New molecular biomarkers in kidney transplantation using DNA methylation signatures



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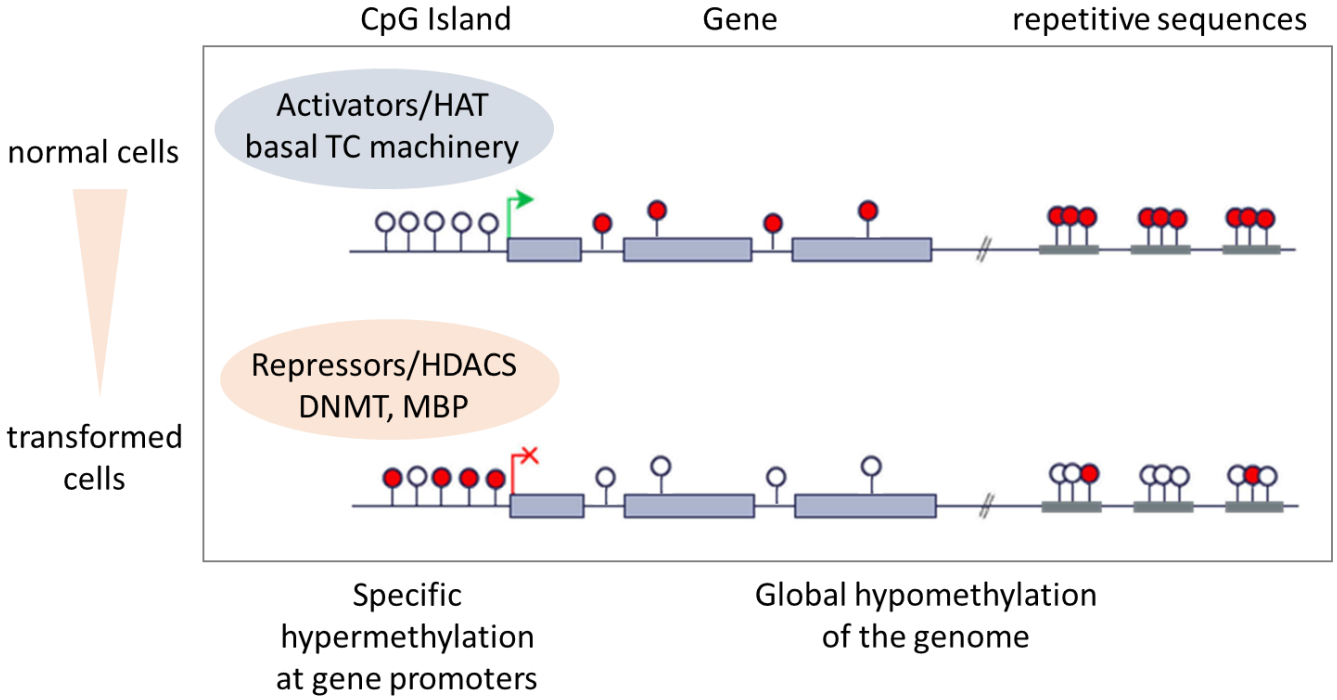
DNA Methylation across genomic structures



Hao et al. 2017, PNAS; modif.
Moison et al. 2014, Atlas of Genetics and Cytogenetics in Oncology and Haematology.

