BREAKING ADVANCES

5647 Highlights from Recent Cancer Literature

REVIEWS

5649 The Kynurenine Pathway in Brain Tumor Pathogenesis
Seray Adams, Nady Braidy, Alban Bessesde, Bruce J. Brew, Ross Grant, Charlie Teo, and Gilles J. Guillemin

5658 FoxM1 and Wnt/β-Catenin Signaling in Glioma Stem Cells
Aihua Gong and Suyun Huang

5663 Realizing the Clinical Potential of Cancer Nanotechnology by Minimizing Toxicologic and Targeted Delivery Concerns
Sanjay Singh Arati Sharma, and Gavin P. Robertson

PRIORITY REPORT

5669 Cytomegalovirus Infection Leads to Pleomorphic Rhabdomyosarcomas in Trp53+/−/− Mice

PRécis: Findings offer perhaps the first causative evidence that cytomegalovirus infections may contribute to the development of certain human cancers, where p53 mutation occurs frequently.

INTEGRATED SYSTEMS AND TECHNOLOGIES

5702 SIRT1 Pathway Dysregulation in the Smoke-Exposed Airway Epithelium and Lung Tumor Tissue
Jennifer Beane, Luis Cheng, Raffaella Soldi, Xiaohui Zhang, Guang Liu, Christina Anderlind, Marc E. Lemburg, Avrum Spira, and Andrea H. Bild

PRécis: Gene expression analysis in airway epithelium exposed to cigarette smoke reveals dysregulation of SIRT1, which is also implicated as a tumor suppressor gene in lung cancer.

5712 Metabolic Associations of Reduced Proliferation and Oxidative Stress in Advanced Breast Cancer
Livnat Jerby, Lior Wolf, Carsten Denkert, Gideon Y. Stein, Mika Hilvo, Matej Oresic, Tamar Geiger, and Eytan Ruppin

PRécis: This study presents the first genome-scale study of the metabolism of breast cancer, providing new system-level insights into the metabolic progression of different subsets of this disease.

CLINICAL STUDIES

5675Clinicopathological Features of Homologous Recombination-Deficient Epithelial Ovarian Cancers: Sensitivity to PARP Inhibitors, Platinum, and Survival

PRécis: Defects in DNA repair mediated by the homologous recombination machinery define a subset of ovarian cancers that are sensitive to PARP inhibitors and that have favorable survival outcomes when cotreated with platinum chemotherapy.
### MICROENVIRONMENT AND IMMUNOLOGY

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<td>5721</td>
<td>NLRP3 Suppresses NK Cell–Mediated Responses to Carcinogen-Induced Tumors and Metastases</td>
<td>Melvyn T. Chow, Jaclyn Sceney, Christophe Paget, Christina S.F. Wong, Helene Duret, Jurgen Tschopp, Andreas Möller, and Mark J. Smyth</td>
<td><em>Precis</em>: Findings reveal a proinflammatory pathway that suppresses cancer-controlling NK cells along with a class of suppressor myeloid cells that actually promotes the anticancer activity of NK cells.</td>
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<td>5733</td>
<td>Endoneurial Macrophages Induce Perineural Invasion of Pancreatic Cancer Cells by Secretion of GDNF and Activation of RET Tyrosine Kinase Receptor</td>
<td>Oren Cavel, Olga Shomron, Ayelet Shabtay, Joseph Vital, Leonor Trejo-Leider, Noam Weizman, Yakov Krelin, Yuman Fong, Richard J. Wong, Morcan Amit, and Ziv Gil</td>
<td><em>Precis</em>: A paracrine response between pancreatic adenocarcinoma cells and macrophages that rove nerve tracks appears to orchestrate nerve invasion by localized tumors, a type of invasion that occurs in various types of encapsulated glandular tumors.</td>
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<td>5757</td>
<td>Galectin-3 Contributes to Melanoma Growth and Metastasis via Regulation of NFAT1 and Autotaxin</td>
<td>Russell R. Braeuer, Maya Zigaret, Takafumi Kamiya, Andrey S. Dobroff, Li Huang, Woonyoung Choi, David J. McConkey, Einav Shoshan, Aaron K. Mobley, Renduo Song, Avraham Raz, and Menashe Bar-Eli</td>
<td><em>Precis</em>: This study elucidates a new mechanism by which galectin-3 contributes to tumor growth and metastasis by regulating the expression of protumorigenic genes, such as autotaxin.</td>
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### MOLECULAR AND CELLULAR PATHOBIOLOGY

