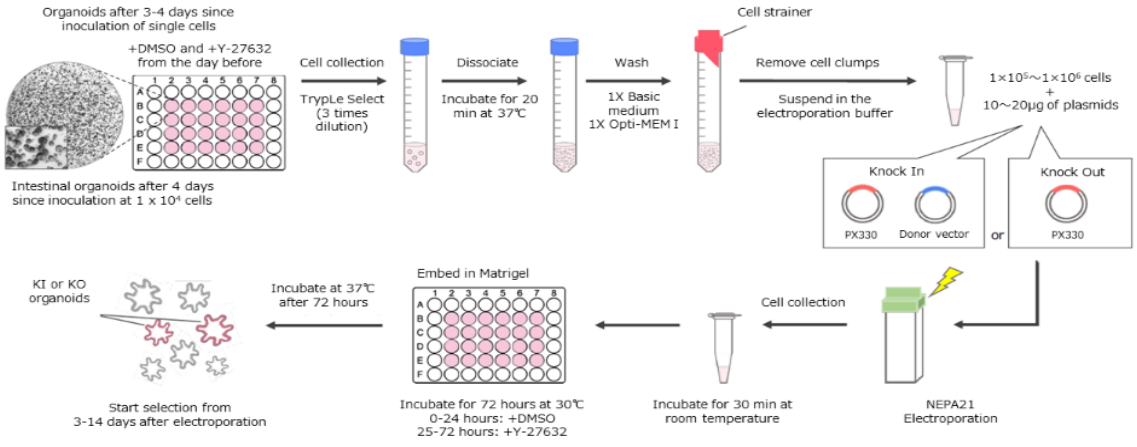
- **A Protocol for Multiple Gene Knockout in Mouse Small Intestinal Organoids Using a CRISPR-concatemer**
  It contains an embedded step-by-step video.
  - https://www.jove.com/video/55916/a-protocol-for-multiple-gene-knockout-mouse-small-intestinal

- **Efficient genetic engineering of human intestinal organoids using electroporation**

- **Universal and Efficient Electroporation Protocol for Genetic Engineering of Gastrointestinal Organoids**
  It contains an embedded step-by-step video.
  - https://www.jove.com/video/60704
    - In this protocol, the client did not dissociate organoids to single cells but to clusters (one-cluster is about 10-15 cells into a cuvette).
    - Plasmid amounts were 30µg, and the client compared **4.2kb and 9.3kb plasmids**.
    - The client then tried the experiment using the **Cas9 plasmid (10ug).**
    - The process described in this publication takes **1 day** instead of the **4 days** in the previous protocol
    - The article demonstrates that a regeneration time after electroporation of more than 10 min up to 40 min increases survivability and transfection efficiency especially of large plasmids. In test experiments, the same could be documented for organoids, leading to an incubation step of 40 min after electroporation in this protocol.
    - The transfection results for GFP plasmids:
      - **Pancreatic ductal adenocarcinoma (PDAC): 4.2kb TE 92.1% / 9.3kb TE 46.7%**
      - **Colorectal cancer (CRC): 4.2kb TE 84.3% / 9.3kb TE 53.4%**
      - **Cholangiocarcinoma (CCC): 4.2kb TE 83.0% / 9.3kb TE 39.5%**
      - **Gastric cancer (GC): 4.2kb TE 74.1% / 9.3kb TE 32.3%**

APPLICATIONS

PRODUCTION OF GENETICALLY MODIFIED ORGANOIDS BY ELECTROPORATION



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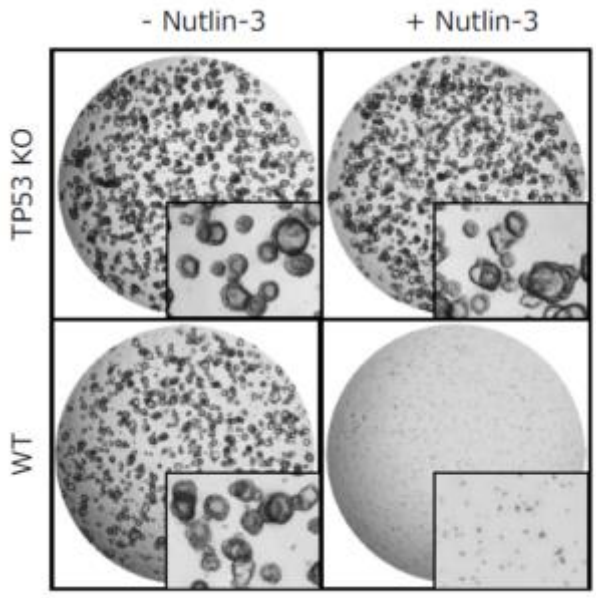

