

nature

REVIEWS

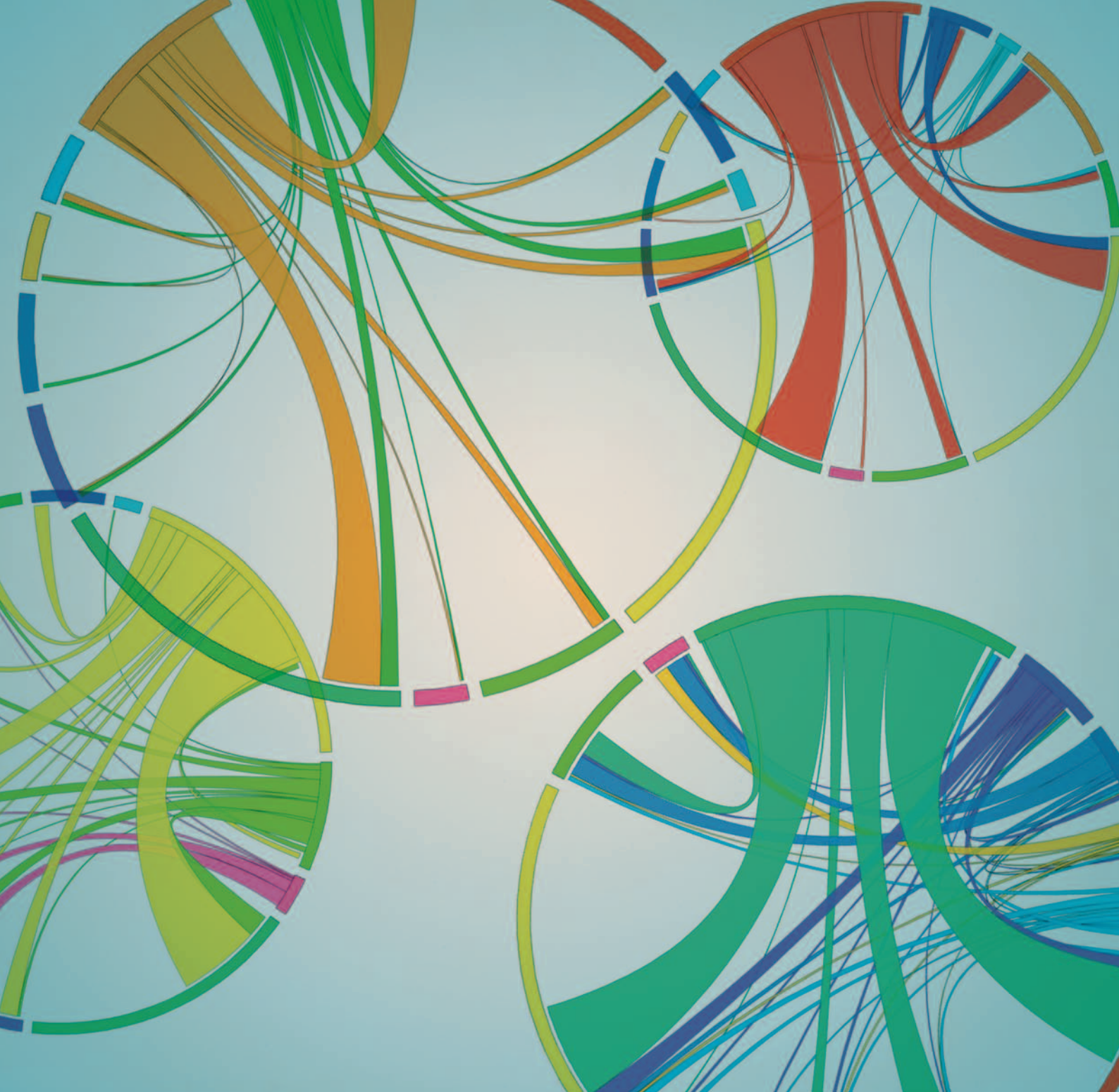
www.nature.com/reviews

CANCER



Produced with support from:





One of the outstanding features of *Nature Reviews Cancer* is our figures. Although they are based on diagrams submitted by our authors, we take great care in making sure that the concepts that the figures aim to show are as clear and as comprehensive as possible. Indeed, given the adage that ‘a picture paints a thousand words’, good figures can encapsulate entire fields of cancer research without the need for extensive explanations.

In our calendar for 2013, we have chosen some of our favourite figures from the past few years that sum up hot topics in cancer research. At the end of the calendar we have included some additional Reviews and Perspectives that discuss important topics related to each figure. Our calendar is freely available thanks to support from OriGene, Your Gene Company and we hope that you find it useful.

Here’s to a happy and productive 2013, and we look forward to meeting some of you at the cancer-related conferences listed at the back of the calendar.

LIST OF ABBREVIATIONS USED IN THE CALENDAR:

7mG, 7methylguanine; α -cat, α -catenin; aKG, α -ketoglutarate; ACLY, ATP citrate lyase; ANGPT1, angiopoietin 1; ARD1, arrest defective 1; ARID1A, AT-rich interactive domain-containing protein 1A; ARP, actin-related protein; BAF57, BRC1-associated factor 57; CA, carbonic anhydrase; CCND, cyclin D; CEBPA, CCAAT/enhancer-binding protein- α ; CINN, α -cyano-4-hydroxycinnamate; CHIP, carboxy terminus of HSP70-interacting protein; CRB, crumbs complex; CTL, cytotoxic T lymphocyte; DCA, dichloroacetate; DLG, discs large; DLL4, delta-like 4; DNMT3A, DNA methyltransferase 3A; EGFL7, epidermal growth factor-like 7; FASN, fatty acid synthase; FDC, follicular dendritic cell; FIH, factor inhibiting HIF; G6P, glucose-6-phosphate; HAF, HIF-associated factor; HK, hexokinase; IDH1, isocitrate dehydrogenase 1; IREBP1, iron response element-binding protein 1; JAG1, jagged 1; JAM, junctional adhesion molecule; LGL, lethal (2) giant larvae; Mal, malate; MAML, mastermind-like; MCT,

monocarboxylate transporter; MDSC, myeloid-derived suppressor cell; NHE1, Na⁺/H⁺ exchanger 1; NICD, NOTCH intracellular domain; NK, natural killer cell; OAA, oxaloacetate; ODD, O₂-dependent degradation domain; OH, hydroxylation; PA \dot{S} , PER-ARNT-SIM; PATJ, PALS1-associated tight junction protein; PBRM1, protein polybromo 1; PDH, pyruvate dehydrogenase; PDK, pyruvate dehydrogenase kinase; PEP, phosphoenol pyruvate; PHD, prolyl hydroxylase; PK, pyruvate kinase; PKD1, protein kinase D1; R5P, ribose 5-phosphate; RBPJ, recombination signal binding protein for immunoglobulin κ region; RHEB, Ras homologue enriched in brain; SMO, Smoothened; SSH, slingshot; TAD, transactivation domain; T_H cell, T helper cell; T_{FH} cell, T follicular helper cell; TEM, tumour educated macrophage; TIE2, protein receptor tyrosine kinase, epithelial specific 2; TSC2, tuberlin; T_{REG} cell, regulatory T cell; VHL, Von Hippel-Lindau; WASP, Wiskott-Aldrich syndrome protein; ZO, zonular occludens protein.



Nature Reviews Cancer:

<http://www.nature.com/nrc/index.html>

Follow @NatureRevCancer on Twitter:

<https://twitter.com/NatureRevCancer>

Calendar compiled and edited by Gemma Alderton, Darren Burgess, Nicola McCarthy and Sarah Seton-Rogers
Copy-edited by Catriona Rodwell
Designed and illustrated by Lara Crow



Streamline your gene-related research with OriGene's broad gene centric tools for molecular and cellular research. Our product offering includes:

- 200,000 expression cDNA clones, with or without tags
- 200,000 RNAi reagents (shRNA, siRNA and miRNA)
- 8,000 purified human proteins from human cells
- 12,000 validated antibodies
- 140,000 human tissues for cancer research
- Constructing any plasmid vectors via gene synthesis

Type the name of your favorite gene into OriGene's search box and be amazed.