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<td>5767</td>
<td>Differential Effects of Polymorphic Alleles of FGFR4 on Colon Cancer Growth and Metastasis</td>
<td>Christine Heinzel, Andrea Gsur, Monika Hunjadi, Zeynep Erdem, Christine Gaughgher, Stefan Stattner, Josef Karner, Martin Klimplinger, Friedrich Wiba, Andrea Reti, Balazs Hagedus, Andreas Baierl, Bettina Grasl-Kraupp, Klaus Holzmann, Michael Grusch, Walter Berger, and Brigitte Marian</td>
<td><em>Precis</em>: A systematic comparison of 2 common polymorphic forms of FGFR4 reveals a higher risk of developing aggressive colorectal cancer for carriers of the FGFR4&lt;sup&gt;arg&lt;/sup&gt; allele, potentially offering a simple prognostic marker in this setting.</td>
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<td>5778</td>
<td>Prohibitin Attenuates Colitis-Associated Tumorigenesis in Mice by Modulating p53 and STAT3 Apoptotic Responses</td>
<td>Arwa S. Kathiria, William L. Neumann, Jennifer Rhees, Erin Hotchkiss, Yulan Cheng, Robert M. Genta, Stephen J. Meltzer, Rhonda F. Souza, and Arianne L. Theiss</td>
<td><em>Precis</em>: Reduced levels of a mitochondrial protein during chronic intestinal inflammation may be an underlying factor promoting colitis-associated cancer by acting to modulate epithelial cell apoptosis.</td>
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<td>Aryl Hydrocarbon Receptor-Induced Adrenomedullin Mediates Cigarette Smoke Carcinogenicity in Humans and Mice</td>
<td>Sergio Portal-Nuñez, Uma T. Shankavaram, Mahadev Rao, Nicole Datrice, Scott Atay, Marta Aparicio, Kevin A. Camphausen, Pedro M. Fernandez-Salgueiro, Han Chang, Pinpin Lin, David S. Schrump, Stavros Garantziotis, Frank Cuttitta, and Enrique Zudaire</td>
<td><em>Precis</em>: Findings suggest that lung cancers arising in smokers may be susceptible to treatment with therapeutics that target a proinflammatory oncogenic pathway known to mediate tumor-immune cell crosstalk, angiogenesis, and metastasis.</td>
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<td>5801</td>
<td>Neuropilin-1–Dependent Regulation of EGF-Receptor Signaling</td>
<td>Sabrina Rizzolio, Noa Babinowicz, Elena Rainero, Letizia Lanzetti, Guido Serini, Jim Norman, Gera Neufeld, and Luca Tamagnone</td>
<td><em>Precis</em>: Findings reveal a new mechanism for controlling EGF signaling in cancer cells through clustering and endocytosis of the receptor Neuropilin-1, which highlights its identification as a rational therapeutic target for cancer treatment.</td>
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An Integrated Genomic Screen Identifies LDHB as an Essential Gene for Triple-Negative Breast Cancer
Mark L. McClendon, Adam S. Adler, Yonglei Shang, Thomas Hunsaker, Tom Truong, David Peterson, Eric Torres, Li Li, Benjamin Haley, Jean-Philippe Stephan, Marcia Belvin, Georgia Hatzivassiliou, Elizabeth M. Blackwood, Laura Corson, Marie Evanglista, Jingping Zha, and Ron Firestein

Precise: While the glycolytic regulator lactate dehydrogenase has been studied previously in breast cancer, this study offers an incisive advance by defining a crucial specific role for a particular isoform of this enzyme in a breast cancer subtype with few therapeutic options.