Courtesy of Professor Toshiro Sato, Dr. Mami Matano, Dr. Mariko Shimokawa, Dr. Masayuki Fujii, School of Medicine, The Sakaguchi Laboratory, Department of Organoid Medicine, Keio University

After electroporation, TP53 knockout colon organoids (TP53 KO) were obtained by selection with Nutlin-3, a niche factor for TP53.

The TP53 KO and the normal colon organoid without TP53 mutation (WT) were cultured in Nutlin-3- and Nutlin-3-free medium for 7 days, and the TP53 KO was not affected by Nutlin-3 addition because it had acquired Nutlin-3 tolerance, while the WT did not grow under Nutlin-3-supplemented conditions.

ORGANOIDS

Client Laboratory Verified RESULTS

Transfection Data: Organoids

See the cell images by clicking the cell names.
V: Viability, TE: Transfection Efficiency.

Cells name	V	TE		Cells name	V	TE
Human Normal Fundic Gastric Organoids		68%		Mouse Fundic Gastric Organoids		65%
Mouse Colorectal Cancer Organoids	100%	50%		Mouse Small Intestine Organoids		

We have a quite a lot of know-how data on organoids transfection (with high efficiency and high viability). Contact sales@sonidel.com for the latest data.

PUBLICATIONS

NEPA21 Organoid Publications: Human Dissociated Organoids and Human Whole Organoids

Normal fallopian tube epithelium	**Human breast**	**Cancer tissue originated spheroids**	**Murine thymic epithelial cells (TEC)**
Human small intestinal	**Human gut**	**Endometrial**	**Murine colon**
Human colon cancer	**Human conjunctiva**	**Cholangiocarcinoma (CCC) organoids**	**Murine small intestinal**
Human colon	**Human fetal brain**	**Fimbria of fallopian tube**	**Murine lacrimal gland**
Human iPSC based neuronal brain	**Human fetal hepatocyte**		**Murine pancreatic**
Human colorectal cancer	**Human head cancer**		**Murine normal colorectal**
Human pancreatic	**Human neck cancer**		**Murine intestinal**
Human intestinal	**Human gastric**		

Human normal colorectal	**Human liver**		
Human airway	**Human biopsy derived duodenal**		
Human large intestinal			
Human hepatocyte			
Human cervix small-cell neuroendocrine carcinoma (SCNEC)			
Human esophageal adenocarcinoma (EAC)			

Normal fallopian tube epithelium

mTOR-mediated p62/SQSTM1 stabilization confers a robust survival mechanism for ovarian cancer
Tamura T, Nagai S, Masuda K, Imaeda K, Sugihara E, Yamasaki J, Kawaida M, Otsuki Y, Suina K, Nobusue H, Akahane T, Chiyoda T, Kisu I, Kobayashi Y, Banno K, Sakurada K, Okita H, Yamaguchi R, Ahmed AA, Yamagami W, Saya H, Aoki D, Nagano O.
Cancer Lett. 2025. Feb 17: 217565.

Human small intestinal

A tunable human intestinal organoid system achieves controlled balance between self-renewal and differentiation
Yang L, Wang X, Zhou X, Chen H, Song S, Deng L, Yao Y, Yin X.
Nat Commun. 2025 Jan 2;16(1):315.

Human intestinal

Differentiation and CRISPR-Cas9-mediated genetic engineering of human intestinal organoids
Martinez-Silgado A, Yousef Yengej FA, Puschhof J, Geurts V, Boot C, Geurts MH, Rookmaaker MB, Verhaar MC, Beumer J, Clevers H.
STAR Protoc. 2022 Aug 18;3(3):101639.