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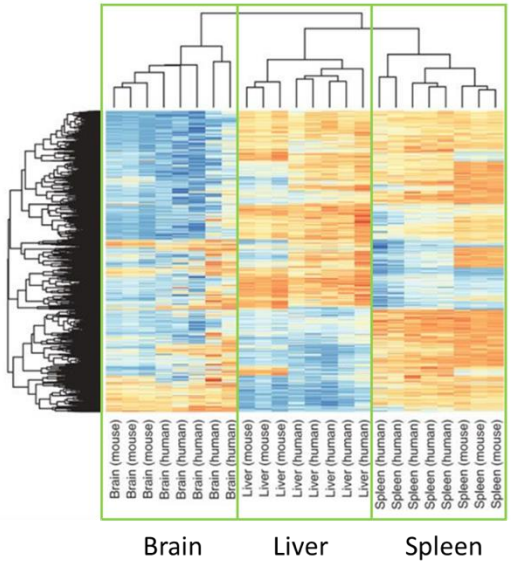
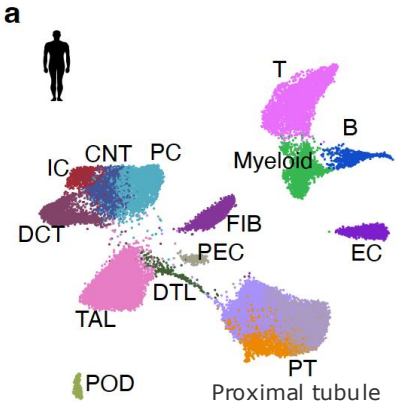
Tissue specific methylome landscape

Jeong et al. 2026, bioRxiv preprint; Irizarry et al. 2006, Nature Genetics.







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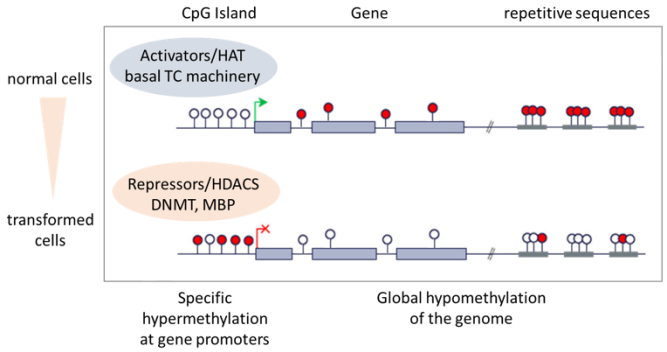
Methylome from Illumina Microarray Technology





https://www.illumina.com/science/technology/microarray.html

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Candidate List → Biomarker?

- Veit Baumann
- Julia Holzhüter

- Discovery cohort n=6 (+6 normal matching control tissue)
  - → DMG list

min_smoothed_fdr	meandiff	maxdiff	SYMBOL	ENSEMBL	no.cpgs
2,14E-137	0.345541764815871	0.617932764089367	MCF2L	ENSG00000126217	16
2,87E-85	0.356187870731404	0.57529919018605	RGS12	ENSG00000159788	11
1,33E-83	0.3863584815212	0.63574952647771	PDE4D	ENSG00000113448	12
1,35E-83	0.373476930284937	0.491020797790031	FBLIM1	ENSG00000162458	12
3,01E-81	0.359090707206953	0.642145857603797	GRAMD1B	ENSG00000023171	14
6,34E-80	0.340263137587216	0.491070816204689	ANKS1B	ENSG00000185046	14
1,23E-75	0.328026311943196	0.571303619884518	MIR100HG	ENSG00000255248	15
1,81E-72	0.308629033940591	0.482156203166782	NFIX	ENSG00000008441	12
6,24E-69	0.395691005933121	0.60221027994963	NPY	ENSG00000122585	18
2,67E-68	0.265269462323531	0.541914022863432	VMO1	ENSG00000182853	12
5,85E-63	0.269656010447819	0.548431925683829	HOXC5	ENSG00000172789	13
6,55E-63	0.376727931818035	0.579586936058309	TSPAN9	ENSG00000011105	7
1,13E-55	0.276486818705065	0.412488915927189	FAM83G	ENSG00000188522	14
2,68E-52	0.329801925232306	0.547510725394781	C1QL3	ENSG00000165985	8
1,46E-51	0.325989897899631	0.461237649291601	MCF2L	ENSG00000126217	14
3,95E-51	-0.319538671433473	-0.554432904540918	SLC22A2	ENSG00000112499	16
3,63E-50	0.234730374138198	0.469812587367309	CHAD	ENSG00000136457	16
1,29E-48	0.269171775818378	0.438958697766106	REC8	ENSG00000100918	15
1,22E-47	0.359056596689543	0.534204491260243	SATB2	ENSG00000119042	10
7,96E-47	0.322344721960563	0.585019633574395	CLDN10	ENSG00000134873	16
5,75E-46	0.314368994072502	0.602205271168513	LINC01342	ENSG00000223823	8
1,09E-43	0.323383273461255	0.516043520560376	PRKCZ	ENSG00000067606	10
1,97E-43	0.257486734204776	0.454298184430354	HOXC4	ENSG00000198353	21
3,10E-43	0.400970528225497	0.525062437892239	LRRC17	ENSG00000128606	7