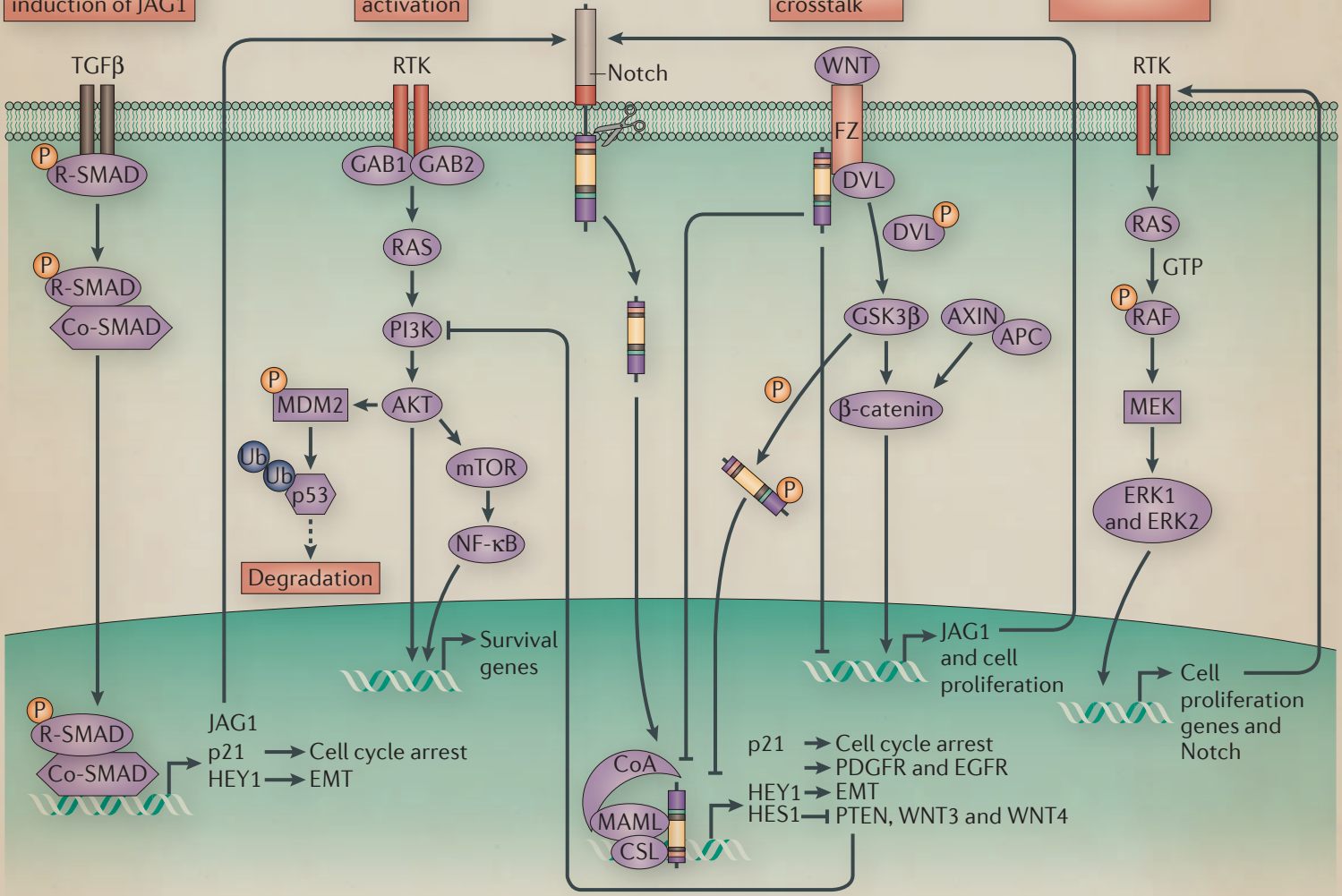
Join thousands of scientists who experienced the quality and convenience of OriGene's tools. Put your project into power drive!
www.origene.com