BMP gradient along the intestinal villus axis controls zonated enterocyte and goblet cell states
Beumer J, Puschhof J, Yengej FY, Zhao L, Martinez-Silgado A, Blotenburg M, Begthel H, Boot C, van Oudenaarden A, Chen YG, Clevers H.
Cell Rep. 2022 Mar 1;38(9):110438

Mapping prohormone processing by proteases in human enteroendocrine cells using genetically engineered organoid models
Beumer J, Bauzá-Martinez J, Veth TS, Geurts V, Boot C, Gilliam-Vigh H, Poulsen SS, Knop FK, Wu W, Clevers H.
Proc Natl Acad Sci U S A. 2022 Nov 16;119(46): e2212057119.

Organoid Derivation and Orthotopic Xenotransplantation for Studying Human Intestinal Stem Cell Dynamics
Shinya Sugimoto, Masayuki Fujii, Toshiro Sato
Methods Mol Biol. 2020;2171: 303-320.

Human Intestinal Organoids Maintain Self-Renewal Capacity and Cellular Diversity in Niche-Inspired Culture Condition.
Fujii M, Matano M, Toshimitsu K, Takano A, Mikami Y, Nishikori S, Sugimoto S, Sato T
Cell Stem Cell. 2018 Dec 6;23(6):787-793.e6.

Efficient genetic engineering of human intestinal organoids using electroporation
Fujii M, Matano M, Nanki K, Sato T
Nat Protoc. 2015 Oct;10(10):1474-85. Epub 2015 Sep 3.

Modeling colorectal cancer using CRISPR-Cas9-mediated engineering of human intestinal organoids.
Matano M, Date S, Shimokawa M, Takano A, Fujii M, Ohta Y, Watanabe T, Kanai T, Sato T.
Nat Med. 2015 Mar;21(3):256-62.

Human colon cancer

Colorectal cancer patients-derived immunity-organoid platform unveils cancer-specific tissue markers associated with immunotherapy resistance
Esposito A, Agostini A, Quero G, Piro G, Priori L, Caggiano A, Scaglione G, Battaglia A, Calegari MA, Salvatore L, Bensi M, Maratta MG, Ceccarelli A, Trovato G, Genovese G, Gurreri E, Ascrizzi S, Martini M, Fiorillo C, Fattorossi A, De Sanctis F, Ugel S, Corbo V, Alfieri S, Tortora G, Carbone C.
Cell Death Dis. 2024 Dec 4;15(12):878.

Human colon

Recapitulating the adenoma–carcinoma sequence by selection of four spontaneous oncogenic mutations in mismatch-repair-deficient human colon organoids
Mizutani T, Boretto M, Lim S, Drost J, González DM, Oka R, Geurts MH, Begthel H, Korving J, van Es JH, van Boxtel R, Clevers H.
Nat Cancer. 2024 Nov 1.

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Chromosome Engineering of Human Colon-Derived Organoids to Develop a Model of Traditional Serrated Adenoma
Kenta Kawasaki, Masayuki Fujii, Shinya Sugimoto, Keiko Ishikawa, Mami Matano, Yuki Ohta, Kohta Toshimitsu, Sirirat Takahashi, Naoki Hosoe, Shigeki Sekine, Takanori Kanai, Toshiro Sato
Gastroenterology, 158 (3), 638-651.e8 Feb 2020

RNF43 truncations trap CK1 to drive niche-independent self-renewal in cancer
Spit M, Fenderico N, Jordens I, Radaszkiewicz T, Lindeboom RG, Bugter JM, Cristobal A, Ootes L, van Osch M, Janssen E, Boonekamp KE, Hanakova K, Potesil D, Zdrahal Z, Boj SF, Medema JP, Bryja V, Koo BK, Vermeulen M, Maurice MM.
EMBO J. 2020 Sep 15;39(18): e103932

Multiparametric and accurate functional analysis of genetic sequence variants using CRISPR-Select
Niu Y, Ferreira Azevedo CA, Li X, Kamali E, Haagen Nielsen O, Storgaard Sørensen C, Frödin M.
Nat Genet. 2022 Dec;54(12):1983-1993.