Cancer Cells Cue the p53 Response of Cancer-Associated Fibroblasts to Cisplatin
Jens G. Schmid, Meng Dong, Silke Haubebiss, Godsebad Friedel, Sabine Boden, Andreas Grabner, German Ott, Thomas E. Murdtler, Moshe Oren, Walter E. Aulitzky, and Heiko van der Kuip

Precise: Within the tumor microenvironment, the p53 response of cancer cell determines the p53 response within adjacent cancer-associated fibroblasts, illustrative of the master-slave relationship that cancer cells enforce on their neighboring cells.

Lymphatic Reprogramming by Kaposi Sarcoma Herpes Virus Promotes the Oncogenic Activity of the Virus-Encoded G-protein–Coupled Receptor
Berence Aguilar, Inho Choi, Dongwon Choi, Hee Kyoung Chung, Sunju Lee, Jaebyuk Yoo, Yong Suk Lee, Yong Sun Maeng, Ha Neul Lee, Eunkyung Park, Kyu Eui Kim, Nam Yoon Kim, Jae Myung Baik, Jae U. Jung, Chester J. Koh, and Young-Kwon Hong

Precise: Findings resolve long-standing questions about the pathological impact of the ability of the Kaposi's sarcoma herpes virus to reprogram the tumor microenvironment, explaining why this process favors formation of Kaposi's sarcomas, which are the most common forms of cancer in HIV patients.

FGFR3 Stimulates Steroyl CoA Desaturase 1 Activity to Promote Bladder Tumor Growth
Xiangnan Du, Qian-Rena Wang, Emily Chan, Mark Merchant, Jinfeng Liu, Dorothy French, Avi Ashkenazi, and Jing Qin

Precise: Findings reveal a previously unrecognized role for the FGF receptor FGFR3 in regulating lipid metabolism to maintain tumor growth and survival.

Basal but not Luminal Mammary Epithelial Cells Require PI3K/mTOR Signaling for Ras-Driven Overgrowth
Kristin A. Plichta, Jessica L. Mathers, Shelley A. Gestl, Adam B. Glick, and Edward J. Gunther

Precise: Oncogenic Ras uses distinct effector pathways to drive dysregulated proliferation of the cells derived from different layers of a stratified epithelium.

DDX31 Regulates the p53-HDM2 Pathway and rRNA Gene Transcription through Its Interaction with NPM1 in Renal Cell Carcinomas
Tomoyo Fukawa, Masaya Ono, Taisuke Matsuo, Hisanori Uehara, Tsuneharu Miki, Yusuke Nakamura, Hiro-omi Kanayama, and Toyomasa Katagiri

Precise: Findings offer potentially seminal insights into the origins of renal cell cancer, addressing long standing questions about how sporadic forms of this cancer develop.

The Metabolomic Signature of Malignant Glioma Reflects Accelerated Anabolic Metabolism
Prakash Chinnaiyan, Elizabeth Kensicki, Gregory Bloom, Antony Prabhu, Bhaswati Sarcar, Soumen Kahali, Steven Eschrich, Xiaotao Qu, Peter Forsyth, and Robert Gillies

Precise: Global metabolomic analysis identifies key features underlying the aggressive phenotype of malignant glioma, providing novel strategies for therapeutic intervention.

Identification of FoxM1/Bub1b Signaling Pathway as a Required Component for Growth and Survival of Rhabdomyosarcoma
Xiaolin Wan, Choh Yeung, Su Young Kim, Joseph G. Dolan, Vu N. Ngo, Sandra Burkett, Javed Khan, Louis M. Staudt, and Lee J. Helman

Precise: Dysregulation of a mitotic checkpoint signaling pathway has a critical role in the growth of pediatric tumors, defining direct interactions between the oncogenic transcription factor, FoxM1, and the key mitotic checkpoint protein, Bub1b.