TGFβ-mediated induction of JAG1

PI3K-AKT activation

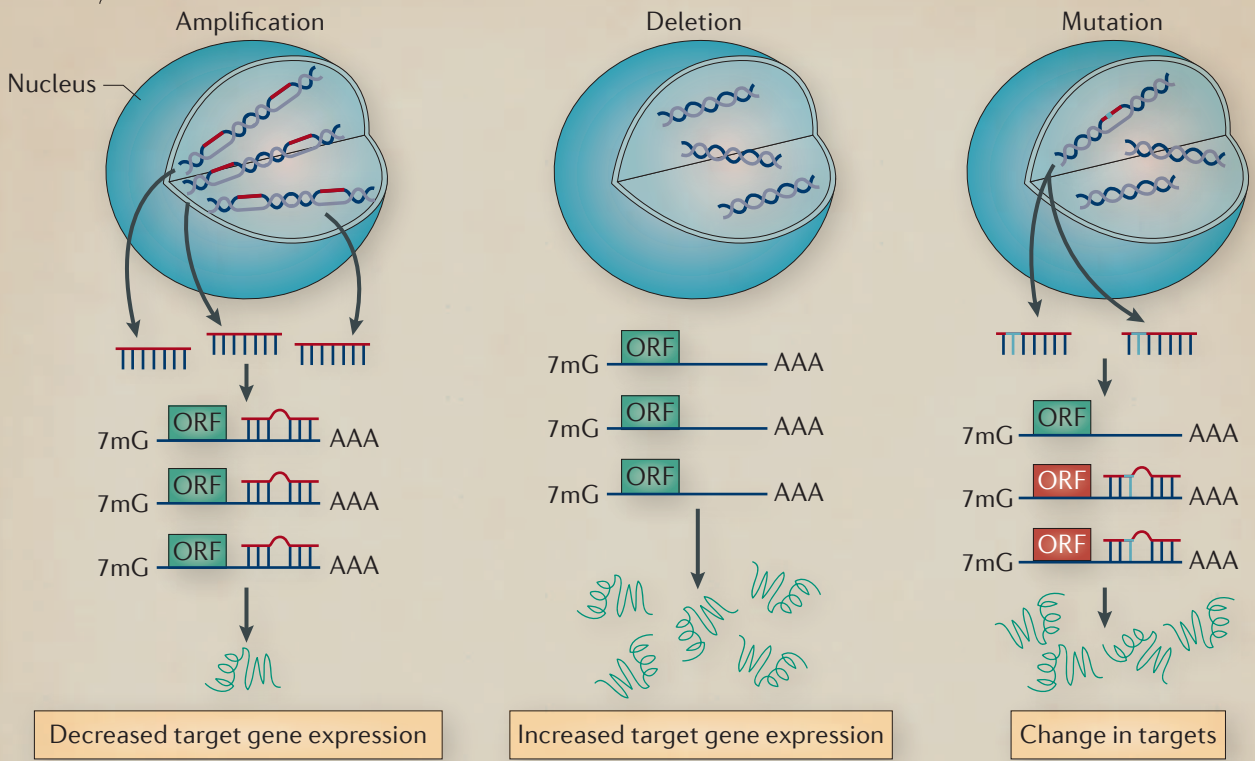
Notch-WNT crosstalk

RTK activation

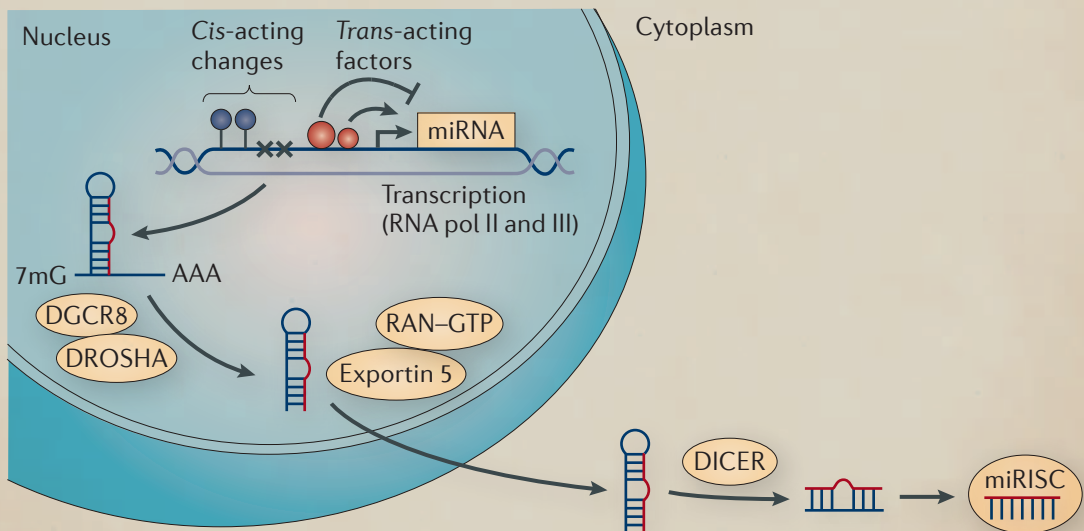


SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

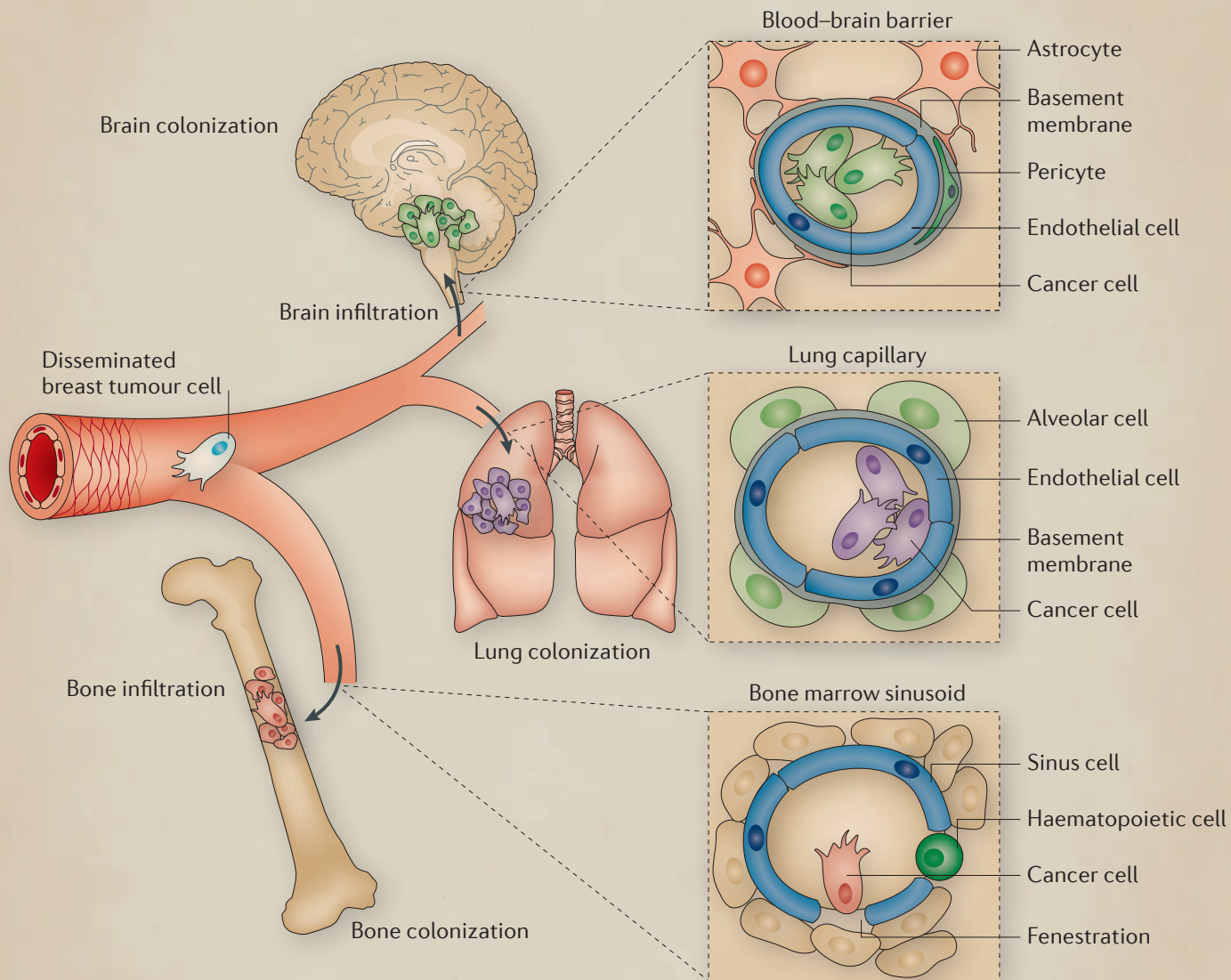
Genomic alterations



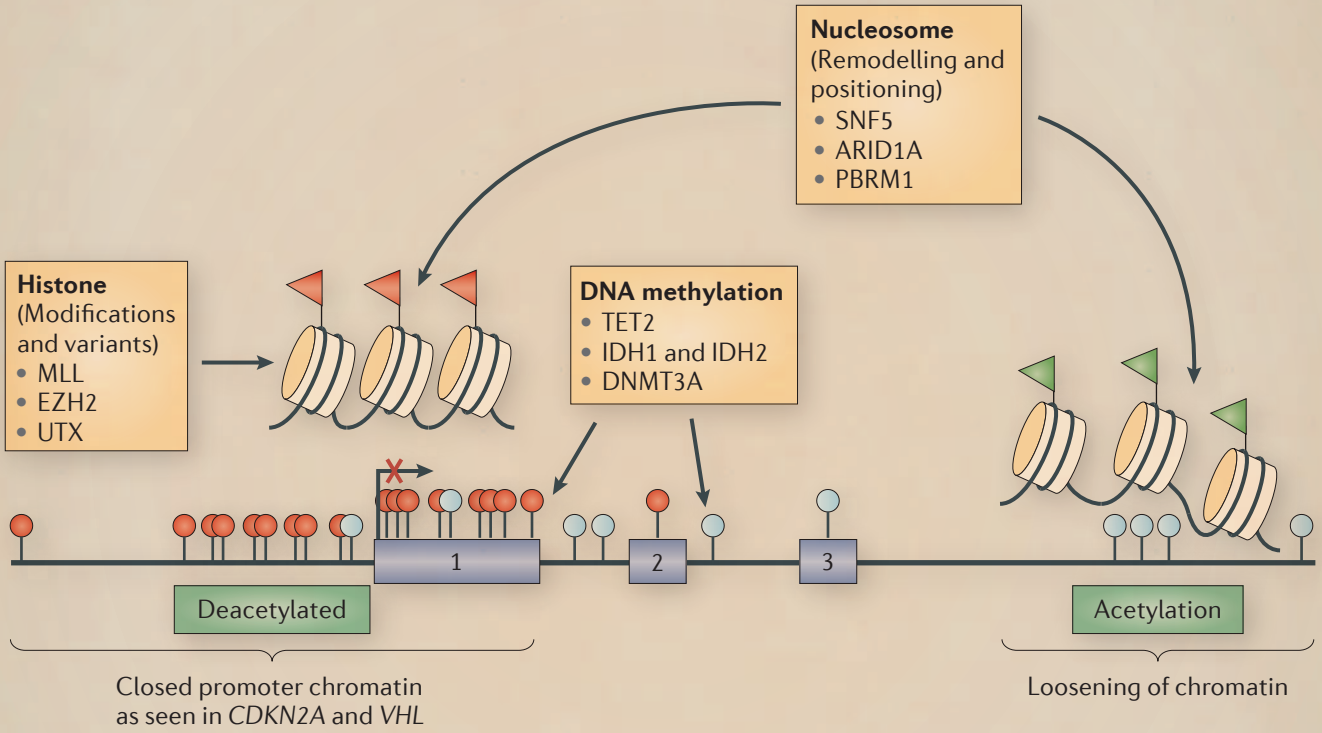
Transcription and processing



SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28		



SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						



nature
REVIEWS

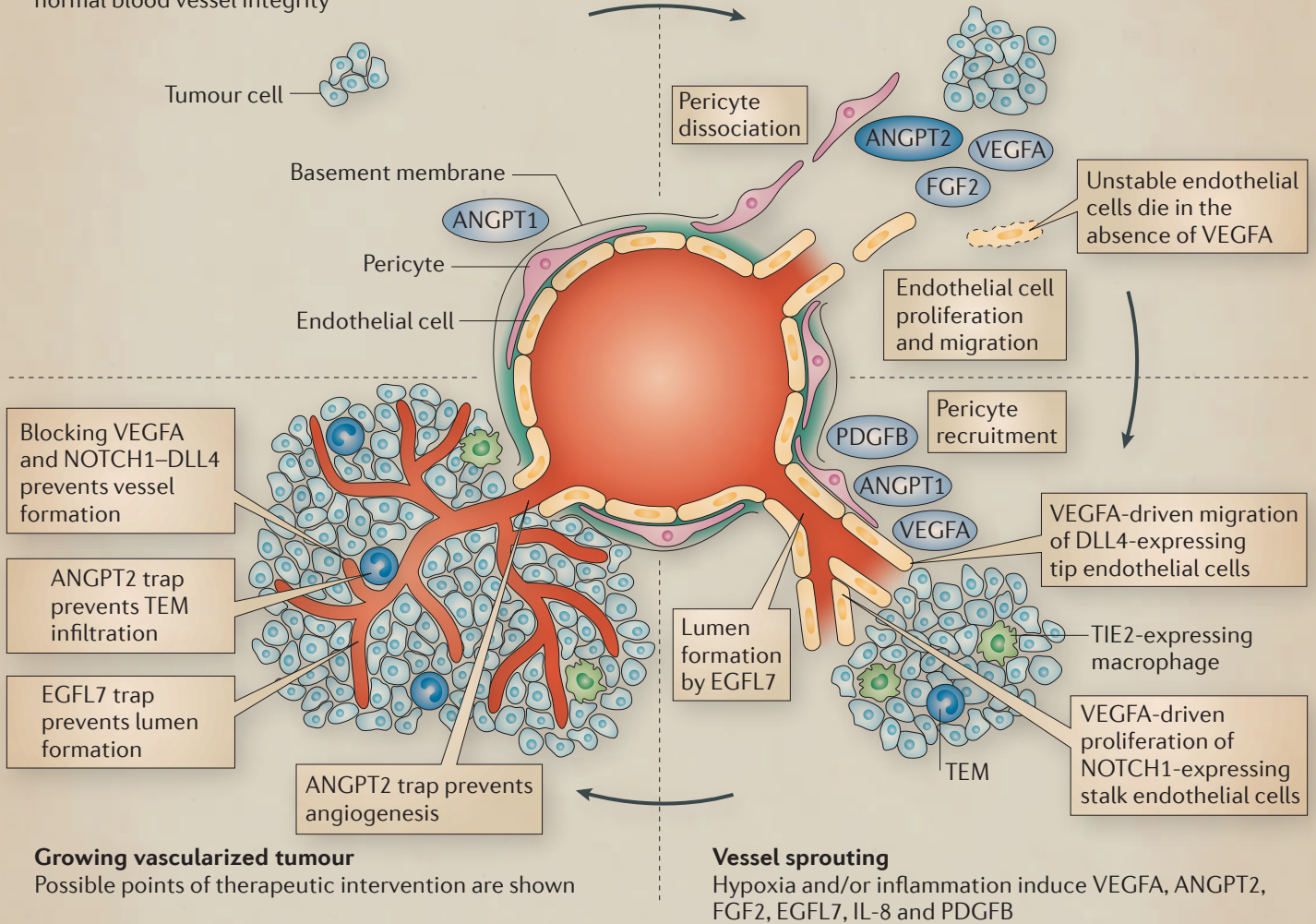