Human iPSC based neuronal brain

Calcium-Enhanced Medium-Based Delivery of Splice Modulating Antisense Oligonucleotides in 2D and 3D hiPSC-Derived Neuronal Models
Buijsen RAM, van der Graaf LM, Kuijper EC, Pepers BA, Daoutsali E, Weel L, Raz V, Parfitt DA, van Roon-Mom WMC.
Biomedicines. 2024 Aug 23;12(9):1933.

Efficient Derivation of Sympathetic Neurons From Human Pluripotent Stem Cells With a Defined Condition
Kosuke Kirino, Tatsutoshi Nakahata, Tomoaki Taguchi, Megumu K Saito
Sci Rep, 8 (1), 12865 2018 Aug 27

Human colorectal cancer

Homopolymer switches mediate adaptive mutability in mismatch repair-deficient colorectal cancer
Kayhanian H, Cross W, van der Horst SEM, Barmpoutis P, Lakatos E, Caravagna G, Zapata L, Van Hoeck A, Middelkamp S, Litchfield K, Steele C, Waddingham W, Patel D, Milite S, Jin C, Baker AM, Alexander DC, Khan K, Hochhauser D, Novelli M, Werner B, van Boxtel R, Hageman JH, Buissant des Amorie JR, Linares J, Ligtenberg MJL, Nagtegaal ID, Laclé MM, Moons LMG, Brosens LAA, Pillay N, Sottoriva A, Graham TA, Rodriguez-Justo M, Shiu KK, Snippert HJG, Jansen M.
Nat Genet. 2024 Jul;56(7):1420-1433.

A novel antifolate suppresses growth of FPGS-deficient cells and overcomes methotrexate resistance
van der Krift F, Zijlmans DW, Shukla R, Javed A, Koukos PI, Schwarz LL, Timmermans-Sprang EP, Maas PE, Gahtory D, van den Nieuwboer M, Mol JA, Strous GJ, Bonvin AM, van der Stelt M, Veldhuizen EJ, Weingarth M, Vermeulen M, Klumperman J, Maurice MM.
Life Sci Alliance. 2023 Aug 17;6(11): e202302058.

SMAD4 Loss Induces c-MYC-Mediated NLE1 Upregulation to Support Protein Biosynthesis, Colorectal Cancer Growth, and Metastasis
Loevenich LP, Tschurtschenthaler M, Rokavec M, Silva MG, Jesinghaus M, Kirchner T, Klauschen F, Saur D, Neumann J, Hermeking H, Jung P.
Cancer Res. 2022 Dec 16;82(24):4604-4623.

Disease Modelling on Tumor Organoids Implicates AURKA as a Therapeutic Target in Liver Metastatic Colorectal Cancer
Boos SL, Loevenich LP, Vosberg S, Engleitner T, Öllinger R, Kumbrink J, Rokavec M, Michl M, Greif PA, Jung A, Hermeking H, Neumann J, Kirchner T, Rad R, Jung P.
Cell Mol Gastroenterol Hepatol. 2022;13(2):517-540.

A protocol for efficient CRISPR-Cas9-mediated knock-in in colorectal cancer patient-derived organoids
Okamoto T, Natsume Y, Yamanaka H, Fukuda M, Yao R.
STAR Protoc. 2021 Sep 16;2(4):100780.

Reconstructing single-cell karyotype alterations in colorectal cancer identifies punctuated and gradual diversification patterns
Bollen Y, Stelloo E, van Leenen P, van den Bos M, Ponsioen B, Lu B, van Roosmalen MJ, Bolhaqueiro ACF, Kimberley C, Mossner M, Cross WCH, Besselink NJM, van der Roest B, Boymans S, Oost KC, de Vries SG, Rehmann H, Cuppen E, Lens SMA, Kops GJPL, Kloosterman WP, Terstappen LWMM, Barnes CP, Sottoriva A, Graham TA, Snippert HJG.
Nat Genet. 2021 Aug;53(8):1187-1195.

