Overview

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Introduction

The goal of this document is to list all publications and web sites that use the SpectraCube® spectral imager
developed by Applied Spectral Imaging, Ltd. (www.spectral-imaging.com). The primary interest is in a biomedical
research and clinical diagnostic technique called spectral karyotyping (SKY™). The references in this document
were obtained from Medline searches (http://www.ncbi.nlm.nih.gov/entrez), Internet searches (such as patent
searches at www.uspto.gov), as well as personal communications from Dr. Thomas Ried (the co-inventor with ASI
of SKY™), and other SKY™ and spectral imager users.

Applied Spectral Imaging, Inc. can be reached directly at:

Applied Spectral Imaging, Inc.
2035 Corte Del Nogal Ste 105
Carlsbad, CA 92009
Phone 760-929-2840
Fax 760-929-2842
www.spectral-imaging.com

Most SKY™ abstracts can be viewed by searching with Public Medline at (Public Medline search option) for
“spectral karyotyp*” (no quotes), or by author (i.e. “Ried T”, “Malik Z”, “Garini Y”, again, no quotes). Note that
PubMed does not use foreign characters like ö in Schröck, so you should search for Dr. Evelin Schröck with “Schröck E”. A (less complete) reference list is also kept in my Multi-Probe Microscopy application note. That microscopy note includes a lot of microscopy tips as well as an explanation of combinatorial labeling schemes. Please contact me (office 323-669-2548 or by cell phone 323-251-8878) if you would like the Microscopy note (or the current version of this document) sent to you (easiest for me by email to gmcnamara@chla.usc.edu).

There is a section with a list of customer, patent and other web sites that refer to the spectral imaging system. Abstracts such as the A.G.T. and ASHG meeting are listed separately from full articles. I have included medline abstract hyperlinks to make it easier for you to get details on individual papers.

A table of cell lines that have been SKY’d is also included, along with "clinical SKY™” results (see bottom). Please send any new information to the author.

Please remember that for human SKY™, the goal is to improve patient outcome, mostly by finding recurrent translocations that have diagnostic, prognostic, and therapeutic impact, not just come out with a CD-ROM with more chromosome translocations than Mitelman’s (cGAP-cCAP Recurrent Aberration Data) G-band database.

This author is curious as to whether SKY should be included as one of the standard of care tests in mouse cancer biology. That is, will large scale mouse SKY provide new insights into the mechanisms of carcinogenesis and feedback new cancer genes to improve health care in humans.

A SKY Users electronic forum http://www.egroups.com/group/skyusers/ has been established. Send electronic mail to the author/moderator at gmcnamara@earthlink.net if you wish to subscribe. Check messages, the file vault, calendar of SKY events, and databases.

The groups that have done many SKY cases include:

**Major SKY Users**

<table>
<thead>
<tr>
<th>Group</th>
<th># Cases</th>
<th>Case type</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ried/Schröck</td>
<td>188</td>
<td>Non hematological cases</td>
<td>E. Schröck, pers. comm. 4/21/2000 and see Schröck and Padilla-Nash (2000). These include cell lines, solid tumors, pre-natal, and post-natal, may (or may not) include the mouse SKY™ total.</td>
</tr>
<tr>
<td>Kent Opheim</td>
<td>&gt;200</td>
<td>Mostly pediatric cancers</td>
<td>Seattle Childrens Hospital and Regional Medical Center. Special mention to Dr. Opheim’s SKY geneticist, Kristi Wolfe.</td>
</tr>
<tr>
<td>Ching Lau / Chuck Harris</td>
<td>&gt;100</td>
<td>Various case types</td>
<td>Texas Childrens Hospital, Houston.</td>
</tr>
<tr>
<td>Arturo Anguiano / Mira Sukova</td>
<td>?</td>
<td>Abstract with 50 cases.</td>
<td>Quest Diagnostics, San Juan Capistrano (you’ll have to check with Quest for number of cases).</td>
</tr>
<tr>
<td>Irit Bar-Am (ASI, Ltd.)</td>
<td>? (&gt;50)</td>
<td>Every possible type. See Clinical SKY in Israel tables.</td>
<td>ASI Ltd’s molecular cytogeneticist. In charge of SKY reagent QC and also has collaborations with clinical groups in Israel.</td>
</tr>
<tr>
<td>Cathy Janish / Margaret Skokan</td>
<td>? (&gt;50)</td>
<td>Every possible type</td>
<td>Cathy Janish and Margaret Skokan are the former and current, respectively.</td>
</tr>
</tbody>
</table>
SKYgeneticists at ASI Inc. They have been running SKY workshops since 1996 and have trained over 100 SKY users. (Note: Cathy Bernier now works for Applied Precision, Inc., www.api.com).

Michael Koehler (ASI, Germany)  
Every possible type  
Michael Koehler is the ASI GmbH representative for Europe. He has done training and demo’s for many SKY users in Europe (honorable mention to Amir Gil, Nir Katzir, Jacob Kaufmann, Yuval Garini, and Irit Bar-Am for their help in European training and demo’s).

Janet Rowley (U. Chicago)  
>40  
Hematological malignancies  
Note that many Rowley cases were done in collaboration with the Ried / Schröck.

Jeremy Squire / Jane Bayani (Ontario Cancer Institute and U. Toronto)  
Various case types and cell lines.  
Ontario Cancer Institute, Toronto.

Drazen Zimonjic (NCI)  
Various cancer cases and mouse tumor cell lines  
Coauthor with Macville, Ried, Schröck, et al., on HeLa molecular karyotype. Now has a SKY system of his own at NCI.

Ilan Kirsch (NCI)  
Various cell lines  
NCI working with Thomas Ried, Meena Augustus and Karl Sirotkin on Molecular Cytogenetics database.

Paul Edwards (Cambridge, England)  
15 breast carcinoma cell lines + __ prostate cell lines  
Breast carcinoma cell lines, 21 primary invasive breast tumor specimens, prostate carcinoma cell lines. 24 short term bladder carcinomas (Fadl-Elmula et al 2001).

Kytölä, Isola, Larsson et al (Lund, Sweden; Karolinska, Sweden; Tampere, Finland)  
Breast, prostate, bladder cell lines and cases.  
Breast carcinoma cell lines, 21 primary invasive breast tumor specimens, prostate carcinoma cell lines. 24 short term bladder carcinomas (Fadl-Elmula et al 2001).

Note: Confirmed number or estimates by this author, as of April, 2000. Dr. Evelin Schröck has her own SKY lab in Jena, Germany, and is independent of Dr. Ried’s group at the National Cancer Institute. Quality and choice of specimens to spend the time and money on count for as much as the raw number of specimens put through a pipeline.

Please see the reviews by Knutsen and Ried (2000) and Schröck and Padilla-Nash (2000) for details.

For an online database of recurrent chromosome aberrations in cancer, please see:

http://cgap.nci.nih.gov/Chromosomes/RecurrentAberrations
Recurrent Aberrations
Spectral Karyotyping (SKY™) and Spectral Imaging with the SpectraCube®

101 SKY Papers...and counting

August 25, 2000 marked the simultaneous publications of the 100th and 101st SKY papers (Pang et al 2000 and Wan et al 2000) published in the primary biomedical literature (the first two sections below). This is 4 years and one month since the first SKY publication (Schröck et al 1996) and less than five years after the invention of SKY in December 1995. This total includes both human (section 1) and mouse (section 2) primary research publications, while excluding spectral FISH (SFISH), pathology (SPY) primary publications and reviews.

February 6, 2001, marked the publication of the 101st human SKY paper.

Spectral Karyotyping, spectral imaging and MFISH Publications and Web Papers by Year

<table>
<thead>
<tr>
<th>Year</th>
<th>Human SKY™</th>
<th>Mouse SKY™</th>
<th>SFISH, SPY, Other</th>
<th>Review (S &amp; M)</th>
<th>Spectral Total</th>
<th>MFISH</th>
<th>hSKY + MFISH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1997</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>17</td>
<td>30</td>
<td>2</td>
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<tr>
<td>1998</td>
<td>9</td>
<td>2</td>
<td></td>
<td></td>
<td>15</td>
<td>35</td>
<td>1</td>
</tr>
<tr>
<td>1999</td>
<td>5</td>
<td>4</td>
<td></td>
<td></td>
<td>10</td>
<td>58</td>
<td>12</td>
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<td>2000</td>
<td>9</td>
<td>7</td>
<td>9</td>
<td>11</td>
<td>76</td>
<td>32</td>
<td>8</td>
</tr>
<tr>
<td>2001</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
<td>2</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>123</td>
<td>29</td>
<td>43</td>
<td>59</td>
<td>226</td>
<td>48</td>
<td>179</td>
</tr>
</tbody>
</table>


Human Spectral Karyotyping (SKY™)

Abdel-Rahman WM, Katsura K, Rens W, Gorman PA, Sheer D, Bicknell D, Bodmer WF, Arends MJ, Wyllie AH, Edwards PA. (2001) Spectral karyotyping suggests additional subsets of colorectal cancers characterized by pattern of chromosome rearrangement. Proc Natl Acad Sci USA 98: 2538-2543. Abstract | [PNAS Abstract] [Full Text] [Supplemental Figure] [PDF]


N.T. Leach, C. Jackson-Cook (2001) The application of spectral karyotyping (SKY) and fluorescent in situ hybridization (FISH) technology to determine the chromosomal content(s) of micronuclei. *Mutat Res.* 495: 11-19.


analysis of a couple of lines but does not directly show any SKY analyses.”. (See also Sawyer et al 1998; Rao et al 1998).


A. van Bokhoven, M. Varella-Garcia, C. Korch, G.J. Miller (2001) TSU-Pr1 and JCA-1 cells are derivatives of T24 bladder carcinoma cells and are not of prostatic origin. *Cancer Res.* 61: 6340-6304. PMID: 11522622. [SKY on T24, M-FISH on TSU-Pr1 and JCA-1]


Mouse Spectral Karyotyping


Spectral Imaging References


**Comparative SKY™genomics**


See also Schröck et al (1996) above.

**Spectral Fluorescence In Situ Hybridization (Spectral FISH)**


**Spectral Immunofluorescence**

Spectral Morphometry (aka Spectral Pathology (SPY): Spectral imaging in histology, cytology and pathology)


**Spectral Bio-Imaging (non-SKY, non-spectral immunofluorescence, non-spectral morphometry)**


**SKY™ Reviews and Book Chapters**


X. Bosch (2001) From epithelial cell to tumour cell. *Lancet Oncol.* 2: 70. [Text] [PDF]


J.C. Cigudosa, M.J. Calasanz, J.L. Garcia Miranda (1999) [Multicolor spectral karyotyping (SKY) and its application to the cytogenetic diagnosis of multiple myeloma]. *Sangre (Barc)* 44: 301-304. [Article in Spanish] [medline]


D.H. Farkas (1999) DNA Simplified II. The Illustrated Hitchhiker's Guide to DNA. Everything you always wanted to know about DNA (so you could sound really intelligent at cocktail parties, staff meetings, and the like). AACC Press, Washington, D.C. (American Association for Clinical Chemistry). A SKY image is featured on page 12 (chromosome = 'colored body').


C. Lee, D. Gisselsson, C. Jin, A. Nordgren, D.O. Ferguson, E. Blennow, J.A. Fletcher, C.C. Morton (2001) Limitations of chromosome classification by multicolor karyotyping. Am J. Hum. Genet. (April 2001, e-publication Feb 19, 2001) 68: ###. Full Text | PDF (260kb). [9 mis-classifications from 9 cases with an unknown total number of chromosomes and total number of cases. In this author’s opinion, the correct comparison is the cost and accuracy of G-banding vs. SKY/MFISH or total experiment cost of SKY/MFISH vs all 12 two color or 24 single color human or 10.5 or 21, respectively, mouse paints].


**The SpectraCube® Technology**


**Additional ASI Publications**


**Patents**

To look up US patents online, please see:


http://www.patents.ibm.com/ibm.html or by patent number at http://patent.womplex.ibm.com/patquery (IBM). (Note: IBM tracks all patent searches and may use the information in a competitive way).


5,539,517 Method for simultaneously measuring the spectral intensity as a function of wavelength of all the pixels of a two dimensional scene. D. Cabib, Z. Friedman, S.G. Lipson, R.A. Buckwald. Filed February 21, 1995.


Spectral Karyotyping Abstracts

This section lists SKY and spectral imaging abstracts by meeting (order by reverse date). Please email new meeting information for inclusion here to geomcnamara@earthlink.net or gmcnamara@chla.usc.edu.

14th International Chromosome Conference, September 4-8, 2001, Würzburg, Germany http://www.chromosome.net/icc14.html

Third European Cytogenetics Conference


HG01-1226-WMA Spectral Karyotyping (SKY) in Acute Myeloid Leukemia. B. Preiss, G. Kerndrup. Department of Pathology - Chromosome Laboratory, Odense University Hospital: 5000 Odense C, Denmark. Poster Session: Cancer Cytogenetics

HG01-2828-WMA Spectral karyotyping of the human colorectal carcinoma cell lines HT-29 and CX-1. S. Koehler1, H. Luehrs2, T. Menzel2, W. Scheppach3, C. Steinlein1, M. Schmid2, R. Melcher2. 1Institute of human genetics: Wuerzburg, Germany ; 2Department of Medicine: Wuerzburg, Germany. Poster Session: Cancer Cytogenetics


Non-SKY papers of interest:


Third Annual Samuel A. Latt Conference - Genomics and Proteomics in Cancer (ISAC)


(abstracts not yet published).