CANCER

APRIL 2013

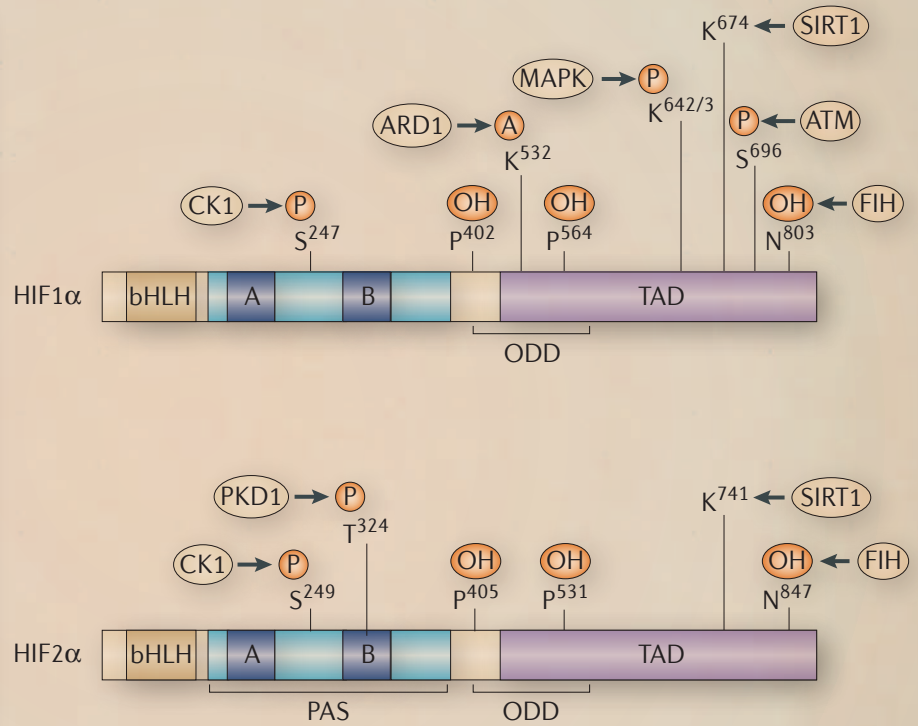
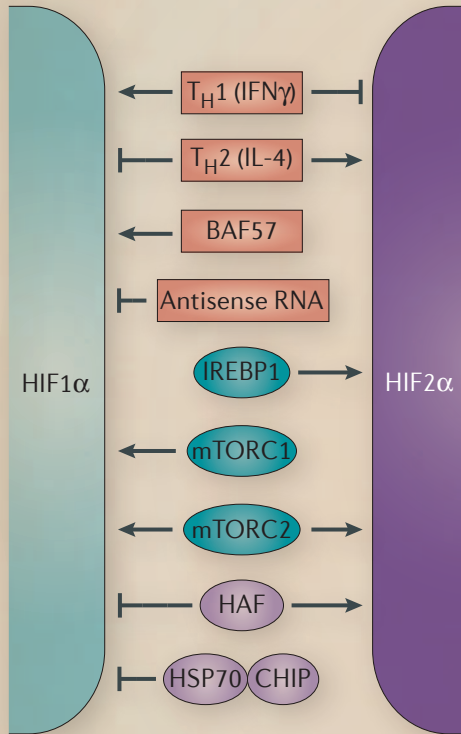
SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

Small avascular tumours at primary site or metastatic foci
 ANGPT1 helps to maintain normal blood vessel integrity

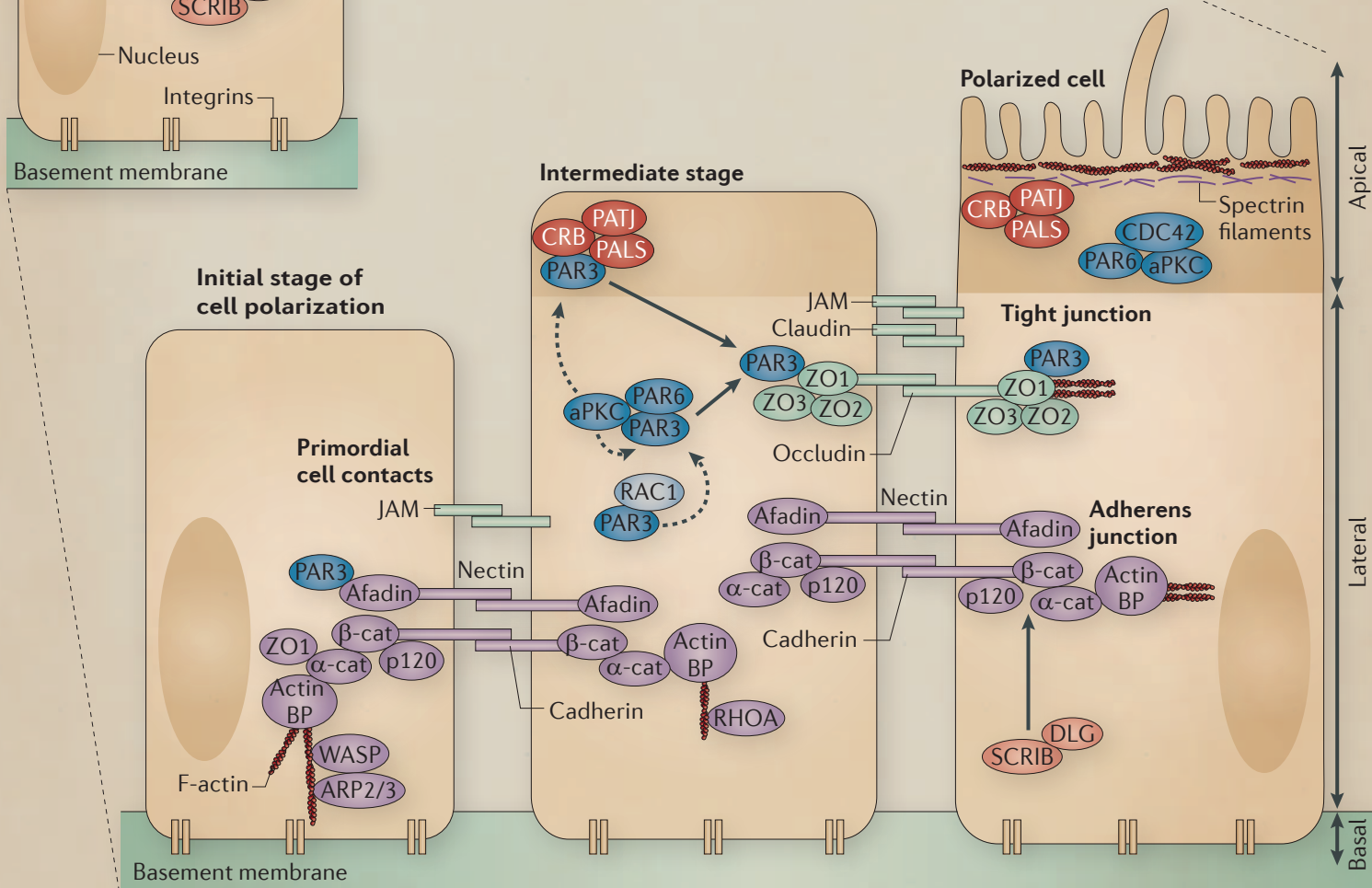
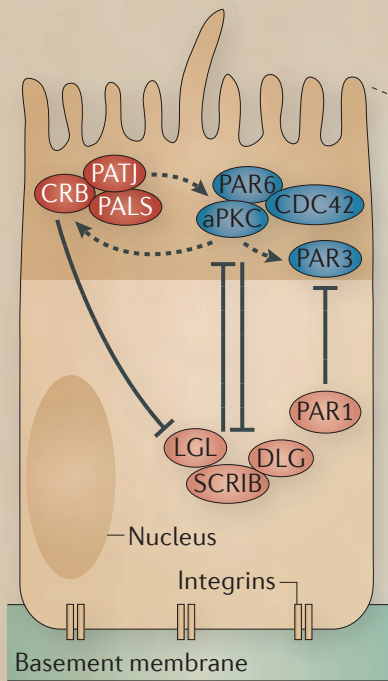
Initiation of angiogenesis
 Hypoxia and/or inflammation induce VEGFA, ANGPT2 and FGF2



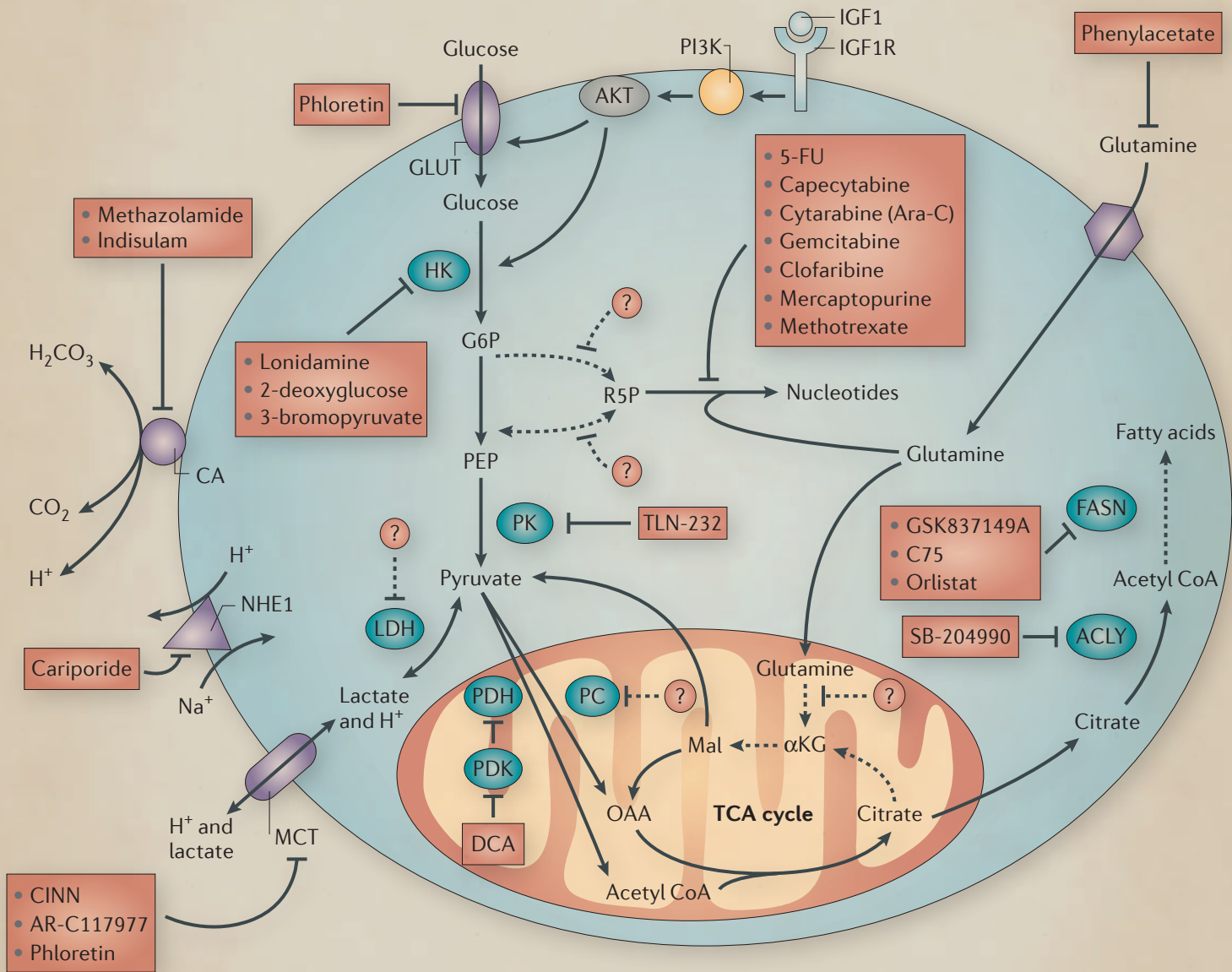
SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	