Activation of WNT/β-catenin signaling results in resistance to a dual PI3K/mTOR inhibitor in colorectal cancer cells harboring PIK3CA mutations.
Park YL, Kim HP, Cho YW, Min DW, Cheon SK, Lim YJ, Song SH, Jin Kim S, Han SW, Park KJ, Kim TY
Int J Cancer. 2019 Jan 15;144(2):389-401.

Human normal colorectal
Human colorectal cancer

Efficient and error-free fluorescent gene tagging in human organoids without double-strand DNA cleavage

Bollen Y, Hageman JH, van Leenen P, Derks LLM, Ponsioen B, Buissant des Amorie JR, Verlaan-Klink I, van den Bos M, Terstappen LWMM, van Boxtel R, Snippert HJG.
PLoS Biol. 2022 Jan 28;20(1):e3001527.

Human cervix small-cell neuroendocrine carcinoma (SCNEC)

Clonal Origin and Lineage Ambiguity in Mixed Neuroendocrine Carcinoma of the Uterine Cervix
Masamune Masuda, Keita Iida, Sadahiro Iwabuchi, Mie Tanaka, Satoshi Kubota, Hiroyuki Uematsu, Kunishige Onuma, Yoji Kukita, Kikuya Kato, Shoji Kamiura, Aya Nakajima, Roberto Coppo, Mizuki Kanda, Kiyoshi Yoshino, Yutaka Ueda, Eiichi Morii, Tadashi Kimura, Jumpei Kondo, Mariko Okada-Hatakeyama, Shinichi Hashimoto, Masahiro Inoue
Am J Pathol. 2024 Mar;194(3):415-429.

Human pancreatic

An alternative splicing signature defines the basallike phenotype and predicts worse clinical outcome in pancreatic cancer
Ruta V, Naro C, Pieraccioli M, Leccese A, Archibugi L, Cesari E, Panzeri V, Allgöwer C, Arcidiacono PG, Falconi M, Carbone C, Tortora G, Borrelli F, Attili F, Spada C, Quero G, Alfieri S, Doglioni C, Kleger A, Capurso G, Sette C.
Cell Rep Med. 2024 Feb 20;5(2):101411.

USP25 promotes pathological HIF-1-driven metabolic reprogramming and is a potential therapeutic target in pancreatic cancer
Nelson JK, Thin MZ, Evan T, Howell S, Wu M, Almeida B, Legrave N, Koenis DS, Koifman G, Sugimoto Y, Llorian Sopena M, MacRae J, Nye E, Howell M, Snijders AP, Prachalias A, Zen Y, Sarker D, Behrens A.
Nat Commun. 2022 Apr 19;13(1):2070.

Human pancreatic
Human colorectal cancer
Cholangiocarcinoma (CCC) organoids
Human_gastric

Universal and Efficient Electroporation Protocol for Genetic Engineering of Gastrointestinal Organoids
Anne-Marlen Gaebler, Alexander Hennig, Katharina Buczolich, Jürgen Weitz, Thilo Welsch, Daniel E Stange, Kristin Pape
J Vis Exp. 2020 Feb 18;(156).

Human esophageal adenocarcinoma (EAC)

Epigenomic analyses identify FOXM1 as a key regulator of anti-tumor immune response in esophageal adenocarcinoma
Ziman B, Yang Q, Zheng Y, Sheth M, Nam C, Zhao H, Zhang L, Hu B, Bhowmick NA, Sinha UK, Lin DC.
Cell Death Dis. 2024 Feb 19;15(2):152.

Human conjunctiva

Human conjunctiva organoids to study ocular surface homeostasis and disease
Bannier-Hélaouët M, Korving J, Ma Z, Begthel H, Giladi A, Lamers MM, van de Wetering WJ, Yawata N, Yawata M, LaPointe VLS, Dickman MM, Kalmann R, Imhoff SM, van Es JH, López-Iglesias C, Peters PJ, Haagmans BL, Wu W, Clevers H.
Cell Stem Cell. 2024 Feb 1;31(2):227-243.e12.