The Second Euroconference on Quantitative Molecular Cytogenetics

Salamanca, Spain, April 26-28, 2001, organized by Dr. J. Graham, Jim.Graham@man.ac.uk. See http://www.isbe.man.ac.uk/QMC and http://www.isac-net.org/enews/fall00/Euroconference.htm.

(abstracts not yet published. M-FISH meeting).


Acquired, Non-Random Chromosomal Abnormalities Associated with the Development of Acute Promyelocytic Leukemia in Transgenic Mice - Drazen B. Zimonjic, Jessica L. Pollock, Peter Westervelt, Nicolae C. Popescu, Timothy J. Ley, National Cancer Institute, NIH, Bethesda, MD; Washington Univ. Sch. of Medicine, St. Louis, MO. (SKY) Poster Session - 334


Molecular Cytogenetic Characterization of Head and Neck Squamous Cell Carcinoma and Refinement of 3q Amplification - Bhuvanesh Singh, Swarana Gogineni, Peter G. Sacks, Ashok R. Shaha, Jatin P. Shah, Archontoula
Stoffel, Pulivarthi H. Rao, Memorial Sloan-Kettering Cancer Center, New York, NY; Rockefeller University, New York, NY; Baylor College of Medicine, Houston, TX. {SKY} Poster Session – 342


Comprehensive Karyotyping of the Human HT-29 Colon Carcinoma Cell Line - Kanji Kawai, Carrie Viars, Virginia Urquidi, David Tarin, Karen Arden, Steve Goodison, UCSD, La Jolla, CA. {SKY} Poster Session – 354

Multicolor Spectral Karyotypic Analysis of Pediatric Acute Lymphoblastic Leukemia (ALL) - Xin Yan Lu, Charles P. Harris, Linda Cooley, Ching C. Lau, Pulivarthi H. Rao, Baylor College of Medicine, Houston, TX; University of Texas, Houston, TX. Poster Session – 1810

Chromosomal Abnormalities in Bronchial Biopsies of Individuals at Risk for Lung Cancer and in Lung Carcinoma Cell Lines Detected by Spectral Karyotyping - Marileila Varella-Garcia, Lin Chen, Roger Powell, Lawrence Hunter, David P. Carbone, Adi F. Gazdar, Wilbur A. Franklin, University of Colorado Cancer Center, Denver, CO; Vanderbilt-Ingram Cancer Center, Nashville, TN; University of Texas Southwestern Medical Center, Dallas, TX. Poster Session – 1930

Expression of Nuclear Matrix High Mobility Group Protein HMGI(Y) in Human Prostate Cancer Cell Lines is Associated with Increased Chromosome Rearrangements - Natsuki Takaha, William B. Isaacs, Jonathan R. Coffman, Anita L. Hawkins, Constance A. Griffin, Donald Vindivich, Donald S. Coffey, The Johns Hopkins University School of Medicine, Baltimore, MD. Poster Session - 2877

Is Chromosome Instability (CIN) in Osteosarcoma (OS) p53 Dependent or Independent? - Khaldoun I. Al-Romaih, Lada Vorobyova, Jane Bayani, Jana Karaskova, Paul C. Park, Maria Zielenska, Jeremy Squire, University of Toronto, Toronto, Canada. Poster Session – 3897

Tumorigenicity in the Absence of Genomic Instability - William C. Hahn, Drazen Dimonjic, Mary W. Brooks, Nicholas Popescu, Robert A. Weinberg, Dana-Farber Cancer Institute, Boston, MA; National Cancer Institute, Bethesda, MA; Whitehead Institute, Cambridge, MA. Minisymposium - 4445

Identification of a Novel Fusion of ETV6/TEL and NTRK3/TRKC in a Primitive Neuroectodermal Tumor (PNET) - Xiao-Nan Li, Chuck Harris, Xin-Yan Lu, Pulivarthi Rao, Hannes Vogel, Robert Dauser, Douglas Strother, Ching C. Lau, Texas Children's Hospital, Baylor College of Medicine, Houston, TX. Poster Session - 4618

Oncogenomics Conference, Tucson, AZ, Jan 25-27, 2001 (successor to IWCST)

http://www.nhgri.nih.gov/CONF/Oncogenomics/

Speakers include Sky customers Ron DePinho, Janet Rowley and Jeff Trent.


European Workshop on the Cytogenetics and Genetics of Solid Tumours

September 7-10, 2000, Edinburgh, Edinburgh Conference Centre, Web: http://www.icnet.uk/conferences/euro7/

P. Edwards (2000) 1001 translocations: FISH analysis of carcinoma cell lines. schedule


SKY at American Society for Reproductive Medicine Conference 10/2000

 Spectral Imaging References

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SKY and MFISH at ASHG2000 (10/2000)


(http://www.faseb.org/ashg00/assigns00.htm Assignments The Abstract Search and Program Planner is on-line at http://www.faseb.org/cgi-bin/ashg00/ashg00)


Spectral Imaging at ISAC2000

**SKY at the Association for Research on Tumors of the Prostate** (France, 2000?)


**SKY at IW CST2000**

The Eight International Workshop on Chromosomes in Solid Tumors. 1/30-2/1/2000. http://www.nhgri.nih.gov/IWSCST/schedule.html (ask an attendee for the abstract book, talks are #5 etc, posters are a## or b##).

#5 Anna Roschke (2000) Structural and numerical chromosomal instability in human cancer cell lines.


#8 Susanne Gollin (2000) Classical and molecular cytogenetic analysis combined with immunohistochemistry reveals chromosomal instability (CIN) and cytoskeletal defects in oral squamous cell carcinoma (OSCC) cells.


A4 B. Behesti et al (2000) Chromosome aberrations in early stage prostate cancer patients and virus-immortalised cell lines identified by combined CGH, SKY, and allelotyping techniques. (See also similar AACR1999 abstract).


**SKY at ASHG1999**


X. Huang, W.S. Saunders, B. Gharaibeh, M. Shuster, A.H. Enyenihi, S.M. Gollin (1999) Aneuploidy, chromosomal instability, and cytoskeletal defects in oral squamous cell carcinoma (OSCC) cells. Program Nr: 902. Poster Wed 10:30am - 8:00am, Thu 7:00am - 7:30pm. (See also http://www.upci.upmc.edu/internet/cytogen/image10.htm, contact sgollin@helix.hgen.pitt.edu).


**SKY at ASH1999**

American Society of Hematology, 41st ASH annual meeting, Dec. 3-7, 1999, in New Orleans.


[1262] Molecular cytogenetic evaluation of MXR overexpression in drug resistant leukemia cell lines. V. Koneti Rao, Thomas Litman, Jens Eriksen, Tito Fojo, Michael Dean, Torben Skovsgaard.


(“The 8 new partners bands were: 1p36, 4q12, 4q22, 6p21, 6q15, 6q25, 12q24 and 17q12. The aberrations include t(1;12)(p36;p13), t(4;12)(q12;p13), t(4;12)(q22;p13), t(6;12)(p21;p13), t(2;12;6)(p15;p13;q15), t(6;12)(q25;p13), inv(12)(p13q24) and t(2;2;5;12;17)(p25;q23;q31;p13;q12). Our present data plus data from us and others suggest that the TEL gene may be involved in the greatest number of translocations, namely 41 at the present time.”).

Specificity and sensitivity of spectral karyotyping (SKY) for the detection of chromosomal rearrangements in acute lymphoblastic leukemia (ALL). Hatem Elghezal, Isabelle Radford-Weiss, Christine Perot, Jacqueline Van Der Akker, Elisabeth A. Macintyre, Patrice Eydoux, Michel Vekemans, Serge P. Romana.


(Note: Published, apparently with some SKY results [no figures], as Shou et al 2000).

Genomic fusion of c-myc and the IgH gene loci in myeloma cells is frequently detected by double-color fluorescence in situ hybridization. Kazuhiro Nishida, Naozo Nakazawa, Yumiko Akano, Kenichit Nomura, Mitsushige Nakao, Shigeo Horiike, Tsukasa Okuda, Kei Kashima, Masafumi Taniwaki.


The following is an interesting M-FISH style abstract from ASH1999:


SKY at AGT1999

Association of Genetic Technologists 1999 Meeting, Orlando, Florida http://www.agt-info.org


**SKY at 2nd European Cytogenetics Conference 1999**

July 1999, Vienna, Austria (*Cytogenet. Cell Genet* 85(1-2)).


I. Bar-Am et al (1999) The detection of cryptic translocations in high-risk populations for chromosomal abnormalities by spectral karyotyping (SKY). *Cytogenet. Cell Genet* 85(1-2): 35. (3 pre/postnatal cases by SKY were: 46,XY,t(6;21), 46,XY,t(11;18), balanced t(1;5). See also clinical SKY tables below).


G.B. Kerndrup, E. Kjeldsen (1999) Acute leukemia cytogenetics. An evaluation of combined G-band karyotyping with multi-colour spectral karyotyping (SKY). *Cytogenet. Cell Genet* 85(1-2): 75. (28 cases, in 8/15 cases ambiguous structural abnormalities were classified and in 3 of these SKY disclosed cryptic translocations; "Additional or confirmatory information was obtained in 87.5% of analysed cases.").


Y. Pan et al (1999) Investigation of complex karyotypes in prostate cancer cell lines by spectral karyotyping. *Cytogenet. Cell Genet* 85(1-2): 40. ("the LNCaP, PC-3 and DU145 cells had multiple, complex and heterogeneous chromosome alterations. … high level gain of c-myc was detected in the PC-3 cells (as) chromosome 8 translocations (and) some double minutes").


L. Trakhtenbrot et al (1999) SKY detection of 11q23 rearrangements in the case of secondary leukemia with a complex karyotype. *Cytogenet. Cell Genet* 85(1-2): 44. (Secondary MDS-RAEB-T; G-banding identified der(5), del(7q), +8 (trisomy and tetrasomy 8); SKY additionally identified t(12;18), t(13;15), iso(11q), t(11;15)(q13;ql5), resulting in 3 copies of MLL and cyclin D1).


**SKY at AUA 1999**


**SKY at AACR1999**


Beheshhti, B., Beatty, B.G., Bayani, J., Sweet, J., Jewett, M.A.S., Squire, J.A. (1999) #1558 Chromosomal abnormalities associated with aggressive prostate cancer as identified by comparative genomic hybridization and spectral karyotyping. (See also [http://www.utoronto.ca/LabMedPathobiology/faculty/assistant/beatty.htm](http://www.utoronto.ca/LabMedPathobiology/faculty/assistant/beatty.htm)).


Spectral Microscopy at BSC1999

Biological Stain Commission 1999 Annual Meeting June 4-5, 1999 aboard the Hotel Queen Mary, Long Beach, CA.


Spectral Microscopy at GFP2


Spectral Microscopy at SCOBUG1999


SKY and SPY at HCS1998

Histochemical Society meeting, Spectral Imaging: Novel Methods For Quantitative Pathology session, July 26, 1998 at the UCSD campus, La Jolla, CA. The four spectral imaging abstracts can be found on the author’s home page, http://home.earthlink.net/~geomcnamara/ or at http://www.jhc.org


Dirk Soenksen, George McNamara (1998) Spectral Pathology (SPY) and Spectral Karyotyping (SKY).

SKY at ASHG1997

(abstract search: http://www.faseb.org/ashg/cgi-bin/searchashg97).


SKY at IWCST1997


SKY at ESCAP1997

M.V.E. Macville, K.M. Heselmeyer, G.U. Auer, M. van der Linden, E.S. Schröck, T.Ried (1999?) Molecular cytogenetic analysis of cervical carcinomas by comparative genomic hybridization, interphase cyto-genetics and spectral karyotyping. (30 cases by CGH plus cell lines HeLa, C33a, C4-1 [C4-I], CXT1, and SW756).
http://home.online.no/~oliberg/abstr_04.htm#a185
SKY Sites: Internet Pages

This section is intended to provide web addresses of users. There is no special order of the addresses (more or less in order added to list). Published papers have links in the reference section above. Most journals have online editions, accessible to individual subscribers or through institutions. A few have only their table of contents (toc) online.