Inactivation of the Dlc1 Gene Cooperates with Downregulation of p15Ink4b and p16Ink4a*, Leading to Neoplastic Transformation and Poor Prognosis in Human Cancer
Xiaolan Qian, Marian E. Durkin, Dunrui Wang, Brajendra K. Tripathi, Lyra Olson, Xu-Yu Yang, William C. Vass, Nicholas C. Popescu, and Douglas R. Lowy

Precise: Diminished expression of a RhoGAP tumor suppressor along with the Cdk inhibitors p15 and p16 drives cell transformation in mouse cells and confers poor prognosis in clinical cases of lung and colon cancer.
Hedgehog Signaling Blockade Delays Hepatocarcinogenesis Induced by Hepatitis B Virus X Protein
Alla Arzumanyan, Vaishnavi Sambandam, Marcia M. Clayton, Steve S. Choi, Guanhua Xie, Anna Mae Diehl, Dae-Yeul Yu, and Mark A. Feitelson

**Précis:** Hedgehog signaling is emerging as a major driver in the development and progression of liver cancer.

**THERAPEUTICS, TARGETS, AND CHEMICAL BIOLOGY**

Temporal Molecular and Biological Assessment of an Erlotinib-Resistant Lung Adenocarcinoma Model Reveals Markers of Tumor Progression and Treatment Response
Zoe Weaver, Simone Dilflippantonio, Julian Carretero, Philip L. Martin, Rajaa El Meskini, Anthony J. Iacovelli, Michelle Gumprecht, Alan Kulaga, Theresa Guerin, Jerome Scholmer, Maureen Baran, Serguei Kozlov, Thomas McCann, Salvador Mena, Fatima Al-Shahrour, Danny Alexander, Kwok-Kin Wong, and Terry Van Dyke

**Précis:** This study illustrates the importance of longitudinal therapeutic studies in preclinical assessment of drug principles by offering in vivo evidence that tyrosine kinase inhibitors can exert a strong, unexpected impact on specific metabolic controls.

Genetic Screening for Synthetic Lethal Partners of Polynucleotide Kinase/Phosphatase: Potential for Targeting SHP-1-Depleted Cancers
Todd R. Mereniuk, Robert A. Maranchuk, Anja Schindler, Jonathan Penner-Chea, Gary K. Freschauf, Samar Hegazy, Raymond Lai, Edan Foley, and Michael Weinfeld

**Précis:** This paper elucidates a synthetic lethal combination of target inactivation events that can increase levels of DNA damage that escape repair, suggesting an effective killing paradigm to exploit therapeutically.

Cisplatin Sensitivity Mediated by WEE1 and CHK1 Is Mediated by miR-155 and the miR-15 Family
Lynn M. Pouliot, Yu-Chi Chen, Jennifer Bai, Rajarshi Guha, Scott E. Martin, Michael M. Gottesman, and Matthew D. Hall

**Précis:** Defeating acquired resistance to platin drugs remains a major goal in the oncology clinic, given the large and diverse number of cancers that use these chemotherapeutic agents in treatment.

Brachytherapy Using Injectable Seeds That Are Self-Assembled from Genetically Encoded Polypeptides In Situ
Wenge Liu, Jonathan McDaniel, Xinghai Li, Daisuke Asai, Felipe Garcia Quiroz, Jeffery Schaal, Ji Sun Park, Michael Zalutsky, and Ashutosh Chilkoti

**Précis:** A novel injectable modality that can self-assemble a polypeptide-based radionuclide seed at tumor sites could radically improve treatment of prostate cancers that are presently treated by brachytherapy, an invasive radiotherapeutic procedure.

p21-Activated Kinase 1 Is Required for Efficient Tumor Formation and Progression in a Ras-Mediated Skin Cancer Model
Hoi Yee Chow, Adrian M. Jubb, Jennifer N. Koch, Zahara M. Jaffer, Dina Stepanova, David A. Campbell, Sergio G. Duron, Marie O’Farrell, Kathy Q. Cai, Andres J.P. Klein-Szanto, J. Silvio Gutkind, Klaus P. Hoeflich, and Jonathan Chernoff

**Précis:** Findings offer preclinical proof-of-concept for a functionally pleiotropic kinase as a therapeutic target in KRAS-driven tumors, illustrating a key mechanism for its action through signaling by Erk but not Akt.

The V-ATPase-Inhibitor Archazolid Abrogates Tumor Metastasis via Inhibition of Endocytic Activation of the Rho-GTPase Rac1
Romina M. Wiedmann, Karin V. Schwarzenberg, Andrea Palamidessi, Laura Schreiner, Rebekka Kubisch, Johanna Liebl, Christina Schempp, Dirk Trauner, Gyorgy Vereb, Stefan Zahler, Ernst Wagner, Rolf Müller, Giorgio Scita, and Angelika M. Vollmar

**Précis:** Findings reveal insights into how a vacular proton pump drives tumor dissemination and metastasis, with implications for how to apply therapeutics that can target this pump.