Human fetal brain

Human fetal brain self-organizes into long-term expanding organoids
Hendriks D, Pagliaro A, Andreatta F, Ma Z, van Giessen J, Massalini S, López-Iglesias C, van Son GJF, DeMartino J, Damen JMA, Zoutendijk I, Staliarova N, Bredenoord AL, Holstege FCP, Peters PJ, Margaritis T, Chuva de Sousa Lopes S, Wu W, Clevers H, Artegiani B.
Cell. 2024 Jan 4:S0092-8674(23)01344-2.

Human fetal hepatocyte

Engineered human hepatocyte organoids enable CRISPR-based target discovery and drug screening for steatosis
Hendriks D, Brouwers JF, Hamer K, Geurts MH, Luciana L, Massalini S, López-Iglesias C, Peters PJ, Rodríguez-Colman MJ, Chuva de Sousa Lopes S, Artegiani B, Clevers H.
Nat Biotechnol. 2023 Nov;41(11):1567-1581.

Establishment of human fetal hepatocyte organoids and CRISPR-Cas9-based gene knockin and knockout in organoid cultures from human liver
Delilah Hendriks, Benedetta Artegiani, Huili Hu, Susana Chuva de Sousa Lopes, Hans Clevers
Nat Protoc. 2020 Nov 27

Human head cancer
Human neck cancer

Patient-derived head and neck cancer organoids allow treatment stratification and serve as a tool for biomarker validation and identification

Millen R, De Kort WWB, Koomen M, van Son GJF, Gobits R, Penning de Vries B, Begthel H, Zandvliet M, Doornaert P, Raaijmakers CPJ, Geurts MH, Elias SG, van Es RJJ, de Bree R, Devriese LA, Willems SM, Kranenburg O, Driehuis E, Clevers H.
Med. 2023 May 12;4(5):290-310.e12.

Human gastric

Generation and multiomic profiling of a TP53/CDKN2A double-knockout gastroesophageal junction organoid model
Zhao H, Cheng Y, Kalra A, Ma K, Zheng Y, Ziman B, Tressler C, Glunde K, Shin EJ, Ngamruengphong S, Khashab M, Singh V, Anders RA, Jit S, Wyhs N, Chen W, Li X, Lin DC, Meltzer SJ.
Sci Transl Med. 2022 Nov 30;14(673): eabq6146.

Helicobacter pylori shows tropism to gastric differentiated pit cells dependent on urea chemotaxis
Aguilar C, Pauzuolis M, Pompaiah M, Vafadarnejad E, Arampatzi P, Fischer M, Narres D, Neyazi M, Kayisoglu Ö, Sell T, Blüthgen N, Morkel M, Wiegering A, Germer CT, Kircher S, Rosenwald A, Saliba AE, Bartfeld S.
Nat Commun. 2022 Oct 5;13(1):5878.

Human Gastric Multi-Regional Assembloids Favour Functional Parietal Maturation and Allow Modelling of Antral Foveolar Hyperplasia
Brendan C Jones, Giada Benedetti, Giuseppe Calà, Lucinda Tullie, Ian C Simcoc, Roberto Lutman, Monika Balys, Ramin Amiri, Jahangir Sufi, Owen Arthurs, Simon Eaton, Glenn Anderson, Nicola Elvassore, Vivian SW Li, Kelsey DJ Jones, Christopher J. Tape, Camilla Luni, Giovanni Giuseppe Giobbe, Paolo De Coppi
bioRxiv, July 11, 2024

Human liver
Human intestinal

Mutation-specific reporter for optimization and enrichment of prime editing
Schene IF, Joore IP, Baijens JHL, Stevelink R, Kok G, Shehata S, Ilcken EF, Nieuwenhuis ECM, Bolhuis DP, van Rees RCM, Spelier SA, van der Doef HPJ, Beekman JM, Houwen RHJ, Nieuwenhuis EES, Fuchs SA.
Nat Commun. 2022 Mar 1;13(1):1028.

Human airway

Modelling of primary ciliary dyskinesia using patient-derived airway organoids
van der Vaart J, Böttinger L, Geurts MH, van de Wetering WJ, Knoops K, Sachs N, Begthel H, Korving J, Lopez-Iglesias C, Peters PJ, Eitan K, Gileles-Hillel A, Clevers H.
EMBO Rep. 2021 Dec 6;22(12):e52058.