Journals with frequent SKY™ or SKY-related publications

- Cancer Genetics and Cytogenetics
- Cytogenetics and Cell Genetics
- Genes, Chromosomes and Cancer
- Cancer Genetics and Cytogenetics
- Cancer Genetics and Cytogenetics
- Cytogenetics and Cell Genetics
- Genes, Chromosomes and Cancer

Additional Journals with frequent molecular cytogenetic publications

- American Journal of Human Genetics
- University of Chicago Press
- American Journal of Medical Genetics
- ESCAP (European Society ACP), ACP at IOS Press
- Analytical Cellular Pathology
- American Society of Hematology,
- Blood
- American Association Cancer Research (www.aacr.org)
- Cancer Research
- Cancer Research
- Chromosome Research
- Clinical Genetics
- Munksgaard International Publishers (toc online)
- European Journal of Human Genetics
- Stockton Press
- Genetics In Medicine
- Lippincott Williams & Wilkins.
- Human Genetics
- Haematologica online
- Human Molecular Genetics
- Springer
- International Journal of Cancer
- Oxford University Press
- Journal of Molecular Medicine
- Wiley-Liss
- Leukemia
- Medical and Pediatric Oncology
- Nature
- Wiley Interscience (focus is pediatric and young adult oncology).
- Human Genetics
- Genetics In Medicine
- Proceedings of the National Academy of Science, USA.

See also the list of Genetics journals at http://www.biologia.uniba.it/eca/journals.html

Internet Sites of Interest

<table>
<thead>
<tr>
<th><a href="http://www.spectral-imaging.com">www.spectral-imaging.com</a></th>
<th>Applied Spectral Imaging, Ltd.</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="http://www.spectral-imaging.com">www.spectral-imaging.com</a></td>
<td>Instrumentation, SKY, contacts</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>http://www_egroups.com/group/skyusers</th>
<th>SKY™ Users Electronic User Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>http://www_egroups.com/group/skyusers</td>
<td>(email <a href="mailto:gmcnamara@chla.usc.edu">gmcnamara@chla.usc.edu</a> to be added).</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>See also</td>
<td>Molecular Cytogenetics (CHG and SKY Web) Database. Created by Dr. Karl Sirotkin, NCBI, with the advice of Thomas Ried, Ilan Kirsch and Meena Augustus. (related to cGAP/cCAP).</td>
</tr>
<tr>
<td><a href="http://www.path.cam.ac.uk/~pawefish/">http://www.path.cam.ac.uk/~pawefish/</a></td>
<td></td>
</tr>
<tr>
<td><a href="http://www.riedlab.nci.nih.gov/LabPersonnel/labPersonMain.html">http://www.riedlab.nci.nih.gov/LabPersonnel/labPersonMain.html</a></td>
<td></td>
</tr>
<tr>
<td>URL</td>
<td>Description</td>
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<td>-------------------------------------------------------------------</td>
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<tr>
<td><a href="http://home.earthlink.net/~geomcnamara">http://home.earthlink.net/~geomcnamara</a></td>
<td>George McNamara's home page SKY, SPY, biomedical imaging</td>
</tr>
<tr>
<td><a href="http://www.findarticles.com/">http://www.findarticles.com/</a></td>
<td>FindArticles.com</td>
</tr>
<tr>
<td><a href="http://www.findarticles.com/In">http://www.findarticles.com/In</a> situ hybridization / Diagnostic use, Chromosome abnormalities / Physiological aspects, Mental retardation / Genetic aspects</td>
<td>FindArticles.com</td>
</tr>
<tr>
<td><a href="http://www.faseb.org/genetics/ashg/ashgmenu.htm">http://www.faseb.org/genetics/ashg/ashgmenu.htm</a></td>
<td>American Society of Human Genetics (ASHG)</td>
</tr>
<tr>
<td><a href="http://www.bme.vanderbilt.edu/bmeoptics/optdx.html">http://www.bme.vanderbilt.edu/bmeoptics/optdx.html</a></td>
<td>Vanderbilt Biomedical Engineering Optical Diagnosis</td>
</tr>
<tr>
<td><a href="http://www.ncbi.nlm.nih.gov/disease">http://www.ncbi.nlm.nih.gov/disease</a></td>
<td>Genes and Disease (features SKY image)</td>
</tr>
<tr>
<td><a href="http://www.bioscience.org/news/scientis/chromcol.htm">http://www.bioscience.org/news/scientis/chromcol.htm</a></td>
<td>SKY Painting (science news digest for physicians and scientists)</td>
</tr>
<tr>
<td><a href="http://www.ncbi.nlm.nih.gov/CCAP/about.html">http://www.ncbi.nlm.nih.gov/CCAP/about.html</a></td>
<td>The Cancer Chromosome Aberration Project (cCAP)</td>
</tr>
<tr>
<td><a href="http://www.nhgri.nih.gov/DIR/VIP/Glossary/pub_glossary.cgi">http://www.nhgri.nih.gov/DIR/VIP/Glossary/pub_glossary.cgi</a></td>
<td>NHGRI Glossary of Genetic Terms</td>
</tr>
<tr>
<td>SKY at NHGRI Talking Glossary of Genetic Terms</td>
<td>Spectral Karyotype Glossary Term</td>
</tr>
<tr>
<td><a href="http://www.nhgri.nih.gov/DIR/VIP/Glossary/Illustration/sky.html">http://www.nhgri.nih.gov/DIR/VIP/Glossary/Illustration/sky.html</a></td>
<td>SKY picture at NHGRI</td>
</tr>
<tr>
<td>SKY Fact Sheet</td>
<td>What is SKY? (NHGRI)</td>
</tr>
<tr>
<td><a href="http://www.upci.upmc.edu/Internet/cytogenetics.html">http://www.upci.upmc.edu/Internet/cytogenetics.html</a></td>
<td>U. Pittsburgh Medical Center, Cytogenetics Facility, Susanne M. Gollin, Director. Does SKY and other FISH tests.</td>
</tr>
<tr>
<td>URL</td>
<td>Description</td>
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<tr>
<td>--------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><a href="http://www.upci.upmc.edu/internet/cytogen/image10.htm">http://www.upci.upmc.edu/internet/cytogen/image10.htm</a></td>
<td>U. Cincinnati Environmental Health SKY system (Jonathan Wiest and Marian Miller)</td>
</tr>
<tr>
<td><a href="http://www.upci.upmc.edu/internet/cytogen/image11.htm">http://www.upci.upmc.edu/internet/cytogen/image11.htm</a></td>
<td></td>
</tr>
<tr>
<td><a href="http://www.niehs.nih.gov/centers/fac-core/cin-fac3.htm">http://www.niehs.nih.gov/centers/fac-core/cin-fac3.htm</a></td>
<td>Johannes Wienberg, Ph.D., Principal Investigator, LGD, DBS, NCI, NIH (a.k.a. Dr. Zoo-FISH)</td>
</tr>
<tr>
<td><a href="http://rex.nci.nih.gov/RESEARCH/basic/lgd/pi_pages/wienberg.htm">http://rex.nci.nih.gov/RESEARCH/basic/lgd/pi_pages/wienberg.htm</a></td>
<td>Siegfried Janz, M.D. (mouse plasmacytoma SKY, with Allen Coleman, as a model of multiple myeloma)</td>
</tr>
<tr>
<td><a href="http://rex.nci.nih.gov/RESEARCH/basic/genetics/janz.html">http://rex.nci.nih.gov/RESEARCH/basic/genetics/janz.html</a></td>
<td>Suzanne Kamel-Reid, Department of Medical Biophysics, U. Toronto (co-author of a SKY paper with Jeremy Squire)</td>
</tr>
<tr>
<td>A nice SKY image is at <a href="http://rex.nci.nih.gov/RESEARCH/basic/genetics/sky.gif">http://rex.nci.nih.gov/RESEARCH/basic/genetics/sky.gif</a></td>
<td></td>
</tr>
<tr>
<td><a href="http://medbio.utoronto.ca/faculty/kamel-reid.html">http://medbio.utoronto.ca/faculty/kamel-reid.html</a></td>
<td>“To date very little is known of the genetic factors involved in the etiology and progression of head and neck squamous cell carcinoma (HNSCC). … We are using Spectral Karyotyping, a new technology that is more sensitive than G-banded analysis, and is well-suited for the identification of consistent, clonal, subtle chromosomal aberrations in head and neck tumors.” Note: Susanne Gollin has published on HNSCC SKY.</td>
</tr>
<tr>
<td><a href="http://www.tokyo-med.ac.jp/genet/cai-e.htm">http://www.tokyo-med.ac.jp/genet/cai-e.htm</a></td>
<td>Animations of structural aberrations</td>
</tr>
<tr>
<td><a href="http://www.ich.bpmf.ac.uk/cmggs/fishnd.htm">http://www.ich.bpmf.ac.uk/cmggs/fishnd.htm</a></td>
<td></td>
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<tr>
<td><a href="http://www.infobiogen.fr/services/chromcancer/index.html">http://www.infobiogen.fr/services/chromcancer/index.html</a></td>
<td>Atlas of Genetics and Cytogenetics at Groupe Francais De Cytogenetique Oncologique</td>
</tr>
<tr>
<td><a href="http://www.infobiogen.fr/services/chromcancer/Anomalies/11q23ID1030.html">http://www.infobiogen.fr/services/chromcancer/Anomalies/11q23ID1030.html</a></td>
<td></td>
</tr>
<tr>
<td><a href="http://amba.charite.de/cgh/">http://amba.charite.de/cgh/</a></td>
<td>CGH Online Database at University Hospital Charité, Berlin</td>
</tr>
<tr>
<td><a href="http://condor">http://condor</a> bcm.tmc.edu/ermb/tgdb/tgdb.html or</td>
<td>Tumor Gene Database (560 entries as of 2/2000)</td>
</tr>
<tr>
<td><a href="http://tyrosine.biomedcomp.com/4d.acgiStDoSrchTGDB">http://tyrosine.biomedcomp.com/4d.acgiStDoSrchTGDB</a></td>
<td></td>
</tr>
<tr>
<td><a href="http://www.amedeo.com">http://www.amedeo.com</a></td>
<td>AMEDEO - Medical Literature Guide is a literature search tool.</td>
</tr>
<tr>
<td><a href="http://www.spie.org/incite">http://www.spie.org/incite</a></td>
<td>SPIE Incite Search Page (SPIE is for engineering/physics/spectroscopy nerds).</td>
</tr>
<tr>
<td><a href="http://cancer.gov/bip">http://cancer.gov/bip</a></td>
<td>NCI Biomedical Imaging Program Vision: Imaging sciences are essential to understanding biological systems,</td>
</tr>
</tbody>
</table>
controlling disease, and enhancing health.

<table>
<thead>
<tr>
<th>URL</th>
<th>Description</th>
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<tbody>
<tr>
<td><a href="http://www.aacr.org/4000/4300/4310/4310p/4310p.html">http://www.aacr.org/4000/4300/4310/4310p/4310p.html</a></td>
<td>Mouse Models of Cancer (2000) AACR Conference, at Hyatt Regency Hotel, La Jolla, CA</td>
</tr>
<tr>
<td><a href="http://www.nci.nih.gov/dcb/odhome.htm#MOUSE">http://www.nci.nih.gov/dcb/odhome.htm#MOUSE</a></td>
<td>Mouse models of human cancer consortium, NCI, NIH</td>
</tr>
<tr>
<td><a href="http://jaxmice.jax.org/index.shtml">http://jaxmice.jax.org/index.shtml</a></td>
<td>Jackson Laboratory Jax Mice Web Site</td>
</tr>
<tr>
<td><a href="http://members.aol.com/cdousa/intro.htm">http://members.aol.com/cdousa/intro.htm</a></td>
<td>Chromosome Deletion Outreach, Inc.</td>
</tr>
<tr>
<td><a href="http://members.aol.com/cdousa/disorder.htm">http://members.aol.com/cdousa/disorder.htm</a></td>
<td>By Jeff Shaw, M.S., Genetic Counselor</td>
</tr>
<tr>
<td><a href="http://members.aol.com/cdousa/disorder2.htm">http://members.aol.com/cdousa/disorder2.htm</a></td>
<td>Translocations page</td>
</tr>
<tr>
<td><a href="http://members.aol.com/sorgl/disorder3.htm">http://members.aol.com/sorgl/disorder3.htm</a></td>
<td>Rings and other</td>
</tr>
<tr>
<td><a href="http://www.nsgc.org">http://www.nsgc.org</a></td>
<td>National Society of Genetic Counselors Homepage</td>
</tr>
<tr>
<td><a href="http://www.agr.kuleuven.ac.be/dtp/faj/history/">http://www.agr.kuleuven.ac.be/dtp/faj/history/</a></td>
<td>F.A. Janssens – short biography on the person who discovered crossing over in meiosis (chiasmatype). “Above all, Janssens was known as the &quot;microscopy wizard&quot;.”</td>
</tr>
<tr>
<td><a href="http://info.med.yale.edu/chldstdy/plomdevelop/">http://info.med.yale.edu/chldstdy/plomdevelop/</a></td>
<td>David Ward lab, Yale U.</td>
</tr>
<tr>
<td>See also</td>
<td>CCK is the color changing karyotype (MFISH variant) pages, including protocols. TMFISH is on telomere FISH probes for both human and mouse.</td>
</tr>
<tr>
<td><a href="http://info.med.yale.edu/genetics/ward/tavi/FISH.html">http://info.med.yale.edu/genetics/ward/tavi/FISH.html</a></td>
<td>Mendelian Cytogenetics Network Database (MCNdb) and affiliated sites</td>
</tr>
<tr>
<td><a href="http://info.med.yale.edu/genetics/ward/tavi/CCKprinciple.html">http://info.med.yale.edu/genetics/ward/tavi/CCKprinciple.html</a></td>
<td>Mendelian Cytogenetics Network Databases</td>
</tr>
<tr>
<td><a href="http://info.med.yale.edu/genetics/ward/tavi/TMFISH.html">http://info.med.yale.edu/genetics/ward/tavi/TMFISH.html</a></td>
<td>Mendelian Cytogenetics Network Databases</td>
</tr>
<tr>
<td><a href="http://www.zi.biologie.uni-muenchen.de/institute/ab/cremer/goethe/speicher/recpub.html">http://www.zi.biologie.uni-muenchen.de/institute/ab/cremer/goethe/speicher/recpub.html</a></td>
<td>Mendelian Cytogenetics Network Databases</td>
</tr>
</tbody>
</table>
**The Dysmorphic Human-Mouse Homology Database (DHMHD)** phenotypic features in human dysmorphic syndromes, mouse syndromes and human cytogenetic aberrations...