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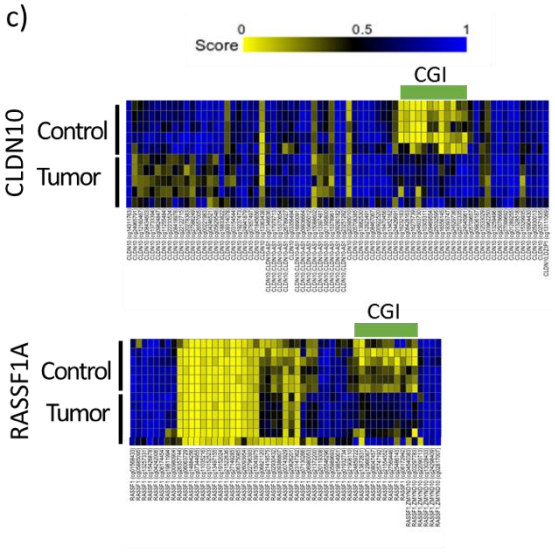
Renal tumors ccRCCs in post transplant

- Discovery cohort (n=6 tumors, 6 matching controls)



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Arroyo et al. 2025, Clinical Epigenetics.
Together with Jan Halbritter

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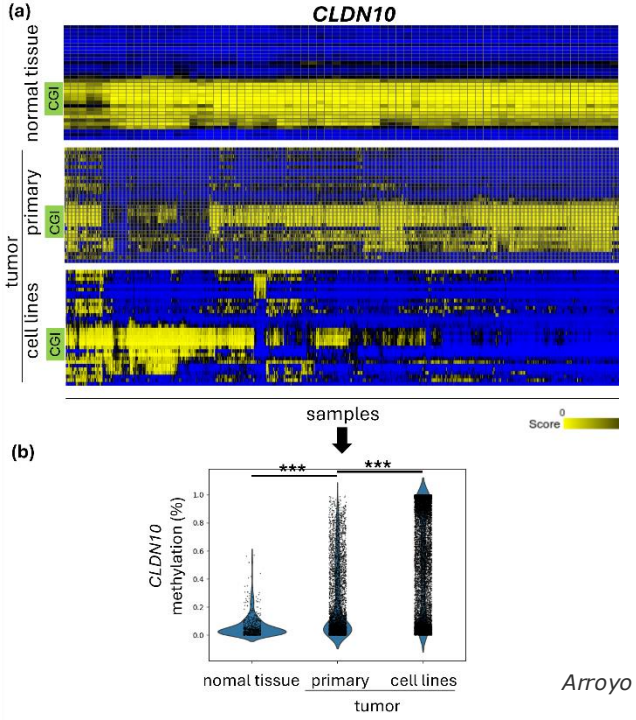
Methylation changes during carcinogenesis

- Increasing methylation pattern



Arroyo et al. 2026, IJMS.