Drug Repurposing for Cystic Fibrosis: Identification of Drugs That Induce CFTR-Independent Fluid Secretion in Nasal Organoids
Lisa W Rodenburg, Livia Delpiano, Violeta Railean, Raquel Centeio, Madalena C Pinto, Shannon M A Smits, Isabelle S van der Windt, Casper F J van Hugten, Sam F B van Beuningen, Remco N P Rodenburg, Cornelis K van der Ent, Margarida D Amaral, Karl Kunzelmann, Michael A Gray, Jeffrey M Beekman, Gimano D Amatngalim
Int J Mol Sci. 2022 Oct 21;23(20):12657.

Human small intestinal
Human airway

A CRISPR/Cas9 genetically engineered organoid biobank reveals essential host factors for coronaviruses
Joep Beumer, Maarten H Geurts, Mart M Lamers, Jens Puschhof, Jingshu Zhang, Jelte van der Vaart, Anna Z Mykytyn, Tim I Breugem, Samra Riesebosch, Debby Schipper, Petra B van den Doel, Wim de Lau, Cayetano Pleguezuelos-Manzano, Georg Busslinger, Bart L Haagmans, Hans Clevers
Nat Commun. 2021 Sep 17;12(1):5498.

Human large intestinal

Evaluating CRISPR-based prime editing for cancer modeling and CFTR repair in organoids
Geurts MH, de Poel E, Pleguezuelos-Manzano C, Oka R, Carrillo L, Andersson-Rolf A, Boretto M, Brunsveld JE, van Boxtel R, Beekman JM, Clevers H.
Life Sci Alliance. 2021 Aug 9;4(10):e202000940.

Human breast

Long-term culture, genetic manipulation and xenotransplantation of human normal and breast cancer organoids
Dekkers JF, van Vliet EJ, Sachs N, Rosenbluth JM, Kopper O, Rebel HG, Wehrens EJ, Piani C, Visvader JE, Verissimo CS, Boj SF, Brugge JS, Clevers H, Rios AC.
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A Living Biobank of Breast Cancer Organoids Captures Disease Heterogeneity.
Sachs N, de Ligt J, Kopper O, Gogola E, Bounova G, Weeber F, Balgobind AV, Wind K, Gracanin A, Begthel H, Korving J, van Boxtel R, Duarte AA, Lelieveld D, van Hoeck A, Ernst RF, Blokzijl F, Nijman IJ, Hoogstraat M, van de Ven M, Egan DA, Zinzalla V, Moll J, Boj SF, Voest EE, Wessels L, van Diest PJ, Rottenberg S, Vries RGJ, Cuppen E, Clevers H.

Cell. 2018 Jan 11;172(1-2):373-386.e10.

Human gut

Establishment of human fetal hepatocyte organoids and CRISPR–Cas9-based gene knockin and knockout in organoid cultures from human liver
Hendriks D, Artegiani B, Hu H, Chuva de Sousa Lopes S, Clevers H.
Nat Protoc . 2021 Jan;16(1):182-217

A xenogeneic-free system generating functional human gut organoids from pluripotent stem cells.
Uchida H, Machida M, Miura T, Kawasaki T, Okazaki T, Sasaki K, Sakamoto S, Ohuchi N, Kasahara M, Umezawa A, Akutsu H
JCI Insight. 2017 Jan 12;2(1):e86492

Human hepatocyte
Human intestinal

Fast and Efficient Generation of Knock-In Human Organoids Using Homology-Independent CRISPR-Cas9 Precision Genome Editing
Benedetta Artegiani, Delilah Hendriks, Joep Beumer, Rutger Kok, Xuan Zheng, Indi Joore, Susana Chuva de Sousa Lopes, Jeroen van Zon, Sander Tans, Hans Clevers
Nat Cell Biol 2020 Mar 2[Online ahead of print]