**Human Cytogenetics Forum**

**Cytogenetic Anomalies of the Mouse** Search for locations and phenotypes of all currently available murine cytologically visible deletions, duplications, homogeneously staining regions, reciprocal translocations, insertions, transpositions and translocations associated with insertion of a transgene.

**Telomere and Imprinting Maps (Chicago)** Provide maps of human telomeres and of imprinted regions

**Atlas of Genetics and Cytogenetics in Oncology and Haematology**

**Animal Models**

**FISH Mapping**

**Physical Mapping & Sequencing**

**Human Genome Project Resources**

**Organizations & Patient Support Groups**

<table>
<thead>
<tr>
<th><a href="http://www.euchromatin.net/">http://www.euchromatin.net/</a></th>
<th>Euchromatin Network</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="http://www.chromatin.net/">http://www.chromatin.net/</a></td>
<td><em>Includes a history of euchromatin and heterochromatin</em></td>
</tr>
</tbody>
</table>

**Nature and Nature Genetics Genome Gateway (free)**

<table>
<thead>
<tr>
<th><a href="http://www.nature.com/genomics/links/">http://www.nature.com/genomics/links/</a></th>
<th>Nature and Nature Genetics -- Genome Gateway</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="http://www.nhgri.nih.gov/CONF/Oncogenomics/">http://www.nhgri.nih.gov/CONF/Oncogenomics/</a></td>
<td>(links at left are a partial list from Dec. 6, 2000).</td>
</tr>
</tbody>
</table>

- **A library of original research papers**, including all genome-related papers from *Nature* and *Nature Genetics* plus links to other major publications. Relevant News and Views articles are also provided.

- **A news service** from *Nature* and *Nature Genetics*, providing up-to-the-minute coverage of research progress, policy issues, funding and ethical implications of genome sequencing.

- **A post-genomics section**, covering the myriad applications of sequencing research and the technologies.

- **A set of links** to the most useful and informative genomics sites on the web.

**Information and Resources**
### Genome-related Publications

- Genomics
- Genomics Today
- GenomeBiology.com
- Genetic Engineering News
- GENE
- Genome Research
- Human Genome News
- Nucleic Acids Research
- Science

### SKY People on the Internet

<table>
<thead>
<tr>
<th>Website</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular Cancer Cytogenetics</td>
<td></td>
</tr>
<tr>
<td><a href="http://www.riedlab.nci.nih.gov/LabPersonnel/labPersonMain.html">http://www.riedlab.nci.nih.gov/LabPersonnel/labPersonMain.html</a></td>
<td></td>
</tr>
<tr>
<td><a href="http://www.riedlab.nci.nih.gov/Protocols/protocols.html">http://www.riedlab.nci.nih.gov/Protocols/protocols.html</a></td>
<td></td>
</tr>
<tr>
<td><a href="http://www.imb-jena.de/www_tumorgen/">http://www.imb-jena.de/www_tumorgen/</a></td>
<td>Evelin Schröck</td>
</tr>
<tr>
<td>Tumor Genetics and Molecular Cytogenetics</td>
<td></td>
</tr>
<tr>
<td><a href="http://genome.imb-jena.de/">http://genome.imb-jena.de/</a></td>
<td></td>
</tr>
<tr>
<td><a href="http://www.hms.harvard.edu/dms/bbs/fac/alt.html">http://www.hms.harvard.edu/dms/bbs/fac/alt.html</a></td>
<td>Frederick Alt (David Ferguson’s boss)</td>
</tr>
<tr>
<td><a href="http://www.hhmi.org/research/investigators/alt.html">http://www.hhmi.org/research/investigators/alt.html</a></td>
<td></td>
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<tr>
<td>Cancer Cytogenetics</td>
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<td></td>
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</tr>
<tr>
<td>The Causes and Consequences of Chromosomal Aberrations</td>
<td>Kuehl, W. Michael, NCI (myeloma)</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
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<tr>
<td><a href="http://www-dcs.nci.nih.gov/resdir/person_index.cfm?p_id=57">http://www-dcs.nci.nih.gov/resdir/person_index.cfm?p_id=57</a></td>
<td></td>
</tr>
<tr>
<td>Molecular Pathogenesis of Multiple Myeloma and Other Plasma Cell Tumors</td>
<td></td>
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<tr>
<td><a href="http://www.sbhcs.com/hospitals/saint_barnabas/press/embryos.htm">http://www.sbhcs.com/hospitals/saint_barnabas/press/embryos.htm</a></td>
<td>Munñé, Santiago, Saint Barnabas Institute // Institute for Reproductive Medicine and Science at Saint Barnabas Medical Center in Livingston, N.J.</td>
</tr>
<tr>
<td>(“Translocations are inherited, and have been found to be the cause in about 9% of repeated miscarriages.”)</td>
<td></td>
</tr>
<tr>
<td><a href="http://ben-may.bsd.uchicago.edu/CCB/faculty/rowley.html">http://ben-may.bsd.uchicago.edu/CCB/faculty/rowley.html</a></td>
<td>Rowley, Janet D.</td>
</tr>
<tr>
<td>(SKY image on the computer monitor).</td>
<td></td>
</tr>
<tr>
<td><a href="http://www.laskerfoundation.com/library/rowley/biography.html">http://www.laskerfoundation.com/library/rowley/biography.html</a></td>
<td></td>
</tr>
<tr>
<td>(Lasker award citation).</td>
<td></td>
</tr>
<tr>
<td>(web page where one of Janet’s review articles on MLL translocations can be downloaded from).</td>
<td></td>
</tr>
</tbody>
</table>

### Internet Sites of Related Technologies

<table>
<thead>
<tr>
<th><strong><a href="http://www.qdots.com">http://www.qdots.com</a></strong></th>
<th>Quantum Dot Corp. Fluorescent nanocrystals (“quantum dots”) are non-bleaching fluorophores that have very nice emission spectral properties.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong><a href="http://www.appliedgenetics.com/prod-point-probes.html">http://www.appliedgenetics.com/prod-point-probes.html</a></strong></td>
<td>(biotinylated. Also have 150 additional probes).</td>
</tr>
<tr>
<td><strong>Note:</strong> AGL’s hyb-banding probes for human and mouse could enable much more rapid chromosome identification in CGH, especially mouse CGH. The idea is to do standard green/red CGH, and add in the AGL hyb-band probes in a Morse code like pattern to uniquely identify each chromosome.</td>
<td></td>
</tr>
<tr>
<td><strong><a href="http://www.resgen.com">www.resgen.com</a></strong></td>
<td>Research Genetics Commercialized set of BAC clones from the NCI cGAP/cCAP initiative.</td>
</tr>
<tr>
<td><strong>James Leary, UTMB molecular cytometry home page</strong></td>
<td>James Leary (flow cytometry and molecular cytometry), UTMB Galveston.</td>
</tr>
<tr>
<td><strong>James Leary Simultaneous immunofluorescence and in situ PCR page</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Molecular Cytometry Course</strong> (1998) with lecture material online</td>
<td></td>
</tr>
<tr>
<td><strong>Cytometry Links from Leary</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Munsell Color Science Laboratory (MCSL)</strong> RIT</td>
<td>MCSCL is an organization color science.</td>
</tr>
<tr>
<td><strong>Lippmann2000 Spectral Imaging Database</strong></td>
<td>The Lippmann2000 project is named in honor of Gabriel Lippmann who in 1891 devised a method to perfectly reconstruct the spectral content of real world scenes. In spite of Lippmann’s invention, a more primitive three-channel model, first demonstrated by James Clerk Maxwell 30 years prior, has dominated the color imaging field. The Maxwellian model, universal in today’s color image capture</td>
</tr>
</tbody>
</table>
Spectral imaging systems, relies on the metameric properties of the human visual system to simulate the appearance of an original color. The capture of full spectral data, while holding advantage over traditional three-channel methods offers new challenges at every point in the imaging chain.

Spectroscopy and Spectrometry Encyclopedia

http://bioresearch.ac.uk/vts/BIORES/index.htm
http://omni.ac.uk/vts/medic/index.htm
http://www.vts.rdn.ac.uk/ Internet Bioresearcher / Internet Medic / RDN Virtual Training Suite. Online tutorial for using the Internet effectively.

NCI60 Cell Lines project
(note: I am interested in SKY results on these 60 cell lines. See bottom of this doc).
See also:
U. Scherf et al. Nature Genetics, 2000 March, 24 (3): 236-244

Spectral Karyotyping (SKY™) of Cell lines ("SkyLines") and Clinical Cases

This section is intended to summarize cell lines that have been karyotyped by SKY. We are doing this to (hopefully) impress you with the amount of work that has been done to date, and also to reduce duplication of effort (so that you can start working on primary tumors). We look forward to the day when we can report on genes cloned from SKY translocation breakpoints. We have tried to provide references or other pointers so that you can get in contact with the SKYer's if you want. Note that independent researchers may get different SKY or G-band results because the cell line has diverged. For an example of this, see the Macville paper on HeLa.

The table is sorted alphabetically by name of the cell line. For unnamed cell lines, the researchers name is used (as in the case of Weaver et al 1999). Each cell line appears in a different row. When a set of lines are published, as in Ghadimi et al 1999, the other lines are listed in the comments field. You may be able to import the online version of the table into Excel and sort differently (i.e. human vs. mouse or tissue derivation). This table is not intended to report the full ISCN karyotype of each cell line. Just because a tissue derivation is listed does not mean it is correct (see Robert et al 1999). If you publish a cell line, please use its name (unlike Bigner and Schröck, 1997). If the cell line is of biomedical significance, we suggest listing its name in the abstract of the publication (i.e. HeLa). Most cell lines are available from the American Type Culture Collection (www.atcc.org). We strongly urge everyone to make their cell lines available through the ATCC.