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- Veit Baumann
- Julia Holzhüter

- Verification cohort n=14 (+14 normal matching control tissue)
  - → DMG list

min_smoothed_fdr	meandiff	maxdiff	SYMBOL	ENSEMBL	no.cpgs
0	0.5170395633778	0.59259410044533	MAST4-AS1	NA	13
0	0.20487349923042	0.465843894261305	TRIM15	ENSG00000204610	34
0	0.284769537753212	0.418745629289112	MCF2L	ENSG00000126217	18
0	-0.231204208099864	-0.400807177187172	ZC3H12D	ENSG00000178199	13
5,49E-289	0.213342009247268	0.346654723367127	HOXB3	ENSG00000120093	25
1,43E-274	-0.237127465656389	-0.606482073743541	KDM8	ENSG00000155666	14
1,16E-268	0.2088513972797	0.412584784815022	HOXC4	ENSG00000198353	23
6,43E-249	0.31751984580496	0.502459066066747	MCF2L	ENSG00000126217	13
1,51E-237	0.250773492702455	0.424115095824929	MIR100HG	ENSG00000255248	20
8,07E-234	0.320761691123622	0.525510226241345	CLDN10	ENSG00000134873	18
1,46E-227	0.330197600239949	0.514298802149055	SBNO2	ENSG00000064932	12
4,04E-220	0.234642306356284	0.365916218350445	ALDH3A1	ENSG00000108602	13
7,62E-216	0.284651179372905	0.540481859197823	TSPAN9	ENSG00000011105	11
3,36E-215	0.25795439420581	0.436461580424973	ANKS1B	ENSG00000185046	15
7,73E-212	0.382700732246595	0.53856561212686	NPY	ENSG00000122585	16
3,34E-208	0.319758501403266	0.512585887775282	PDE4D	ENSG00000113448	14
4,39E-200	0.273751108708542	0.425509692452763	ABAT	ENSG00000183044	14
8,34E-199	-0.344275798199547	-0.439720487598337	ALPL	ENSG00000162551	7
6,67E-197	0.329474643719095	0.47171669331532	SH3BP2	ENSG00000087266	10
2,61E-188	-0.245974995814709	-0.455000788445318	SLC5A11	ENSG00000158865	10
3,77E-186	0.208860344164041	0.340348411559372	CTNNA1	ENSG00000044115	14
2,98E-185	0.299977150256463	0.4661023423552	DEF6	ENSG00000023892	11
5,02E-185	-0.383297101491192	-0.51023211646882	SLC28A1	ENSG00000156222	7
1,09E-179	0.227783051247974	0.535855808786836	PRKCZ	ENSG00000067606	16
4,16E-175	0.273087578315435	0.502747889862101	LIMA1	ENSG00000050405	11

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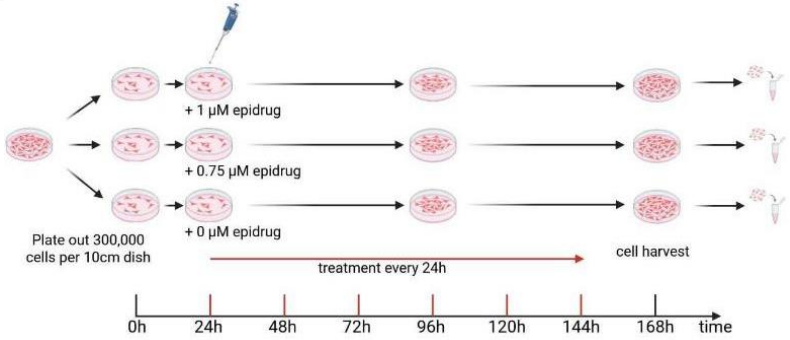
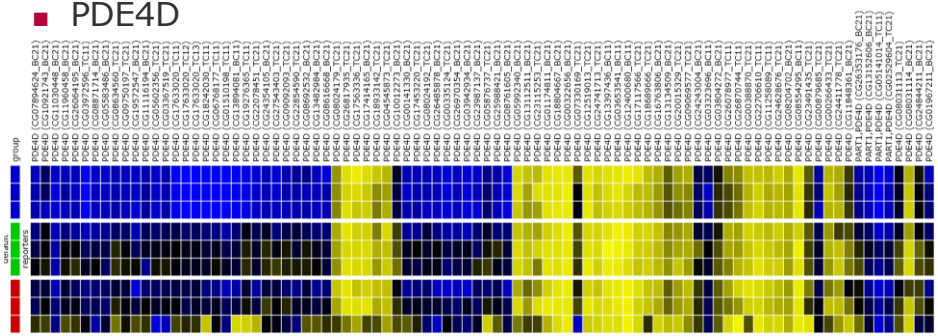
Epigenetic Drug Testing on cell culture ccRCC