OTX2 Represses Myogenic and Neuronal Differentiation in Medulloblastoma Cells
Ren-Yuan Bai, Verena Stadelke, Hart G. Lidov, Charles G. Eberhart, and Gregory J. Riggins

**Précis:** Findings may hold the key to understanding the etiology of medullo-myeloblastoma, a subtype of the common pediatric brain tumor medulloblastoma that is marked by the presence of differentiated muscle cells.
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<td>Rat Mcs1b Is Concordant to the Genome-Wide Association-Identified Breast Cancer Risk Locus at Human 5q11.2 and MIER3 Is a Candidate Cancer Susceptibility Gene</td>
<td>Aaron D. denDekker, Xin Xu, M. Derek Vaughn, Aaron H. Puckett, Louis L. Gardner, Courtney J. Lambring, Lucas Deschenes, and David J. Samuelson</td>
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<td>A Synthetic Matrix with Independently Tunable Biochemistry and Mechanical Properties to Study Epithelial Morphogenesis and EMT in a Lung Adenocarcinoma Model</td>
<td>Bartley J. Gill, Don L. Gibbons, Laila C. Roudsari, Jennifer E. Saik, Zain H. Rizvi, Jonathon D. Roybal, Jonathan M. Kurie, and Jennifer L. West</td>
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<td>6024</td>
<td>Rab25 Is a Tumor Suppressor Gene with Antiangiogenic and Anti-Invasive Activities in Esophageal Squamous Cell Carcinoma</td>
<td>Man Tong, Kwok Wah Chan, Jessie Y.J. Bao, Kai Yau Wong, Jin-Na Chen, Pak Shing Kwan, Kwan Ho Tang, Li Fu, Yan-Ru Qin, Si Lok, Xin-Yuan Guan, and Stephanie Ma</td>
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<td>Loss of SNAIL Regulated miR-128-2 on Chromosome 3p22.3 Targets Multiple Stem Cell Factors to Promote Transformation of Mammary Epithelial Cells</td>
<td>PengXu Qian, Arindam Banerjee, Zheng-Sheng Wu, Xiao Zhang, Hong Wang, Vijay Pandey, Wei-Jie Zhang, Xue-Fei Lv, Sheng Tan, Peter E. Lobie, and Tao Zhu</td>
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<td>Oncostatin M Modulates the Mesenchymal–Epithelial Transition of Lung Adenocarcinoma Cells by a Mesenchymal Stem Cell-Mediated Paracrine Effect</td>
<td>Mong-Lien Wang, Chih-Ming Pan, Shih-Hwa Chiu, Wen-Hsin Chen, Hsiang-Yi Chang, Oscar Kuang-Sheng Lee, Han-Sui Hsu, and Cheng-Wen Wu</td>
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<td>Gliomagenesis Arising from Pten- and Ink4a/Arf-Deficient Neural Progenitor Cells Is Mediated by the p53-Fbxw7/Cdc4 Pathway, Which Controls c-Myc</td>
<td>Hong Sug Kim, Kevin Woolard, Chen Lai, Peter O. Bauer, Dragan Maric, Hua Song, Aiguo Li, Svetlana Kotliarova, Wei Zhang, and Howard A. Fine</td>
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**ABOUT THE COVER**

Perineural invasion of cancer cells is found in most patients with pancreatic adenocarcinoma and is common in other tumors as well. Immunohistochemical analysis of specimens excised from patients with pancreatic cancer showed a significant increase in the number of endoneurial macrophages around nerves invaded by cancer. Using animal models and time-lapse analysis, we noticed that these endoneurial macrophages facilitated cancer cells dissociation from tumors and the formation of cell clusters that migrated in a unidirectional fashion along the nerve toward the ganglion. The study identified a paracrine response between endoneurial macrophages and cancer cells, which orchestrates the formation of nerve invasion. For details, see article by Cavel and colleagues on page 5733.