<table>
<thead>
<tr>
<th>Cell Lines and Tumor Derived Lines</th>
<th>Cell line</th>
<th>Species</th>
<th>Tissue Derivation</th>
<th>Comments</th>
<th>Source (assume et al)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1532T 1535T 1542T 1535N PrEC-T</td>
<td>Human</td>
<td>Prostate epithelial cells</td>
<td>SKY performed on all 5 cell lines. Main point is frequent rearrangements in chromosome 8 resulting in loss of 8p. 1535N from HPV E6/E7 retroviral vector transduction of normal prostate epithelium; 1535T, 1532T and 1542T from E6/E7 immortalization of malignant epithelium. PrEC-T cells from transfection with an SV40 TAg plasmid.</td>
<td>Macoska, Squire et al 2000</td>
<td></td>
</tr>
<tr>
<td>5637</td>
<td>Human</td>
<td>Bladder</td>
<td>Abstract cited: 5637, BK-10, HT</td>
<td>Padilla-Nash 99</td>
<td></td>
</tr>
<tr>
<td>Cell Line</td>
<td>Species</td>
<td>Tumor Type</td>
<td>References</td>
<td></td>
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<tr>
<td>A172</td>
<td>Human</td>
<td>Glioblastoma cell line</td>
<td>9 glioblastoma cell lines analyzed (U251, SNB-19, U373-MG, SP101, SP102, Y98G, A172, DBTRG-05MG, YKG-1), first three had very similar karyotypes. Kubota et al 2001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A549 (A-549)</td>
<td>Human</td>
<td>Non-small cell lung carcinoma (lung adenocarcinoma)</td>
<td>SKY, CGH, FISH on A549 and MGH7 Luk, Squire et al 2001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A818.1</td>
<td>Human</td>
<td>Pancreatic</td>
<td>SKY &amp; CDKN2A (9p21) homozygous deletion. Sirivatanauksorn et al 2001</td>
<td></td>
<td></td>
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<tr>
<td>AsPC1 (Asp?)</td>
<td>Human</td>
<td>Pancreatic carcinoma</td>
<td>From a SKY, CGH and FISH study of AsPC1, BxPC-3, Capan-1, Capan-2, CFPAC-1, Hs 766T, MIA-PaCa-2, PANC-1, SU.86.86. V.K. Rao (1998) cited the Cold Spring Harbor 1998 Advanced Molecular Cytogenetics course as analyzing Colo201, Mia, T-84, Asp and MCF-7. Ghadimi 1999; Sirivatanauksorn et al 2001 (20 pancreatic cell lines).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atm-/-</td>
<td>Mouse</td>
<td>Thyoma (thymic lymphoma)</td>
<td>Metaphases from primary cell culture? (non-SKY paper: Lu, Shipley et al 2001 Cancer Genet Cytogenet 126: 97-101 found the ATM gene was disrupted in one of nine primary breast tumors and two of eight breast carcinoma cell lines: MCF-7 and MDA-MB-231). Liyanage 1996 (same model published in Barlow 1996).</td>
<td></td>
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</tr>
<tr>
<td>Beheshti CaP tumors</td>
<td>Human</td>
<td>early stage pT1/pT2 CaP tumours</td>
<td>14 early stage pT1/pT2 CaP tumours analyzed by SKY and CGH, along with DU145, LNCaP, and PC3 cell lines. Beheshti 1999 (AACR abstract).</td>
<td></td>
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<tr>
<td>BK-10</td>
<td>Human</td>
<td>Bladder carcinoma</td>
<td>Detailed karyotype. Abstract cited: 5637, BK-10, HT 1197, J82, RT4 and UM-UC-3 bladder carcinoma lines. (See also Figure 113.2 in Spector et al (1998) book). Padilla-Nash 1999; Padilla-Nash 99 abstract</td>
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<tr>
<td>BT-474</td>
<td>Human</td>
<td>Breast carcinoma</td>
<td>Rummukainen,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cell Line</td>
<td>Primary Tissue</td>
<td>Subtype</td>
<td>Source of Information</td>
<td></td>
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<tr>
<td>BxPC-3</td>
<td>Human</td>
<td>Pancreatic carcinoma</td>
<td>Kytola, Larsson, Isola et al 2001</td>
<td></td>
<td></td>
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<tr>
<td>C170</td>
<td>Human</td>
<td>Unpublished SKY results (Steve Goodison and George McNamara).</td>
<td>UCSD and ASI.</td>
<td></td>
<td></td>
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<tr>
<td>CA46</td>
<td>Human</td>
<td>Burkitt’s lymphoma (EBV-) cell line</td>
<td>Zimonjic et al 2001</td>
<td></td>
<td></td>
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<tr>
<td>Caco2</td>
<td>Human</td>
<td>Colorectal carcinoma</td>
<td>Davidson, Edwards 2000 (20 cell lines on web site)</td>
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<tr>
<td>Capan-1</td>
<td>Human</td>
<td>Pancreatic carcinoma</td>
<td>Ghadimi 1999; Sirivatanauksorn et al 2001 (20 pancreatic cell lines).</td>
<td></td>
<td></td>
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<tr>
<td>Capan-2</td>
<td>Human</td>
<td>Pancreatic carcinoma</td>
<td>Ghadimi 1999</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CFPAC-1</td>
<td>Human</td>
<td>Pancreatic carcinoma</td>
<td>Ghadimi 1999; Sirivatanauksorn et al 2001 (20 pancreatic cell lines).</td>
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<tr>
<td>COH82-14-46</td>
<td>Human</td>
<td>Small cell lung carcinoma (SCLC)</td>
<td>Dennis 1999</td>
<td></td>
<td></td>
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<tr>
<td>Colo357</td>
<td>Human</td>
<td>Pancreatic</td>
<td>Sirivatanauksorn et al 2001 (20 pancreatic cell lines).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DBTRG-05MG</td>
<td>Human</td>
<td>Glioblastoma</td>
<td>Kubota et al 2001</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DBTRG-05MG: 9 glioblastoma cell lines analyzed

Kubo et al., 2001


SKY: Ghadimi et al (2000) 18 numerical and 16 structural aberrations (no SKY details); aneuploid, MMR proficient.

COH82-14-46: Reverse chromosome painting (microdissected probes) of this and 5 other lines indicated that complex rearrangements of 3q13.2 are important in SCLC.

CA46 cell line: EBV negative, t(7;8;14)(q11.2;q24;q32)[novel IgH-c-myc configuration], partial duplication 1q23-24 proposed to harbor a tumor cell invasiveness gene. See also ST486.
<table>
<thead>
<tr>
<th>Cell Line</th>
<th>Species</th>
<th>Tumor Type</th>
<th>Reference</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>U251, SNB-19, U373-MG, SP101, SP102, Y98G, A172, DBTRG-05MG, YKG-1</td>
<td>Mouse</td>
<td>Plasmacytoma</td>
<td>Wiener 1999</td>
<td>One of a small number of mouse plasmacytomas that are chromosome translocation negative for Ig-myc, but found that &quot;c-myc and IgH genes on extrachromosomal elements (EEs) from which c-myc is transcribed&quot;.</td>
</tr>
<tr>
<td>DCPC21</td>
<td>Mouse</td>
<td>Plasmacytoma</td>
<td>Ghadimi et al (2000)</td>
<td>0 numerical and 3 structural aberrations (no SKY details); diploid MMR deficient.</td>
</tr>
<tr>
<td>DU 145</td>
<td>Human</td>
<td>Prostate (Carcinoma) Cell Line</td>
<td>Brothman et al (1999, Figure 2): t(3;11),t(7;?;8),t(14;18),t(11;12),t(15;20) (SKY, partial results). Pan et al 1999 (abstract): SKY of PC-3, LNCaP, DU145.</td>
<td>Brothman et al 1999; Pan et al 1999 (paper).</td>
</tr>
<tr>
<td>EJ</td>
<td>Human</td>
<td>Unpublished SKY results</td>
<td>UCSD&amp;ASI</td>
<td>Unpublished SKY results (Karen Arden, Carrie Viars, George McNamara).</td>
</tr>
<tr>
<td>FA6</td>
<td>Human</td>
<td>Pancreatic</td>
<td>Sirivatanauksorn et al 2001</td>
<td>(20 pancreatic cell lines).</td>
</tr>
<tr>
<td>FR4</td>
<td>Human</td>
<td>Multiple Myeloma</td>
<td>Rao 1998</td>
<td>From a SKY &amp; G-band study of FR4, SKMM1, SKMM2, U266, XG1, XG2, XG4, XG5, XG6, XG7,</td>
</tr>
<tr>
<td>Goodison-1 Goodison-2</td>
<td>Human</td>
<td>Breast carcinoma</td>
<td>A pair of cloned cell lines with different behaviors <em>in vivo</em> (in nude mice) were isolated from a parental cell line.</td>
<td>S. Goodison, UCSD, unpublished. (not available until publication).</td>
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<tr>
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</tr>
<tr>
<td>GOT1</td>
<td>Human</td>
<td>ileal carcinoid</td>
<td>“By using SKY it was possible to identify the origin and organization of all clonal marker chromosomes and to identify cryptic translocations not detectable by conventional chromosome banding. The stemline karyotype of low passage GOT1 cells was interpreted as 43,XX, der(1)del(1)(?), inv(2)(p25q13), del(3)(p21), del(5)(q13q31), del(6)(q13), -9,-13,-15, del(16)(q22). Analysis of the GOT1 cells after about 2.5 years of propagation in nude mice allowed us to follow the in vivo progression of this tumor.”</td>
<td>Sjogren et al 2000</td>
</tr>
<tr>
<td>H1</td>
<td>Human</td>
<td>Hepatocellular carcinoma</td>
<td>H1 HBV+, 45-50 chr H2 HBV+, 50-74 chr H3 HBV+, 67-78 chr H4 HBV+, 68-83 chr H5 HBV+, 49-56 chr H6 HBV+, 35-40 chr H7 HBV+, 57-77 chr H8 HBV+, 63-75 chr H9 HBV+, 82-143 chr H10 HBV+, 65-77 chr H11 HBV+, 64-85 chr H12 HBV+, 77-131 chr H13 HBV+, 75-84 chr H14 HCV+, 61-122 chr H15 HCV+, 47-70 chr</td>
<td>Wong et al 2000 (also SKY on PCL/PRF/5, Hep 3B and HepG2 cell lines).</td>
</tr>
<tr>
<td>H929</td>
<td>Human?</td>
<td>Multiple myeloma</td>
<td>No details (conference proceedings).</td>
<td>Hilgenfeld 1999</td>
</tr>
<tr>
<td>HB4a</td>
<td>Human</td>
<td>Breast</td>
<td>Davidson, Edwards 2000,</td>
<td>Davidson, Edwards 2000 (20 cell lines on web site)</td>
</tr>
<tr>
<td>Reference</td>
<td>Lines</td>
<td>Type</td>
<td>Karyotypes</td>
<td>Comments</td>
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<tr>
<td>-----------</td>
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</tr>
<tr>
<td>HDLM-1</td>
<td>Human</td>
<td>Hodgkin’s disease (Hodgkin’s lymphoma) derived sibling cell lines</td>
<td>36 chromosomes (sub-diploid), 24 markers resolved by SKY. The sister cell lines studied “carried interstitial 9p subtelomeres and rDNA rearrangements.”. Although complex, most rearrangements in HDLM cells arose in vivo and included few rare but many typical HD breakpoints, notably at the r(ribosomal)DNA regions.”. 52 breakpoints found (SKY and banding). An interesting analysis is “Concordance to the cytogenetic picture reported for HD was derived by subtracting numbers of HD negative from positive breakpoints present in each cell line. As anticipated, concordance among the 13 highly rearranged control cell lines (BE-13, DEL, GRANTA-519, HEL, KARPAS-45, MEG-01, MEGAL, SR-786, SU-DHL1, SUP-B2, TANOUE, WSU-NHL, YT) approximated zero (mean 0.23, range +2 to-2), indicating the level of the stochastic background.” MacLeod et al report that the 9p2 amplification includes the JAK2 gene. Conventional cytogenetics – see (see also D. Falzetti, C. Mecucci et al (1999) Haematologica 84: 298-305 Abstract</td>
<td>MacLeod et al 2000</td>
</tr>
<tr>
<td>HDLM-2</td>
<td>Human</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HDLM-3</td>
<td>Human</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HeLa</td>
<td>Human</td>
<td>Cervical carcinoma</td>
<td>Integrated karyotype of SKY, CGH, FISH.</td>
<td>Macville 1999</td>
</tr>
<tr>
<td>HepG2 (Hep G2)</td>
<td>Human</td>
<td>Well differentiated hepatoblastoma</td>
<td>Wong et al SKY: (HBV-, HCV-). 52-78 chr.</td>
<td>Wong et al 2000</td>
</tr>
<tr>
<td>HKCI-1</td>
<td>Human</td>
<td>hepatocellular carcinoma cell line</td>
<td>der(X)(X;11)(q10;p10), der(1)(1;10)(q10;?pq), der(4)(4;16)(p10;q10), i(5p), del(5)(q13), der(7)(7;21)(q32q10::q10), der(8)(8;17)(q10;p10), der(9)(9;22)(q34;?pq). Patient was a hepatitis B virus (HBV) carrier. TP53 mutational</td>
<td>Pang, Wong et al 2000</td>
</tr>
</tbody>
</table>
## Spectral Imaging References