Veit Baumann

- Methylome EPIC



- PDE4D



- Mock
- Treated
- Treated

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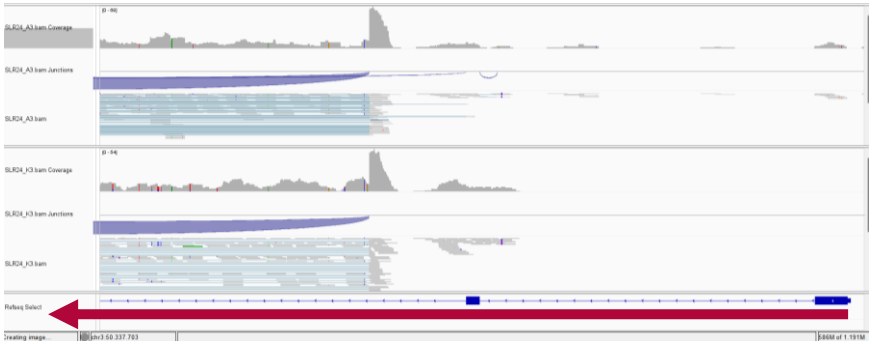
Epigenetic Drug Testing on cell culture ccRCC

- Transcription RNA Seq

- treated
- mock



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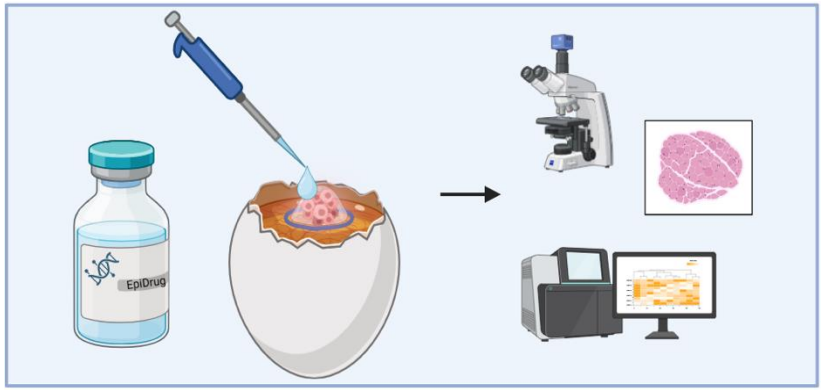
Epigenetic Drug Testing on CAM Model



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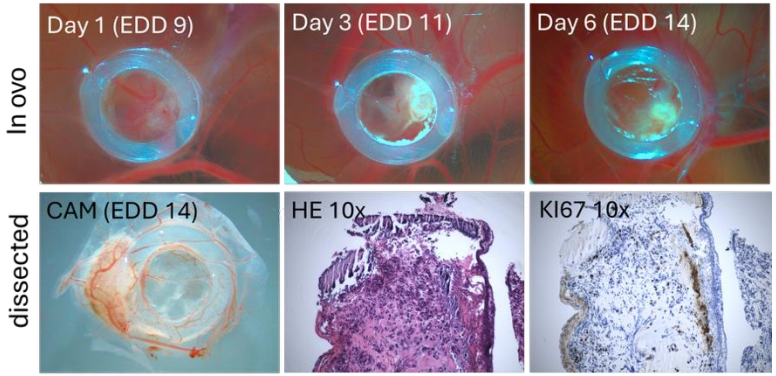
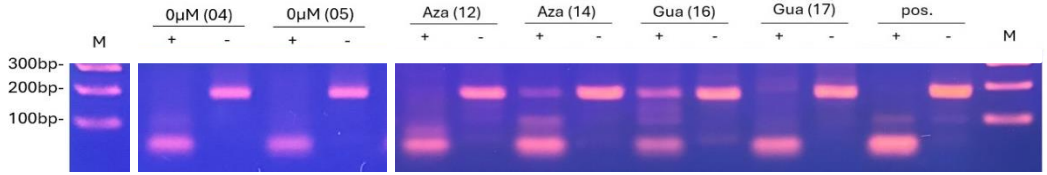
Epigenetic Drug Testing on CAM Model