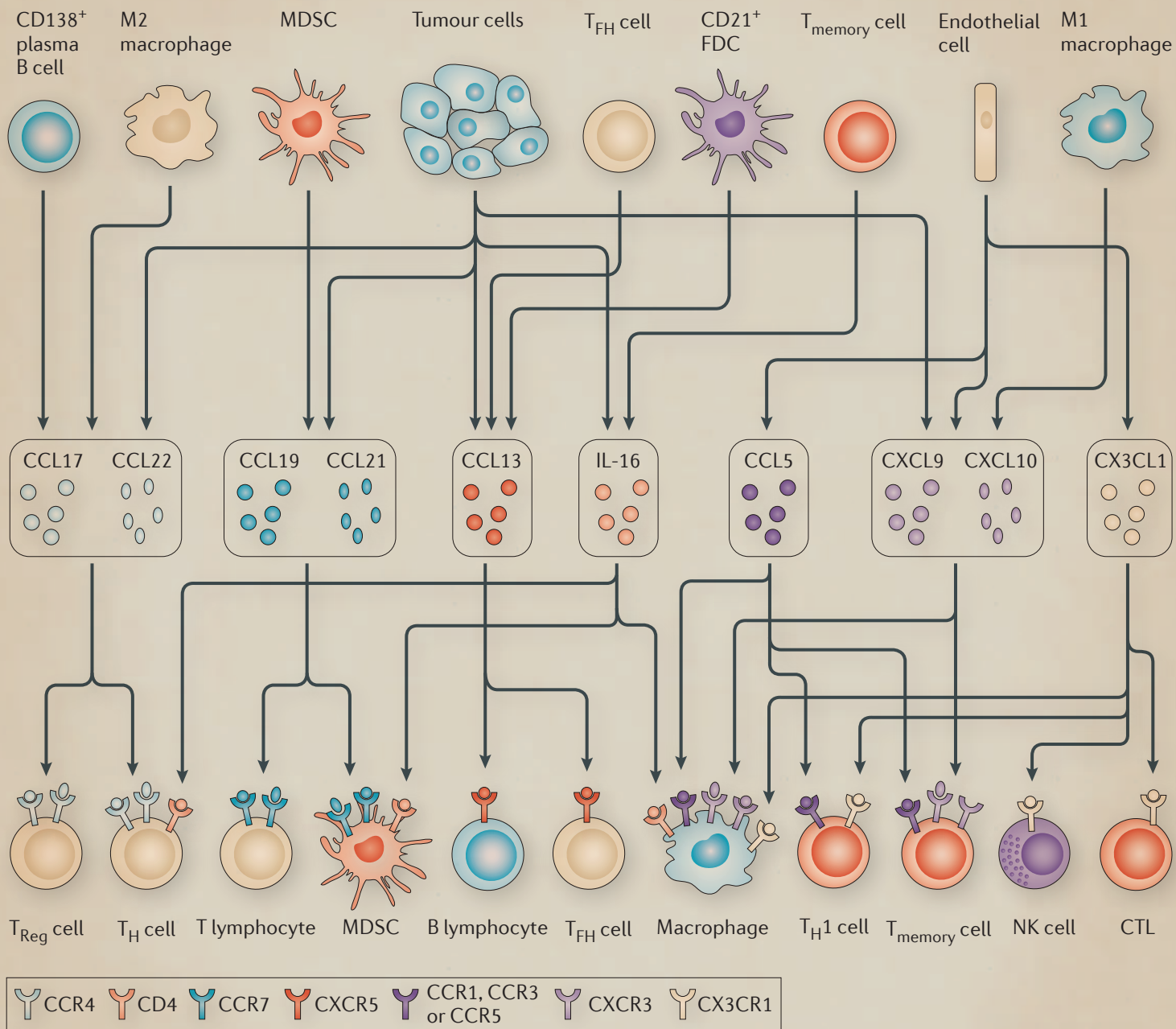
SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						



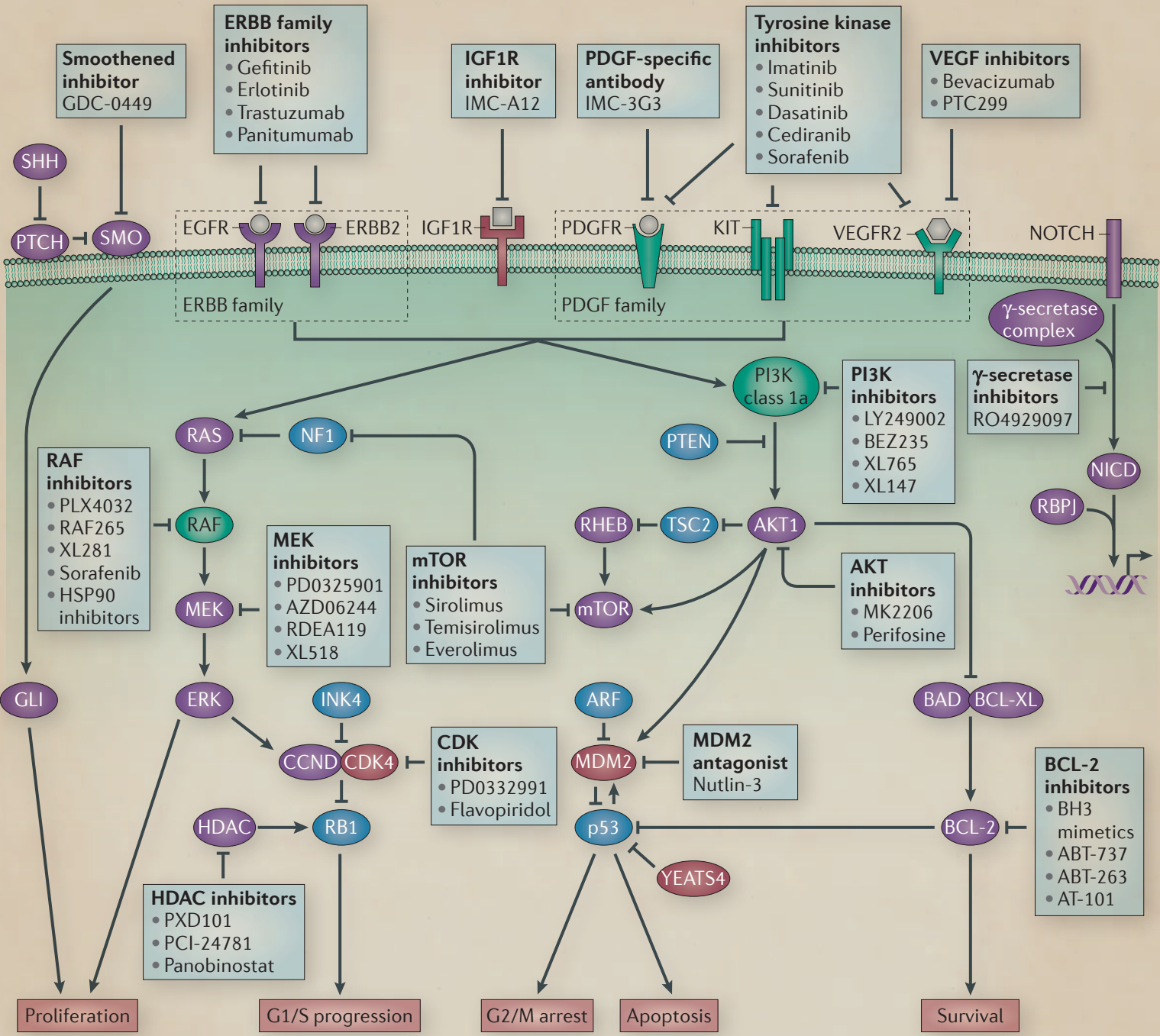
SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			



SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

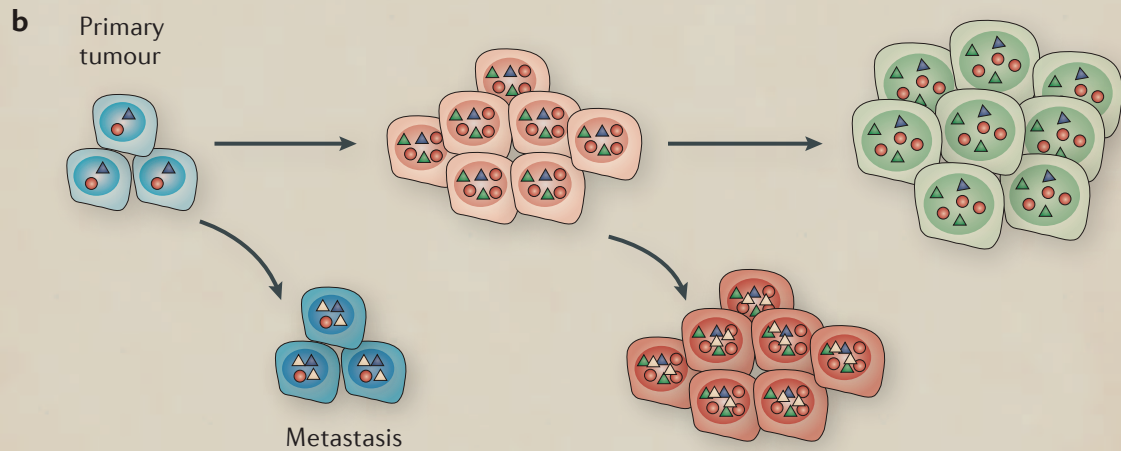
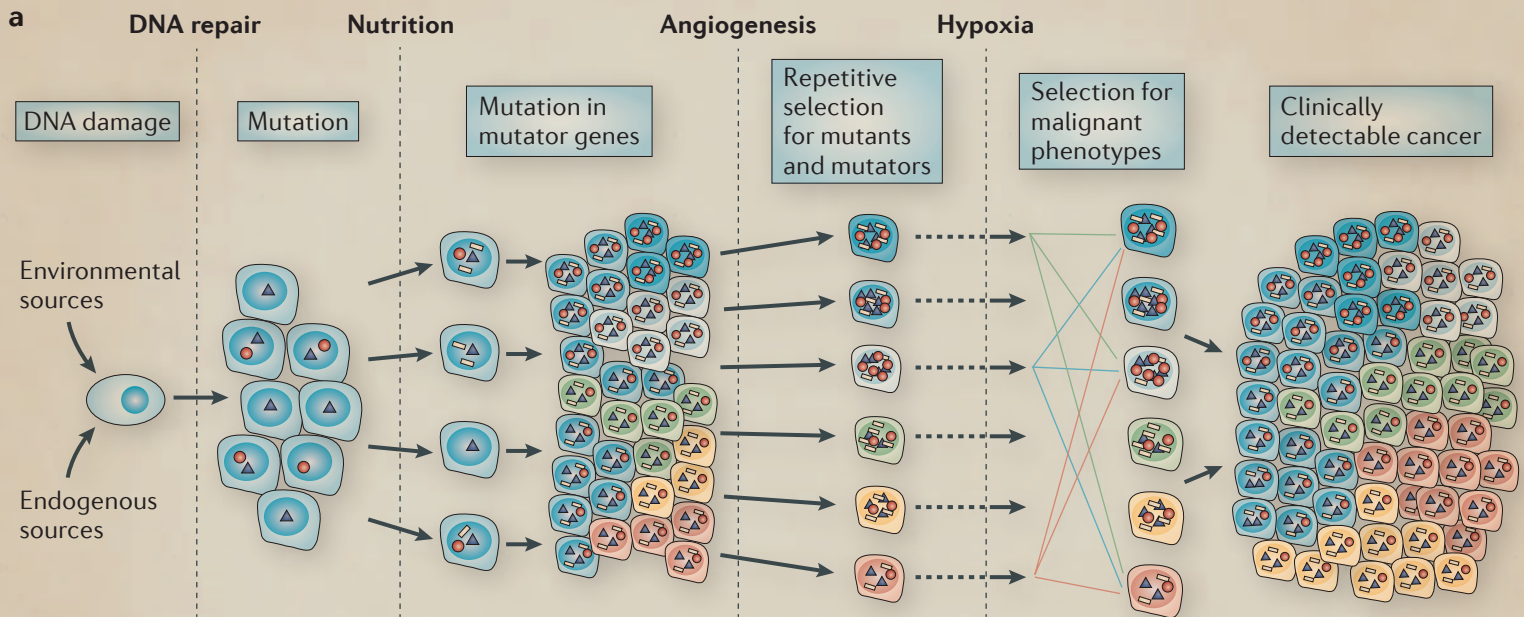


SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					



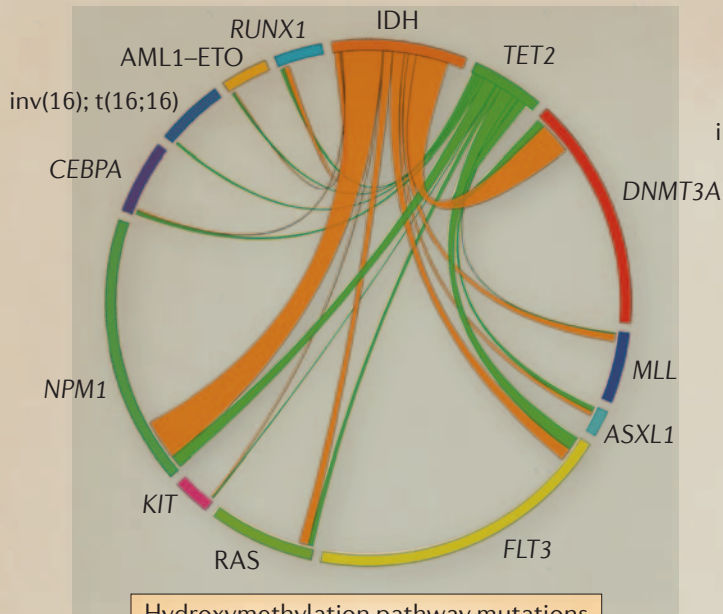
● Predominantly mutated
 ● Predominantly deleted and/or underexpressed
 ● Predominantly amplified and/or overexpressed

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		



- | | |
|-------------------------|----------------------------------|
| ▲ Early driver mutation | ● Mutator mutation |
| ▲ Late driver mutation | △ Mutation arising in metastasis |

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

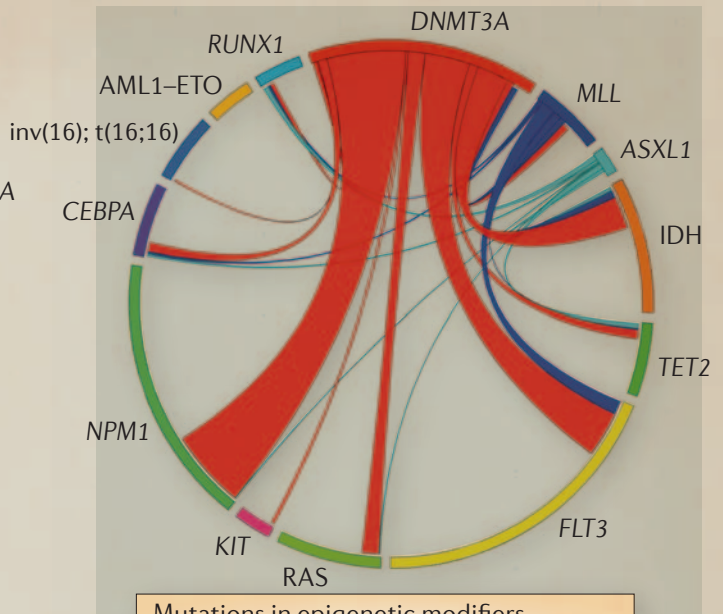


Hydroxymethylation pathway mutations

- TET2 mutations
- IDH1 or IDH2 mutations

Class I alterations

- FLT3 mutations
- NRAS or KRAS mutations
- KIT mutations

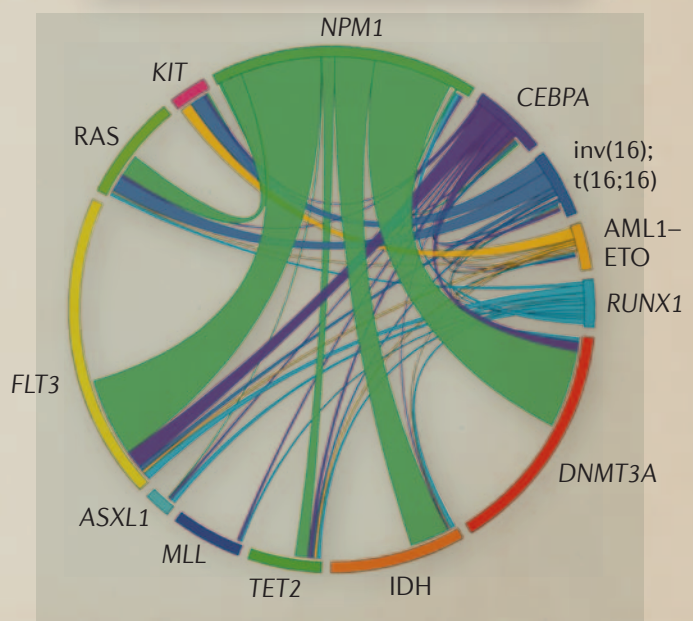
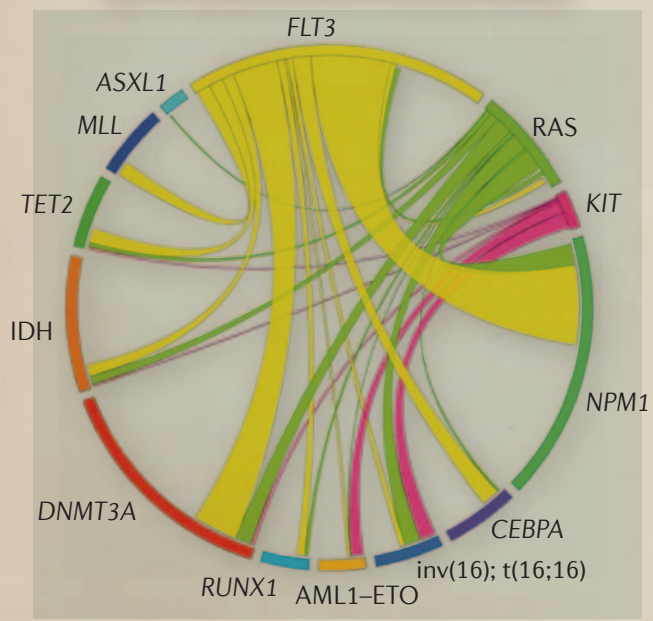