<table>
<thead>
<tr>
<th>HK hep-1</th>
<th>Human</th>
<th>hepatocellular carcinoma cell line</th>
<th>69-76 chromosomes, secretes alpha-fetoprotein, negative for hepatitis B, t(1q;10), t(Xq;11), t(1;19), t(4;16), t(7;21), t(8;17;10).</th>
<th>Wong (1999) AACR abstract</th>
</tr>
</thead>
<tbody>
<tr>
<td>HL-60 (HL60)</td>
<td>Human</td>
<td>Acute myelogenous leukemia (AML)</td>
<td>44,X-,X,del(5;17)(q11;p11),del(7)(p?),der (7)t(5;7)(q11;q21),t(5;16)(q1;1q?), add(8)(q?),der(9)del(9)(p2?)t(9;14)( q2?:q2?),del(10)(p?),ins(11;8)(q13;?), der(14)t(14;15)(q1;q?),-15,der(16)t(16)(q22<del>24),del(1 6)t(7;16)(q22</del>24),+18 (passage 20; SKY, FISH). Authors contrast their results with Shipley et al 1996 Genes Chrom. Cancer 15: 182-186 (a CGH and FISH study).</td>
<td>Liang 1999</td>
</tr>
<tr>
<td>Hs 766T (Hs766T)</td>
<td>Human</td>
<td>Pancreatic carcinoma</td>
<td>From a SKY, CGH and FISH study of AsPC1, BxPC-3, Capan-1, Capan-2, CFPAC-1, Hs 766T, MIA-PaCa-2, PANC-1, SU.86.86.</td>
<td>Ghadimi 1999; Sirivatanauksorn et al 2001 (20 pancreatic cell lines).</td>
</tr>
<tr>
<td>HT-29 (HT29)</td>
<td>Human</td>
<td>Colon carcinoma cell line</td>
<td>SKY and CGH: Figue 1B and 1D in Ghadimi et al 2000 (*“genomic instability” paper, summary table says “17 numerical, 19 structural aberrations, no ISCN karyotype). My interpretation of CGH plus one SKY classification image: Hypotriploid, del(4q), +del(5), t(6;14?), del(6)x2, +7, iso(8q?), +11, iso(13q?), -14, +15, t(17;19)](del for part of 17; del for Ried, Schröck &amp; March 1999 CSHL course (unpublished); S. Goodison (UCSD) pers. comm.; Ghadimi/Ried et al 2000 Abstract</td>
<td></td>
</tr>
<tr>
<td>Cell Line</td>
<td>Species</td>
<td>Type</td>
<td>References</td>
<td></td>
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<tr>
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</tr>
<tr>
<td>HT 1197</td>
<td>Human</td>
<td>Bladder carcinoma</td>
<td>Abstract cited: 5637, BK-10, HT 1197, J82, RT4 and UM-UC-3 bladder carcinoma lines.</td>
<td></td>
</tr>
<tr>
<td>Htori-3 (and subclones)</td>
<td>Human</td>
<td>Thyroid cell line(s)</td>
<td>“Subclones were generated from the human thyroid epithelial cell line (HTori-3) by exposure to gamma or alpha irradiation. SKY analysis revealed multiple translocations and, combined with G-banding, allowed the definition of targets for positional cloning of tumor related genes.”</td>
<td></td>
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<tr>
<td>J82</td>
<td>Human</td>
<td>Bladder carcinoma</td>
<td>Abstract cited: 5637, BK-10, HT 1197, J82, RT4 and UM-UC-3 bladder carcinoma lines.</td>
<td></td>
</tr>
<tr>
<td>JCA-1</td>
<td>Human</td>
<td>T24 bladder carcinoma cell line derivative (previously though to ve a Prostate cancer cell line)</td>
<td>See van Bokhoven et al (2001) for details on identification of TSU-Pr1 and JCA-1 as T24 bladder carcinoma cell line derivatives (not prostate carcinoma lines as previously thought).</td>
<td></td>
</tr>
<tr>
<td>Kakazu 1999</td>
<td>Human</td>
<td>myelodysplastic syndrome (secondary leukemia) derived cell line</td>
<td>Publication analyzed &quot;20 myelodysplastic syndromes (MDSs) (13 primary MDSs, 3 therapy-related MDSs, and 4 acute leukemias developed from MDS, including 1 cell line established from a secondary leukemia) previously analyzed by G-banding. ... In total, SKY identified the chromosomal basis of 38 mar, add, and hsr, corrected 8 abnormalities misidentified by G-banding, and revealed 6 cryptic translocations in 5 cases.&quot;</td>
<td></td>
</tr>
<tr>
<td>Karpas 620</td>
<td>Human</td>
<td>Myeloma</td>
<td>SKY&amp;FISH (12.5 Kb FISH probe in SKY reagents). See Tonon et al 2000 for list of chromosome aberrations and details on copy number and location of the c-myc-IgH fusion gene.</td>
<td></td>
</tr>
<tr>
<td>KY821</td>
<td>Human?</td>
<td>Leukemia</td>
<td>SKY, CGH, double minutes.</td>
<td></td>
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<tr>
<td>LN CaP (LNCaP) (a.k.a. CaP)</td>
<td>Human</td>
<td>Prostate (carcinoma) cell line</td>
<td>Pan et al 1999 (abstract); SKY of PC-3, LNCaP, DU145. Metastatic prostate cell line (Augustus 1999). (Androgen) hormone dependent</td>
<td></td>
</tr>
</tbody>
</table>

Kakazu 1999

Pan 1999 (abstract), Pan et al 1999 (paper).

Beheshiti 1999 (AACR abstract).
Brothman et al (1999, Prostate, Figure 3) “SKY karyotype of the LNCaP prostate cancer cell line, showing a grossly abnormal chromosome complement. This particular cell indicates translocations involving chromosomes 1 and 15; 3 and 11; 1, 10, and 4; 4 and 6; 6 and 16; and 15 and 22. Chromosomal size differences and copy numbers suggest additional abnormalities.” In ISCN style:

\[
\begin{align*}
&\text{t}(1;15) \\
&\text{t}(3;11) \\
&\text{t}(1;10;4) \\
&\text{t}(4;6) \\
&\text{t}(6;16) \text{ (see below)} \\
&\text{t}(15;22)
\end{align*}
\]

Veronese, Croce et al (1996) Cancer Res. 56: 728-732 observed that the LNCaP t(6;16)(p21;q22) translocation results in a tpc/hpr fusion transcript(s), and that similar translocations have been observed in primary prostatic adenocarcinomas by Lundgren, Heim, Mitelman et al (1992) Genes, Chromosomes & Cancer 4: 16-24. Veronese et al mention that hpr is a haptoglobin related gene and tpr is a novel gene coding for a protein similar to ribosomal protein S10.

PC-3, and 3 of 13 primary tumors, have gene amplifications in the Urokinase-type plasminogen activator (uPA) gene (Helenius et al 2001 Cancer Research 61, 5340-5344). Helenius mentions that uPA is sensitive to amelioride. (PC-3 is also amplified in HIF-1alpha (13q23)).

<table>
<thead>
<tr>
<th>Cell Line</th>
<th>Species</th>
<th>Tumor Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNCaP</td>
<td>Human</td>
<td>Prostate carcinoma</td>
<td>Origin: “established from the left supraclavicular lymph node metastasis from a 50-year-old man with prostate carcinoma in 1977; cells were described to be androgen-sensitive” <a href="http://www.dsmz.de/mutz/mutz256.htm">http://www.dsmz.de/mutz/mutz256.htm</a></td>
</tr>
<tr>
<td>M12</td>
<td>Human</td>
<td>Prostate epithelial cells transfected with SV40 TAg</td>
<td>M12 is a tumorigenic and metastatic sublines generated from the parental P69SV40TAg cell line by passing in mice for 6 months and phenotypic selection. Parental line from normal cells from a 63 year old African-american man.</td>
</tr>
<tr>
<td>MaTu/Ham</td>
<td>Human</td>
<td>Breast</td>
<td><a href="http://www.path.cam.ac.uk/~pawefish/mcf7.htm">Davidson, Edwards 2000</a> (20 cell lines on web site)</td>
</tr>
<tr>
<td>McCormack</td>
<td>Mouse</td>
<td>Mammary glands from MMTV-cmyc (and p53 mutant) transgenic mice</td>
<td>SKY of mouse cell cultures from 5 transgenic mice, some with p53 knockouts.</td>
</tr>
<tr>
<td>MCF-7 (MCF7)</td>
<td>Human</td>
<td>Breast (carcinoma?)</td>
<td>Davidson, Edwards 2000, MCF7: <a href="http://www.path.cam.ac.uk/~pawefish/mcf7.htm">http://www.path.cam.ac.uk/~pawefish/mcf7.htm</a> A highly rearranged, near triploid cell line, held at the ATCC. Translocations involve all chromosomes, except 4. Several markers are very complex, having undergone multiple rearrangements. Deletions were detected on chromosomes 3 and 13.</td>
</tr>
</tbody>
</table>

65(61-72) 1x1, der(1)t(X;1), 2x2, der(2)t(2;3)(q36;?), 3x2, del(3)(p?), der(3)t(3;6), 4x3, 5x3, der(5)t(5;13)(p12;q22), 6x1, der(6)t(6;7), der(6)t(3;6), 7x1, der(7)t(1;19;7;6), der(7)t(7;19;7), 8x1, der(?)(t(16;11;8;11;3), der(8)t(8;15), der(?)(t(8;12), der(8)t(8;16), 9x2, der(?)(t(6;20;9;3), der(9)t(8;9), 10x2, der(10)t(7;10)(?;q22), 11x2, der(?)(t(11;17;19;17), 12x3, der(19)t(12;19), del(13)(q?), der(13)t(13;15;11;16), der(13)t(13;14), der(13)t(13;16), |

[Davidson, Edwards 2000](http://www.path.cam.ac.uk/~pawefish/mcf7.htm) (20 cell lines on web site) |
| Ried, Schröck & CSHL courses (unpublished); Knutsen et al 2000 (row below). |
14x2, der(?)t(7;14), 15x2, der(16)t(15;16), 16x2, 17x1, der(17)t(3;17), 18x2, der(18)t(18;21), 19x1, der(19)t(7;19), 20x1, der(?)t(17;19;17;20), der(20)t(3;20;1;20;1;20), der(20)t(20;1;21?), 21x3, der(22)t(7;22), der(22)t(16;22), Xx2 cp[6].


V.K. Rao (1998) cited the Cold Spring Harbor 1998 Advanced Molecular Cytogenetics course as analyzing Colo201, Mia, T-84, Asp and MCF-7. Also used at CSHL courses for Her-2/neu and c-myc FISH and CGH. Very well known steroid growth factor model system (estrogen receptor).

More on MCF7: Kallioniemi (1994) PNAS 91: 2156-2160 (CGH on 15 breast cell lines and 33 tumors).


Turid Knutsen (NCI/NIH, pers. comm. 10/2000) pointed out that MCF-7 sublines have different karyotypes. He is interested in collecting labs observations and publishing a compendium. Contact him (knutsent@mail.nih.gov) if you have results.

(non-SKY paper: Lu, Shipley et al 2001 Cancer Genet Cytogenet 126: 97-101 found the ATM gene was disrupted in one of nine primary breast tumors and two of eight
| MCF-7 AdVp3000 | Human | Breast carcinoma | AdVp3000 and MX sublines are mitoxantrone resistant, have chr 4q21-22 translocations (by SKY) that involve the newly isolated MXR "half transporter" gene implicated in the drug resistance phenotype. S1-M1-80 (resistant) and the parental (sensitive) MCF-7 cell lines lack chr 4 aberrations. See also T. Knutsen 1998 Genes Chr Cancer 23: 44-54. See NCI60 gene expression paper (table 6 below) for more on MCF-7. | Knutsen et al 2000 Genes Chr Cancer 27: 110-116. |
| MCF-7 MX | | | |
| MCF-7 S1-M1-80 | | | |

**MDA series**

**MDA-MB-134**

| Human | Breast carcinoma | Davidson, Edwards 2000 SKY and CGH: [http://www.path.cam.ac.uk/~pawefish/mda-mb-134.htm](http://www.path.cam.ac.uk/~pawefish/mda-mb-134.htm) A hypodiploid cell line which appears to have undergone a monosomic pattern of evolution. Translocations involve chromosomes 8, 11, 15, 16, 17 and 18, and of note is the duplicated marker with coamplification of 8 and 11. The 2nd larger clone has duplicated its chromosomes, but some chromosomes and markers have been lost. However, there has been a gain of chromosome 16. 44 (37-47) and 66(60-77).1x2, 2x2, 3x2, 4x2, 5x2, 6x2, 7x1, 8x2, der(?)t(8;11)ins(11;8)nx2, 9x2, 10x2, 11x1, 12x2, 13x1, 14x2, 15x1, der(?)t(15;17), 16x1, 17x1, 18x1, der(18)t(16;18), 19x2, 20x2, 21x2, 22x2, Xx2 cp[8]/ idem x2, -1, -5x2, +16x2, +18, -X, - der(?)t(8;11)ins(8;11)n [7]. | Davidson, Edwards 2000 (20 breast carcinoma cell lines on web site) |

**MDA-MB-157**

| Human | Breast carcinoma | Davidson, Edwards 2000 SKY and CGH: [http://www.path.cam.ac.uk/~pawefish/mda-mb-157.htm](http://www.path.cam.ac.uk/~pawefish/mda-mb-157.htm) A near triploid cell line exhibiting a pattern of 'loss-with-reduplication' evolution. Translocations involve all chromosomes, except 7 and 11. Several marker chromosomes have been duplicated. Isochromosomes are present for 8 and 13. One alternate clone is missing 1 marker, | Davidson, Edwards 2000 (20 breast carcinoma cell lines on web site) |
but has a unique duplicated deletion. A larger clone has duplicated all its chromosomes, but lost 2 markers, chromosomes 19 and X and isochromosome 13. It has however acquired a new translocation and a new deletion.