- Chiara Linzmeyer
- Veit Baumann





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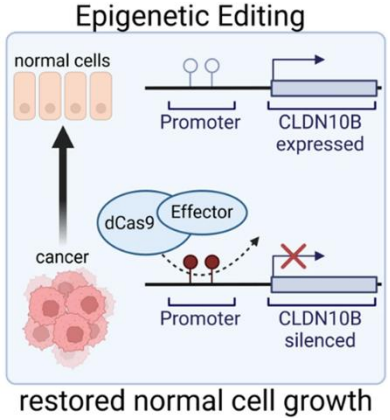
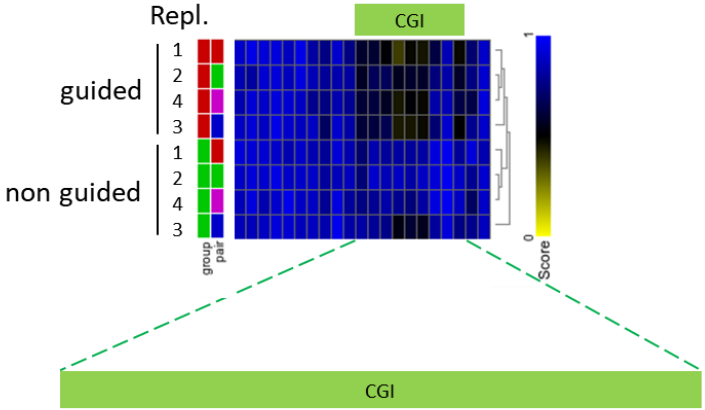
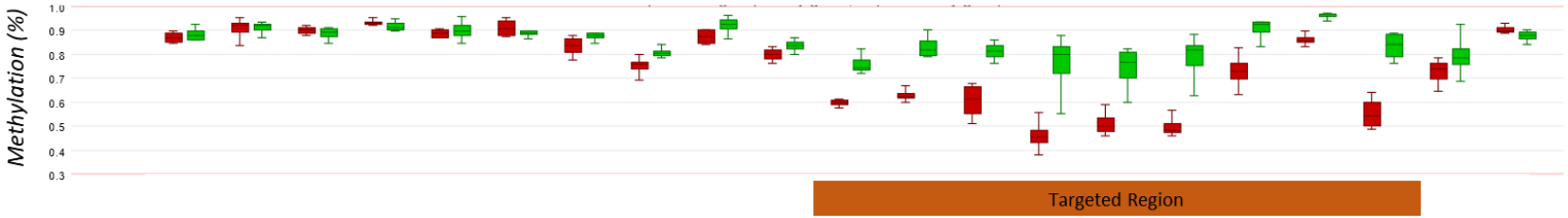
Crispr based Epigenetic Editing

Sarah Arroyo







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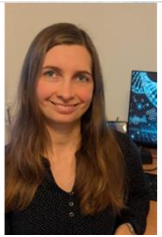
Thanks to


Niklas Philipp


Julia Holzhüter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Prof. Rafael Ariza

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Prof. Margaret Ahmad

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