Human liver
Human hepatocyte

Human liver ductal organoids: Single intact ordanoids electroporation by CUY650P1 electrodes
Human hepatocyte organoids: Dissociated single cells cuvette electroporation
Probing the Tumor Suppressor Function of BAP1 in CRISPR-Engineered Human Liver Organoids
Benedetta Artegiani, Lisa van Voorthuijsen, Rik G H Lindeboom, Daniëlle Seinstra, Inha Heo, Pablo Tapia, Carmen López-Iglesias, Daniel Postrach, Talya Dayton, Rurika Oka, Huili Hu, Ruben van Boxtel, Johan H van Es, Johan Offerhaus, Peter J Peters, Jacco van Rheenen, Michiel Vermeulen, Hans Clevers
Cell Stem Cell, 24 (6), 927-943.e6 2019 Jun 6

Human biopsy derived duodenal

Intestinal Failure and Aberrant Lipid Metabolism in Patients With DGAT1 Deficiency
van Rijn JM, Ardy RC, Kuloğlu Z, Härter B, van Haaften-Visser DY, van der Doef HPJ, van Hoesel M, Kansu A, van Vugt AHM, Thian M, Kokke FTM, Krolo A, Başaran MK, Kaya NG, Aksu AÜ, Dalgıç B, Ozcay F, Baris Z, Kain R, Stigter ECA, Lichtenbelt KD, Massink MPG, Duran KJ, Verheij JBGM, Lugtenberg D, Nikkels PGJ, Brouwer HGF, Verkade HJ, Scheenstra R, Spee B, Nieuwenhuis EES, Coffer PJ, Janecke AR, van Haaften G, Houwen RHJ, Müller T, Middendorp S, Boztug K
Gastroenterology. 2018 Jul;155(1):130-143.e15.

Human_large_intestinal
Murine_small_intestinal

Introducing the Stem Cell ASCL2 Reporter STAR into Intestinal Organoids
Heinz MC, Oost KC, Snippert HJG.
STAR Protoc. 2020 Oct 8;1(3):100126.

Murine thymic epithelial cells (TEC)

Derivation of functional thymic epithelial organoid lines from adult murine thymus
Lim S, J F van Son G, Wisma Eka Yanti NL, Andersson-Rolf A, Willemsen S, Korving J, Lee HG, Begthel H, Clevers H.
Cell Rep. 2024 Apr 23;43(4):114019.

Murine colon

Casein kinase 2 phosphorylates and induces the SALL2 tumor suppressor degradation in colon cancer cells
Hermosilla VE, Gyenis L, Rabalski AJ, Armijo ME, Sepúlveda P, Duprat F, Benítez-Riquelme D, Fuentes-Villalobos F, Quiroz A, Hepp MI, Farkas C, Mastel M, González-Chavarría I, Jackstadt R, Litchfield DW, Castro AF, Pincheira R.
Cell Death Dis. 2024 Mar 16;15(3):223.

Murine small intestinal

Intestinal Paneth cell differentiation relies on asymmetric regulation of Wnt signaling by Daam1/2
Colozza G, Lee H, Merenda A, Wu SS, Català-Bordes A, Radaszkiewicz TW, Jordens I, Lee JH, Bamford AD, Farnhammer F, Low TY, Maurice MM, Bryja V, Kim J, Koo BK.
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Mutational inactivation of Apc in the intestinal epithelia compromises cellular organisation
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Murine intestinal

A Protocol for Multiple Gene Knockout in Mouse Small Intestinal Organoids Using a CRISPR-concatemer

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Murine lacrimal gland

Establishment, Maintenance, Differentiation, Genetic Manipulation, and Transplantation of Mouse and Human Lacrimal Gland Organoids

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Murine pancreatic

GREM1 is required to maintain cellular heterogeneity in pancreatic cancer

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Murine normal colorectal

Low neoantigen expression and poor T-cell priming underlie early immune escape in colorectal cancer

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Murine lacrimal gland

Exploring the human lacrimal gland using organoids and single-cell sequencing

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Cancer tissue originated spheroids

Dedifferentiation of neuroendocrine carcinoma of the uterine cervix in hypoxia

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Endometrial

One-step generation of tumor models by base editor multiplexing in adult stem cell-derived organoids

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Fimbria of fallopian tube

An Organoid Platform for Ovarian Cancer Captures Intra- And Interpatient Heterogeneity

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