62 (41-68) and 116(101-120). 1x1, der(1)t(1;13)(?;q21), der(1)t(5;16;1)x2, der(1)t(1;20)x2, 2x1, del(2)(p?), der(2)t(2;8), 3x2, der(3)t(3;4), 4x2, 5x2, 6x2, der(16)t(6;16), 7x3, 8x1, del(8)(p?), i(8)(q?)2, der(?)(t;8;18), 9x1, der(9)t(X;9), 10x2, 11x2, 12x1, der(12)t(12;19), 13x1, i(13)(q), der(14)t(9;14)x2, der(?)(t;14;22;17)x2, der(5)t(5;15)x2, 16x1, 17x2, 18x2, 19x2, der(19)t(10;19)x2, 20x2, der(20)ins(20;13)x2, der(21)t(16;21)x2, der(21)t(X;21), Xx3 cp[5]/ idem., der(1)t(1;13), +
del(1)(q31)x2 [5]/ idem x2, +19, +der(3)t(3;4), +der(5)t(5;15), +del(8)(q?), +der(12)t(12;19), +der(19)t(10;19), +der(21)t(16;21) [6]

<p>| MDA-MB-175 | Breast carcinoma | Davidson, Edwards 2000 (20 breast carcinoma cell lines on web site) |
| MDA-MB-231 | Human Breast carcinoma | (non-SKY paper: Lu, Shipley et al 2001 Cancer Genet Cytogenet 126: 97-101 found the ATM gene was disrupted in one of nine primary breast tumors and two of eight breast carcinoma cell lines: MCF-7 and MDA-MB-231). |
| MDA-MB-361 | Human Breast carcinoma | Davidson, Edwards 2000 (20 breast carcinoma cell lines on web site) |
| MDA-MB-435 | Human Breast carcinoma | Davidson, Edwards 2000 SKY and CGH: <a href="http://www.path.cam.ac.uk/~pawefish/mda-mb-435.htm">http://www.path.cam.ac.uk/~pawefish/mda-mb-435.htm</a> A highly rearranged, near triploid cell line held at the ATCC, obtained from Dr Mike O'Hare. Translocations involve 1, 3, 6, 7, 8, 10, 11, 13, 14, 15, 16, 18, 20, 21 and 22. One marker has been duplicated. Deletions were detected on chromosomes 2, 3, 5, 8, 10 and 20. | Davidson, Edwards 2000 (20 breast carcinoma cell lines on web site) |</p>
<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Tumor Type</th>
<th>Genotype Information</th>
<th>Reference</th>
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</thead>
<tbody>
<tr>
<td>MDA Panc-3</td>
<td>Human</td>
<td>Pancreatic</td>
<td>Spectral Imaging References 61 of 96</td>
<td>Sirivatanauksorn et al 2001 (20 pancreatic cell lines)</td>
</tr>
<tr>
<td>Medulloblastoma/</td>
<td>Human</td>
<td>Medulloblastoma</td>
<td>SKY result of 46,XX,dic(1;13),i(17q).</td>
<td>Bigner &amp; Schröck 1997</td>
</tr>
<tr>
<td>Bigner</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mel202</td>
<td>Human</td>
<td>Uveal melanoma cell line</td>
<td>50&lt;sup&gt;+&lt;/sup&gt;53,XX… SKY added information to 7 partially characterized chromosomes.</td>
<td>Naus et al 2001</td>
</tr>
<tr>
<td>Mel270</td>
<td>Human</td>
<td>Uveal melanoma cell line</td>
<td>43&lt;sup&gt;+&lt;/sup&gt;48,XY… SKY reclassified a normal(17) as der(17)t(7;17)(?;?) and added information to 13 partially characterized chromosomes.</td>
<td>Naus et al 2001</td>
</tr>
<tr>
<td>MGH7</td>
<td>Human</td>
<td>Non-small cell lung carcinoma (lung squamous cell carcinoma)</td>
<td>SKY, CGH, FISH on A549 and MGH7</td>
<td>Luk, Squire et al 2001</td>
</tr>
<tr>
<td>MOPC315</td>
<td>Mouse</td>
<td>Mineral oil plasmacytoma (available from ATCC)</td>
<td>SKY on Allens lab's subline. MOPC315 is often used as a fusion partner in making hybridoma's for monoclonal antibody production.</td>
<td>Coleman 1999</td>
</tr>
<tr>
<td>MT-1</td>
<td>Human</td>
<td>Breast carcinoma</td>
<td></td>
<td>Davidson, Edwards 2000 (20 breast carcinoma cell lines on web site)</td>
</tr>
<tr>
<td>MT-3</td>
<td>Human</td>
<td>Breast carcinoma</td>
<td></td>
<td>Davidson, Edwards 2000 (20 breast carcinoma cell lines on web site)</td>
</tr>
<tr>
<td>multiple myelomas</td>
<td>Human</td>
<td>Multiple myeloma</td>
<td></td>
<td>Rao 1998</td>
</tr>
<tr>
<td>OP202</td>
<td>Human</td>
<td>Ovarian</td>
<td>OV202hp is a high passage cell line</td>
<td>Bible et al 2000 CCR</td>
</tr>
<tr>
<td>Cell Line</td>
<td>Species</td>
<td>Type</td>
<td>Origin</td>
<td>Description</td>
</tr>
<tr>
<td>-----------</td>
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<tr>
<td>OP202hp</td>
<td>Human</td>
<td>Carcinoma cell line</td>
<td>that spontaneously developed drug resistance (to Cisplatin and Flavopiridol) during passaging. First cell line described with resistance to flavopiridol. OP202 is the parental low passage line.</td>
<td>abstract</td>
</tr>
<tr>
<td>OPM2</td>
<td>Human</td>
<td>Multiple myeloma</td>
<td>No details</td>
<td>Hilgenfeld 1999</td>
</tr>
<tr>
<td>OSI-LY8</td>
<td>Human</td>
<td>Immunoblastic lymphoma cell line (a type of Non-Hodgkin lymphoma)</td>
<td>SKY identified marker(s)</td>
<td>S.R. Chaganti et al 1998</td>
</tr>
<tr>
<td>Osteosarcomas</td>
<td>Human</td>
<td>Osteosarcomas</td>
<td>Zielenska, Bridge, Squire et al (1999 abstract) did SKY on 10 primary tumors and 3 OS cell lines (and CGH on 24 OS tumors and 3 cell lines). &quot;High degree of structural and numerical aberrations…consistent changes detected in chr 1, 2, 4, 6, 7, 12, 14, 18, 20, 21, 22.&quot;</td>
<td>Zielenska 1999</td>
</tr>
<tr>
<td>NCI-H660</td>
<td>Human</td>
<td>Prostate cancer cell line</td>
<td></td>
<td>Pan, Kytölä, et al 2001 (see also Pan et al 1999)</td>
</tr>
<tr>
<td>Neuroblastoma tumor - Lawce</td>
<td>Human</td>
<td>Neuroblastoma (24 hour culture)</td>
<td>G-banding (H. Lawce, 1996 Applied Cytogenetics 22: 199-200 brain tickler (literally!)): 46,XY, del(1)(p36), add(8)(p23), der(16)t(6;17)(p?11;q?11), +dms (double minutes), interphase FISH: 40-200 copies of N-myc. SKY (Knutsen 1997): 46,XY, der(1)t(1;12)(p36;q24.3), ins(8;2)(p21;p23.1), der(16)t(16;17)(p11;q11), +dmin(2) [at least 13 dmin(2)’s]. Upshot: SKY refined two aberrations and identified all the double minutes.</td>
<td>Knutsen et al 1997 figure 3</td>
</tr>
<tr>
<td>P388</td>
<td>Mouse</td>
<td>Pre-B lymphoma (P388) and progenitor macrophage-like tumor</td>
<td>SKY and CGH study &quot; … to elucidate the divergent cytogenetic make-up of the prototypical bilineage lymphoblastic pre-B lymphoma, P388, and its progenitor macrophage-like tumor, P388D1. P388 was found to be diploid and genomically stable. P388D1 was triploid, highly unstable and characterized by numerous marker chromosomes (Chrs) and composite rearrangements.&quot; (they are related).</td>
<td>Coleman 1999</td>
</tr>
<tr>
<td>Cell Line</td>
<td>Type</td>
<td>Description</td>
<td>References</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>---------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>PaCa-3 (PaCa3)</td>
<td>Human Pancreatic carcinoma</td>
<td>From a SKY, CGH and FISH study of AsPC1, BxPC-3, Capan-1, Capan-2, CFPAC-1, Hs 766T, MIA-PaCa-2, PANC-1, SU.86.86.</td>
<td>Sirivatanauksorn et al 2001 (20 pancreatic cell lines).</td>
<td></td>
</tr>
<tr>
<td>PANC-1</td>
<td>Human Pancreatic carcinoma</td>
<td></td>
<td>Ghadimi 1999; Sirivatanauksorn et al 2001 (20 pancreatic cell lines).</td>
<td></td>
</tr>
<tr>
<td>PaTuI</td>
<td>Human Pancreatic</td>
<td></td>
<td>Sirivatanauksorn et al 2001 (20 pancreatic cell lines).</td>
<td></td>
</tr>
<tr>
<td>PaTuII</td>
<td>Human Pancreatic</td>
<td></td>
<td>Sirivatanauksorn et al 2001 (20 pancreatic cell lines).</td>
<td></td>
</tr>
</tbody>
</table>

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Helenius mentions that uPA is sensitive to amelioride.

The following paper found high level gene amplification of HIF-1alpha in PC-3 (map location 14q23). Also reported extra copies in 4 other cell lines and in 36% (of 117) prostate tumors.


The following discussed CGH of metastatic variants of PC-3 (PC3M) and LNCaP:


PC-3 Origin: “established from the bone marrow metastasis isolated post-mortem from a 62-year-old Caucasian man with grade IV prostate cancer (poorly differentiated adenocarcinoma) after androgen suppression therapy; described to form tumors in nude mice, to grow in soft agar, and to be unresponsive to androgen treatment. References: Kaighn et al. (1979) Invest. Urol. 17: 16-23.” [http://www.dsmz.de/mutz/mutz465.htm](http://www.dsmz.de/mutz/mutz465.htm).

<table>
<thead>
<tr>
<th>Cell Line</th>
<th>Origin</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>PMC42</td>
<td>Human</td>
<td>Breast Carcinoma</td>
</tr>
<tr>
<td>PPC-1</td>
<td>Human</td>
<td>Prostate cancer cell line</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Primary prostate cancer cell line</th>
<th>Human</th>
<th>Prostate (carcinoma) cell line</th>
<th>Manuscript submitted 8/99 by Meena Augustus and Thomas Ried. al 1999</th>
<th>M. Augustus et al (submitted, see PC-3 for details)</th>
</tr>
</thead>
<tbody>
<tr>
<td>QGP-1</td>
<td>Human</td>
<td>Pancreatic</td>
<td>SKY, CGH and microarray. See also SJRH30 cell line.</td>
<td>Sirivatanauksorn et al 2001 (20 pancreatic cell lines).</td>
</tr>
<tr>
<td>RD</td>
<td>Human</td>
<td>Rhabdomyosarcoma</td>
<td></td>
<td>Pandita 1999</td>
</tr>
<tr>
<td>&quot;Ried photo&quot; primary bladder cancer cell line</td>
<td>Human</td>
<td>primary bladder cancer cell line</td>
<td>Single metaphase figure (113.2): t(8;19) t(3;8) t(8;14) t(Y;17;22) t(6;21) t(X;19) t(9;15) t(10;18) t(8;19) Note: the cell line was analyzed by Ried and colleagues, but is not from Ried's cells.</td>
<td>Ried et al (1997) Cells book chapter, figure 113.2</td>
</tr>
<tr>
<td>RMS 1598</td>
<td>Human</td>
<td>Ewing's/ primitive neuroectodermal tumor (PNET) (this paper) or rhabdomyosarcoma (ATCC listing).</td>
<td>t(13;11;22) and more. Roberts suggested tumor type on basis of RT-PCR finding of a EWS-FLI1 fusion transcript.</td>
<td>Roberts 1999</td>
</tr>
<tr>
<td>Rossi</td>
<td>Human</td>
<td>Pancreatic</td>
<td></td>
<td>Sirivatanauksorn et al 2001 (20 pancreatic cell lines).</td>
</tr>
<tr>
<td>RT4</td>
<td>Human</td>
<td>Bladder carcinoma</td>
<td>Abstract cited: 5637, BK-10, HT 1197, J82, RT4 and UM-UC-3 bladder carcinoma lines.</td>
<td>Padilla-Nash 99 abstract</td>
</tr>
<tr>
<td>RWP-1</td>
<td>Human</td>
<td>Pancreatic</td>
<td></td>
<td>Sirivatanauksorn et al 2001 (20 pancreatic cell lines).</td>
</tr>
<tr>
<td>S48T</td>
<td>Human</td>
<td>Pediatric thyroid tumor</td>
<td>“Line S48T was generated from a primary tumor of a child exposed to elevated levels of radiation following the Chernobyl nuclear accident.”</td>
<td>Zitzelsberger et al 1999 (SPIE abstract)</td>
</tr>
<tr>
<td>SCC172 (UPCI:SCC172)</td>
<td>Human</td>
<td>Oral squamous cell carcinoma cell line</td>
<td>Near triploid. See the online table of SKY Results for UPCI:SCC172 for details. SKY image online (See Shuster et al 2000 Genes, Chromosome and Cancer 28: 153-163, for analysis of several other cell lines for 11q13 (RIN1, cyclin D1, FGF3 and FGF4 genes) amplification in several OSCC cell lines…did not analyze SCC172).</td>
<td>Saunders et al 2000 PNAS abstract</td>
</tr>
<tr>
<td>SJRH30</td>
<td>Human</td>
<td>Rhabdomyosarcoma</td>
<td>SKY, CGH and microarray. See also RD cell line.</td>
<td>Pandita 1999</td>
</tr>
</tbody>
</table>
| SKBR3 (SK-BR-3) (SKBR-3) | Human Breast (carcinoma?) | Also used at CSHL courses for Her2/neu and c-myc FISH and CGH. Well known breast culture model system. See Ried et al 1997 for CGH results (7p12 derived EGFR gene amplification). One of the marker chromosomes is a four way translocation whose largest segment is chromosome 8 amplified material (c-myc and more) that by FISH also contains interspersed her-2/neu gene copies (Ried and Schröck, 1999 CSHL ISH course, pers. comm.). SKY&FISH metaphase available at [http://home.earthlink.net/~geomcnamar](http://home.earthlink.net/~geomcnamar) (note: the analyzed version, McNamara and Goodison, unpublished, has 81 chromosomes and additional translocations not discussed by Ried et al 1997 or Schröck et al 1996).