Mutations in epigenetic modifiers

- DNMT3A mutations
- ASXL1 mutations
- MLL alterations

Class II alterations

- CEBPA mutations
- AML1-ETO fusions
- NPM1 mutations
- inv(16); t(16;16) translocations
- RUNX1 mutations



nature
REVIEWS

CANCER

DECEMBER 2013

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

READING LIST

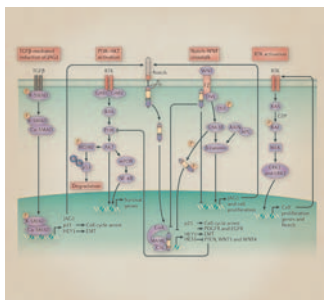
JANUARY

SIGNALLING

Adapted from Ranganathan, P., Weaver, K. L. & Capobianco, A. J. Notch signalling in solid tumours: a little bit of everything but not all the time. *Nature Rev. Cancer* **11**, 338–351 (2011)

FURTHER READING

- Pylayeva-Gupta, Y., Grabocka, E. & Bar-Sagi, D. RAS oncogenes: weaving a tumorigenic web. *Nature Rev. Cancer* **11**, 761–774 (2011)
- Yarden, Y. & Pines, G. The ERBB network: at last, cancer therapy meets systems biology. *Nature Rev. Cancer* **12**, 553–563 (2012)
- Casaleto, J. B. & McClatchey, A. I. Spatial regulation of receptor tyrosine kinases in development and cancer. *Nature Rev. Cancer* **12**, 387–400 (2012)



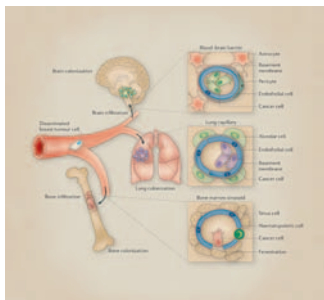
MARCH

METASTASIS

Adapted from Nguyen, D. X., Bos, P. D. & Massagué, J. Metastasis: from dissemination to organ-specific colonization. *Nature Rev. Cancer* **9**, 274–284 (2009)

FURTHER READING

- Sethi, N. & Kang, Y. Unravelling the complexity of metastasis — molecular understanding and targeted therapies. *Nature Rev. Cancer* **11**, 735–748 (2011)
- Steeg, P. S., Camphausen, K. A. & Smith, Q. R. Brain metastases as preventive and therapeutic targets. *Nature Rev. Cancer* **11**, 352–363 (2011)
- Klein, C. A. Parallel progression of primary tumours and metastases. *Nature Rev. Cancer* **9**, 302–312 (2009)
- Focus on Migration and metastasis. *Nature Rev. Cancer* (Apr 2009)



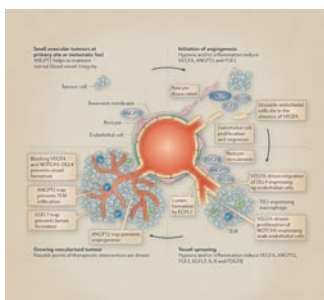
MAY

TUMOUR MICROENVIRONMENT

Adapted from Huang, H., Bhat, A., Woodnutt, G. & Lappe, R. Targeting the ANGPT–TIE2 pathway in malignancy. *Nature Rev. Cancer* **10**, 575–585 (2010)

FURTHER READING

- Swartz, M. A. & Lund, A. W. Lymphatic and interstitial flow in the tumour microenvironment: linking mechanobiology with immunity. *Nature Rev. Cancer* **12**, 210–219 (2012)
- Meads, M. B., Gatenby, R. A. & Dalton, W. S. Environment-mediated drug resistance: a major contributor to minimal residual disease. *Nature Rev. Cancer* **9**, 665–674 (2009)
- Joyce, J. A. & Pollard, J. W. Microenvironmental regulation of metastasis. *Nature Rev. Cancer* **9**, 239–252 (2009)
- Psaila, B. & Lyden, D. The metastatic niche: adapting the foreign soil. *Nature Rev. Cancer* **9**, 285–293 (2009)



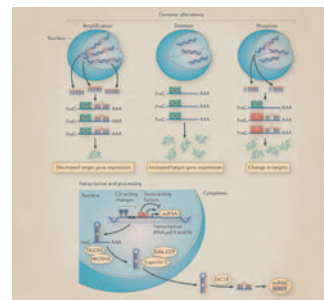
FEBRUARY

MicroRNAs

Adapted from Kasinski, A. L. & Slack, F. J. MicroRNAs en route to the clinic: progress in validating and targeting microRNAs for cancer therapy. *Nature Rev. Cancer* **11**, 849–864 (2011)

FURTHER READING

- Hermeking, H. MicroRNAs in the p53 network: micromanagement of tumour suppression. *Nature Rev. Cancer* **12**, 613–626 (2012)
- van Kouwenhove, M., Kedde, M. & Agami, R. MicroRNA regulation by RNA-binding proteins and its implications for cancer. *Nature Rev. Cancer* **11**, 644–656 (2011)
- Ryan, B. M., Robles, A. I. & Harris, C. C. Genetic variation in microRNA networks: the implications for cancer research. *Nature Rev. Cancer* **10**, 389–402 (2010)



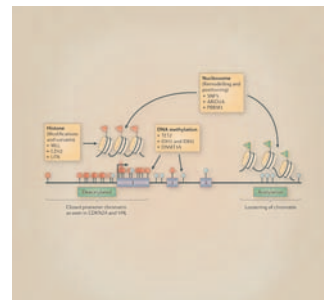
APRIL

EPIGENETICS

Adapted from Baylín, S. B. & Jones, P. A. A decade of exploring the cancer epigenome — biological and translational implications. *Nature Rev. Cancer* **11**, 726–734 (2011)

FURTHER READING

- Wilson, B. G. & Roberts, C. W. M. SWI/SNF nucleosome remodellers and cancer. *Nature Rev. Cancer* **11**, 481–492 (2011)
- Chi, P., Allis, C. D. & Wang G. G. Covalent histone modifications — miswritten, misinterpreted and mis-erased in human cancers. *Nature Rev. Cancer* **10**, 457–469 (2010)
- Chen, J., Odenike, O. & Rowley, J. D. Leukaemogenesis: more than mutant genes. *Nature Rev. Cancer* **10**, 23–36 (2010)



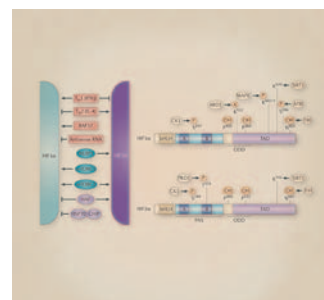
JUNE

HYPOXIA

Adapted from Keith, B., Johnson, R. S. & Simon, M. C. HIF1 α and HIF2 α : sibling rivalry in hypoxic tumour growth and progression. *Nature Rev. Cancer* **12**, 9–22 (2012)

FURTHER READING

- Wilson, W. R. & Hay, M. P. Targeting hypoxia in cancer therapy. *Nature Rev. Cancer* **11**, 393–410 (2011)
- Kaelin, W. G. Jr. The von Hippel–Lindau tumour suppressor protein: O₂ sensing and cancer. *Nature Rev. Cancer* **8**, 865–873 (2008)
- Bristow, R. G. & Hill, R. P. Hypoxia, DNA repair and genetic instability. *Nature Rev. Cancer* **8**, 180–192 (2008)
- Web Focus on Hypoxia and metabolism. www.nature.com/nrc/focus/hypoxia-metabolism (Nov 2009)



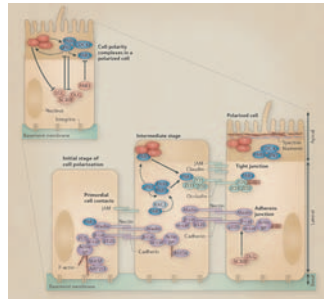
JULY

CELL POLARITY

Adapted from Martin-Belmonte, F. & Perez-Moreno, M. Epithelial cell polarity, stem cells and cancer. *Nature Rev. Cancer* **12**, 23–38 (2012)

FURTHER READING

- Banks, L., Pim, D. & Thomas, M. Human tumour viruses and the deregulation of cell polarity in cancer. *Nature Rev. Cancer* **12**, 877–886 (2012)
- Brabletz, T. To differentiate or not — routes towards metastasis. *Nature Rev. Cancer* **12**, 425–436 (2012)
- Polyak, K. & Weinberg, R. A. Transitions between epithelial and mesenchymal states: acquisition of malignant and stem cell traits. *Nature Rev. Cancer* **9**, 265–273 (2009)



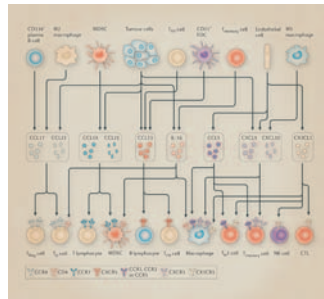
SEPTEMBER

IMMUNOLOGY

Adapted from Fridman, W. H., Pagès, F., Sautès-Fridman, C. & Galon, J. The immune contexture in human tumours: impact on clinical outcome. *Nature Rev. Cancer* **12**, 298–306 (2012)

FURTHER READING

- Focus on Tumour immunology and immunotherapy. *Nature Rev. Cancer* (Apr 2012)
- Gattinoni, L., Klebanoff, C. A. & Restifo, N. P. Paths to stemness: building the ultimate antitumour T cell. *Nature Rev. Cancer* **12**, 671–684 (2012)
- Sharma, P., Wagner, K., Wolchok, J. D. & Allison, J. P. Novel cancer immunotherapy agents with survival benefit: recent successes and next steps. *Nature Rev. Cancer* **11**, 805–812 (2011)



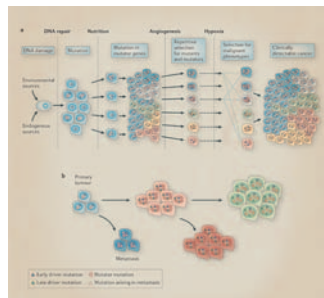
NOVEMBER

TUMORIGENESIS

Adapted from Loeb, L. A. Human cancers express mutator phenotypes: origin, consequences and targeting. *Nature Rev. Cancer* **11**, 450–457 (2011)

FURTHER READING

- Vogt, P. K. Retroviral oncogenes: a historical primer. *Nature Rev. Cancer* **12**, 639–648 (2012)
- Marine, J.-C. Spotlight on the role of COP1 in tumorigenesis. *Nature Rev. Cancer* **12**, 455–464 (2012)
- Nguyen, L. V., Vanner, R., Dirks, P. & Eaves, C. J. Cancer stem cells: an evolving concept. *Nature Rev. Cancer* **12**, 133–143 (2012)
- Focus on p53 — 30 years on. *Nature Rev. Cancer* (Oct 2009)



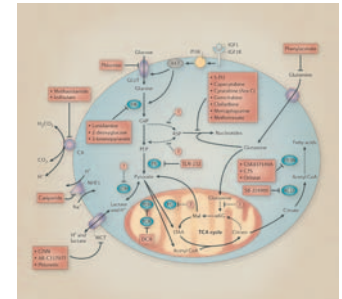
AUGUST

METABOLISM

Adapted from Tennant, D. A., Durán, R. V. & Gottlieb, E. Targeting metabolic transformation for cancer therapy. *Nature Rev. Cancer* **10**, 267–277 (2010)

FURTHER READING

- Chiarugi, A., Dölle, C., Felici, R. & Ziegler, M. The NAD metabolome — a key determinant of cancer cell biology. *Nature Rev. Cancer* **12**, 741–752 (2012)
- Pollak, M. The insulin and insulin-like growth factor receptor family in neoplasia: an update. *Nature Rev. Cancer* **12**, 159–169 (2012)
- Koppenol, W. H., Bounds, P. L. & Dang, C. V. Otto Warburg's contributions to current concepts of cancer metabolism. *Nature Rev. Cancer* **11**, 325–337 (2011)



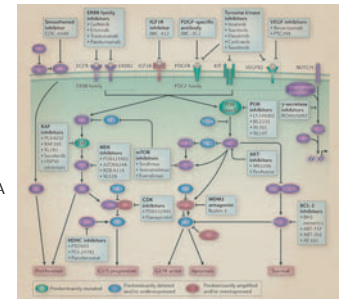
OCTOBER

THERAPEUTICS

Adapted from Taylor, B. S., Barretina, J., Maki, R. G., Antonescu, C. R., Singer, S. & Ladanyi, M. Advances in sarcoma genomics and new therapeutic targets. *Nature Rev. Cancer* **11**, 541–557 (2011)

FURTHER READING

- Sennino, B. & McDonald, D. M. Controlling escape from angiogenesis inhibitors. *Nature Rev. Cancer* **12**, 699–709 (2012)
- Bouwman, P. & Jonkers, J. The effects of deregulated DNA damage signalling on cancer chemotherapy response and resistance. *Nature Rev. Cancer* **12**, 587–598 (2012)
- Yap, T. A., Sandhu, S. K., Workman, P. & de Bono, J. S. Envisioning the future of early anticancer drug development. *Nature Rev. Cancer* **10**, 514–523 (2010)



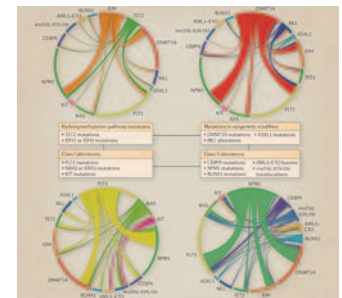
DECEMBER

GENOMICS

Adapted from Shih, A. H., Abdel-Wahab, O., Patel, J. P. & Levine, R. L. The role of mutations in epigenetic regulators in myeloid malignancies. *Nature Rev. Cancer* **12**, 599–612 (2012)

FURTHER READING

- Santarius, T., Shipley, J., Brewer, D., Stratton, M. R. & Cooper, C. S. A census of amplified and overexpressed human cancer genes. *Nature Rev. Cancer* **10**, 59–64 (2010)
- Lange, S. S., Takata, K. & Wood, R. D. DNA polymerases and cancer. *Nature Rev. Cancer* **11**, 96–110 (2011)
- Fletcher, O. & Houlston, R. S. Architecture of inherited susceptibility to common cancer. *Nature Rev. Cancer* **10**, 353–361 (2010)



CALENDAR OF EVENTS

2013

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
JANUARY			1	2	3	4	5
	6	7	8	9	10	11	12
	13	14	15	16	17	18	19
	20 Keystone: Noncoding RNAs in development & cancer, Vancouver, Canada				24	25	26
	27 Keystone: Cancer immunology & immunotherapy, Vancouver, Canada				31		
FEBRUARY						1	2
	3	4	5	6	7	8	9
	10	11	12	13	14 25 th Anniversary Lorne cancer conference, Victoria, Australia		
	17	18	19	20	21 Ninth AACR-JCA Joint Conference, Hawaii, USA		
	24		25	26 Keystone: Tumor metabolism, Colorado, USA			
MARCH						1	2
	3	4	5	6	7	8	9
	10	11	12	13	14	15	16
	17	18	19	20 Keystone: Epigenetic marks & cancer drugs, New Mexico, USA			
	24		25	26	27	28	29
APRIL		1	2	3	4	5	6 AACR Annual
	7 Meeting, District of Columbia, USA	9	10	11	12	13	
	14	15	16	17	18	19	20
	21 GRC: Cancer genetics & epigenetics, Lucca, Italy		24	25	26	27	
	28	29	30				
MAY				1	2	3	4
	5	6	7	8	9	10	11
	12	13	14	15	16	17 AACR: Synthetic lethality & cancer,	
	19 Washington, USA		21 Keystone: The Hippo tumor suppressor network, California, USA			25	
	26	27	28	29	30	31	
JUNE							1
	2	3	4	5	6	7	8
	9	10	11	12	13	14	15
	16	17	18	19	20 25 th Pezcoller Symposium: Metabolism & tumorigenesis,		
	23 Trento, Italy	24 GRC: Cell growth & proliferation, Vermont, USA		27	28	29	
30							

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
JULY		1	2	3	4	5	6	
	7	Beatson Institute: Targeting the tumour stroma, Glasgow, UK				11	12	13
	14	GRC: Cancer nanotechnology, Vermont, USA			17	18	19	20
	21	22	23	24	25	26	27	
	28	GRC: Hormone-dependent cancers, Rhode Island, USA				31		
AUGUST					1	2	3	
	4	5	6	7	Salk Institute: Models and mechanisms of cancer, California, USA			
	11	12	13	14	15	16	17	
	18	19	20	21	22	23	24	
	25	26	27	28	29	30	31	
SEPTEMBER	1	CSH Asia: Cell signaling in metabolism, inflammation & cancer, Suzhou, China				6	7	
	8	9	10	11	12	13	14	
	15	16	17	18 AACR: Advances in ovarian cancer research: from concept to clinic, Florida, USA				
	22	23	24	25	26	27	28	
	29	30						
OCTOBER			1	2	3 AACR: Advances in breast cancer research, California, USA			
	6	7	8	9	10	11	12	
	13	14	15	16	17	18	19 AACR-NCI-	
	20	EORTC: Molecular targets & cancer therapeutics, Massachusetts, USA				24	25	26
27	Nature – CNIO: Frontiers in tumour heterogeneity & plasticity, Madrid, Spain				31			
NOVEMBER						1	2	
	3	4	5 AACR: The translational impact of model organisms in cancer, California, USA				9	
	10	11	12	13	14	15	16	
	17	18	19	20	21	22	23	
	24	25	26	27	28	29	30	
DECEMBER	1	2	3	4	5	6	7	
	8	9	10 CTRC-AACR San Antonio breast cancer symposium, Texas, USA				14	
	15	16	17	18	19	20	21	
	22	23	24	25	26	27	28	
	29	30	31					



nature publishing group

4 Crinan Street,
London, N1 9XW
www.nature.com/nrc