**Note:** **bold** = largest chr segment.

Schröck et al 1996 figure 3C shows 6 markers:
- t(13;3;big 8;3;8;13) [her-2 amplified in "big 8"]
- t(4;14)
- t(12;6;4;17)
- t(8;4;14)
- t(8;14)
- t(2;12).

Ried et al 1997 (J. Mol. Med.) figure 6 lists:
- t(13;3;17;big 8;17;big 8;17;8;3;8;17;8;13) [interspersed 17 material in 8 material is described as 8 and 17 co-amplification (c-myc and her-2/neu?), framed by material from 3 and 13].
- t(8;17;8;14) [17=her2 amp]
- t(X;8;17) [17=telomere her2?]
- t(20;5;17;19;8;17) [big 17 block]
- t(8;4;19;14).

Ried et al CGH results include (fig 2 text summary):
- DNA gains: 1q, 7, 8q, 10q, 17q, 19q, 20, Xp.
- DNA losses: 2q, partial 3, 4p, 5q, 6q, 8p, 9p, 10q, 16q.
- DNA amplifications identified at 8q21 [mystery gene] and 8q24 (c-myc).

The Ried paper does not mention her-2/neu as the specific...|
<table>
<thead>
<tr>
<th>Cell Line</th>
<th>Type</th>
<th>Cell Type</th>
<th>References</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>SK-BR-7</td>
<td>Human, Breast</td>
<td>Carcinoma</td>
<td>Davidson, Edwards 2000 SKY and CGH: SK-BR-3</td>
<td></td>
</tr>
<tr>
<td>SK-MM1</td>
<td>Human, Multiple</td>
<td>Myeloma</td>
<td>From a SKY &amp; G-band study of FR4, SKMM1, SKMM2, U266, XG1, XG2, XG4, XG5, XG6, XG7, and 9 tumors from 8 patients.</td>
<td></td>
</tr>
<tr>
<td>SNB-19</td>
<td>Human, Glioblastoma cell line</td>
<td>9 glioblastoma cell lines analyzed (U251, SNB-19, U373-MG, SP101, SP102, Y98G, A172, DBTRG-05MG, YKG-1), first three had very similar karyotypes.</td>
<td>Kubota et al 2001</td>
<td></td>
</tr>
<tr>
<td>SP101</td>
<td>Human, Glioblastoma cell line</td>
<td>9 glioblastoma cell lines analyzed (U251, SNB-19, U373-MG, SP101, SP102, Y98G, A172, DBTRG-05MG, YKG-1), first three had very similar karyotypes.</td>
<td>Kubota et al 2001</td>
<td></td>
</tr>
<tr>
<td>SP102</td>
<td>Human, Glioblastoma cell line</td>
<td>9 glioblastoma cell lines analyzed (U251, SNB-19, U373-MG, SP101, SP102, Y98G, A172, DBTRG-05MG, YKG-1), first three had very similar karyotypes.</td>
<td>Kubota et al 2001</td>
<td></td>
</tr>
<tr>
<td>ST486</td>
<td>Human, Burkitt’s lymphoma (EBV-) cell line</td>
<td>ST486 cell line: EBV negative, t(8;8;14)(q24;q32;q23)[novel IgH-c-myc configuration]. See also CA46.</td>
<td>Zimonjic et al 2001</td>
<td></td>
</tr>
<tr>
<td>SU.86.86</td>
<td>Human, Pancreatic carcinoma</td>
<td>From a SKY, CGH and FISH study of AsPC1, BxPC-3, Capan-1, Capan-2, CFPAC-1, Hs 766T, MIA-PaCa-2, PANC-1, SU.86.86.</td>
<td>Ghadimi 1999</td>
<td></td>
</tr>
<tr>
<td>SUIT-2</td>
<td>Human, Pancreatic</td>
<td></td>
<td>Sirivatanauksorn et al 2001 (20 pancreatic cell lines).</td>
<td></td>
</tr>
<tr>
<td>SUM-159</td>
<td>Human, Breast</td>
<td>Carcinoma</td>
<td>Davidson, Edwards</td>
<td></td>
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</tr>
<tr>
<td>SW48</td>
<td>Human</td>
<td>Colorectal carcinoma</td>
<td>SKY: Ghadimi et al (2000) 1 numerical and 5 structural aberrations (no details). Diploid MMR deficient.</td>
<td>2000 (20 breast carcinoma cell lines on web site)</td>
</tr>
<tr>
<td>SW620</td>
<td>Human</td>
<td>Colorectal carcinoma (Colon cancer) “from a biopsy of a metastatic spread to the abdominal wall of the same patient as SW480”.</td>
<td>Melcher et al (2000) detailed SKY results on SW480 and SW620 [mentions that Gagos et al 1995 Anticancer Res. 15: 369-378, did G-banding on SW480 and SW620]. Melcher et al: “In SW620, 14 altered chromosomes were detected by Gagos et al. (1995), leaving one marker of unknown origin. Our study detected 18 alterations.” …. “Several marker chromosomes previously classified by G-banding analysis turned out to be more complex alterations when analyzed by SKY: der(16)t(3;16;1;16;8;16;1;16;10) in SW620 and der(19)t(19;8;19;5) in SW480. The (erroneously) classified marker chromosomes der(2)t(2;3)(q24;p21) and der(10)t(10;12)(p13;q12), described by Gagos et al. (1995), and several unidentified translocated fragments, e.g., der(5)t(5;20)(q15;p12) and der(8)t(8;17)(p2;q14), reflect the difficulties in the identification of small translocated fragments by conventional banding. Four oncogenes (TERT, SAP2, ERBB3, and MAF) are located in</td>
<td>Melcher et al (2000).</td>
</tr>
<tr>
<td>Cell Line</td>
<td>Species</td>
<td>Tumor Type</td>
<td>Chromosome Aberrations</td>
<td>Reference</td>
</tr>
<tr>
<td>--------------</td>
<td>---------</td>
<td>-----------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>SW756</td>
<td>Human</td>
<td>Cervical carcinoma</td>
<td>84,XXXX,i(Xp),i(Xq),del(3)x4, i(5p),del(8),del(8),del(8),i(8q), t(1;3),t(11p;7q),t(7p;11q),t(2;7), t(8;15),t(8;17) [only one chr. 13, one 20, most others 3-4 copies].</td>
<td>Garini 1996</td>
</tr>
<tr>
<td>SW-979 (SW979)</td>
<td>Human</td>
<td>Pancreatic</td>
<td>Unpublished SKY results (Karen Arden, Carrie Viars, George McNamara).</td>
<td>Sirivatanauksorn et al 2001 (20 pancreatic cell lines).</td>
</tr>
</tbody>
</table>

Van Bokhoven et al (2001) found that TSU-Pr1 and JCA-1 cells are derivatives of T24, “We did not detect a Y chromosome in TSU-Pr1 or JCA-1 cells. However, the original descriptions of these cell lines both mention the presence of a Y chromosome (9, 10). Ironically, this fact was used as proof that these cells were unrelated to HeLa cells. We believe that this chromosome was misidentified in previous publications because, using M-FISH and SKY analysis, we reclassified Y-like chromosomes as chromosome 15 derivatives (Table 1). T24 cells are of female origin and do not contain a Y chromosome (11). … The p53 mutation that we detected in codon 126 (TAC→TAG) in TSU-Pr1, JCA-1, and T24 cells is uncommon. In addition, it has only been reported in a squamous cell carcinoma of the head and neck, in the cell line (HOC605) derived from this tumor, and in the bladder carcinoma cell line BT-1 (17). … Comparison of the published BT-1 (19) karyotype with our T24 karyotype reveals several possible similarities indicating that BT-1 cells might also be a product of T24 contamination. No karyotype has been published for HOC605 cells. … T24 is recognized to have
been the source of contamination in numerous cases. Most of these (EJ/ MGH-U1, MGH-U2, Hu456, Hu549, Hu961T, HCV29T<sub>inv</sub>, and Hu609T<sub>inv</sub>) were already accredited to a bladder origin and subsequently identified as cross-contaminants from T24 (20, 21, 22). Additional cell lines from other organ sites (ECV304, HAG, RAMAK-1, and GHE) have also been identified as cross-contaminants from T24 (6). ECV304, the most frequently used cell line in endothelial research, was first described in 1990 as a spontaneously transformed and immortalized human endothelial cell line (23). However, in 1999, it was found to be the result of cross-contamination by T24 cells (6).

Origin (see also above): “established from the primary tumor of an 81-year-old Caucasian woman with urinary bladder carcinoma (transitional cell carcinoma, grade III) in 1970; described to produce a variety of cytokines (e.g. G-CSF, IL-6 and SCF) and to carry a p53 mutation.

References: Bubenik et al., Int. J. Cancer 5: 310-319 (1970)."

<table>
<thead>
<tr>
<th>Cell Line</th>
<th>Species</th>
<th>Tumor Type</th>
<th>Description</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>T3M-4 (T3M4)</td>
<td>Human</td>
<td>Pancreatic</td>
<td></td>
<td>Sirivatanauksorn et al 2001 (20 pancreatic cell lines).</td>
</tr>
<tr>
<td>T-47D (T47D)</td>
<td>Human</td>
<td>Breast carcinoma</td>
<td></td>
<td>Davidson, Edwards 2000 (20 breast carcinoma cell lines on web site).</td>
</tr>
<tr>
<td>THP-1 (THP1)</td>
<td>Human</td>
<td>Acute monocytic leukemia cell line</td>
<td>MLL-AF9 gene fusion line</td>
<td>Odero, Rowley et al 2000</td>
</tr>
<tr>
<td>TIG-7 (TIG7)</td>
<td>Human</td>
<td>Diploid cell strain</td>
<td>Heteromorphic short arm 15p+ study</td>
<td>Satoh 1998</td>
</tr>
<tr>
<td>TSU-Pr1</td>
<td>Human</td>
<td>derived from T24 bladder carcinoma cell</td>
<td>See van Bokhoven et al (2001) for details on identification of TSU-Pr1 and JCA-1 as T24 bladder</td>
<td>Pan, Kytölä, et al 2001 (see also Pan et al 1999), van</td>
</tr>
<tr>
<td>Cell Line</td>
<td>Species</td>
<td>Type</td>
<td>Description</td>
<td>Reference(s)</td>
</tr>
<tr>
<td>------------</td>
<td>--------------</td>
<td>-------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>U251</td>
<td>Human</td>
<td>Glioblastoma cell line</td>
<td>9 glioblastoma cell lines analyzed (U251, SNB-19, U373-MG, SP101, SP102, Y98G, A172, DBTRG-05MG, YKG-1), first three had very similar karyotypes.</td>
<td>Bokhoven et al (2001)</td>
</tr>
<tr>
<td>U266</td>
<td>Human</td>
<td>Multiple myeloma</td>
<td>From a SKY &amp; G-band study of FR4, SKMM1, SKMM2, U266, XG1, XG2, XG4, XG5, XG6, XG7, and 9 tumors from 8 patients.</td>
<td>Rao 1998</td>
</tr>
<tr>
<td>U373</td>
<td>Human</td>
<td>Glioblastoma cell line</td>
<td>9 glioblastoma cell lines analyzed (U251, SNB-19, U373-MG, SP101, SP102, Y98G, A172, DBTRG-05MG, YKG-1), first three had very similar karyotypes.</td>
<td>Kubota et al 2001</td>
</tr>
<tr>
<td>UM-UC-3</td>
<td>Human</td>
<td>Bladder carcinoma</td>
<td>Abstract cited: 5637, BK-10, HT 1197, J82, RT4 and UM-UC-3 bladder carcinoma lines.</td>
<td>Padilla-Nash 99 abstract</td>
</tr>
<tr>
<td>VP267</td>
<td>Human</td>
<td>Breast Carcinoma</td>
<td></td>
<td>Davidson, Edwards 2000 (20 breast carcinoma cell lines on web site)</td>
</tr>
<tr>
<td>VP299</td>
<td>Human</td>
<td>Breast Carcinoma</td>
<td></td>
<td>Davidson, Edwards 2000 (20 breast carcinoma cell lines on web site)</td>
</tr>
<tr>
<td>Weaver MMTV-c-myc lines</td>
<td>Mouse</td>
<td>Mammary glands from MMTV-cmyc transgenic mice</td>
<td>8 cell lines (or primary cultures from different mice) characterized by SKY and CGH.</td>
<td>Weaver 1999</td>
</tr>
<tr>
<td>WEHI-231</td>
<td>Mouse</td>
<td>DLCL (lymphoma)</td>
<td>BCL-6 gene organization and expression on cell line and many mouse lymphomas. SKY on only the WEHI-231 cell line.</td>
<td>Qi, Coleman et al 2000</td>
</tr>
<tr>
<td>WMP2</td>
<td>Mouse</td>
<td>WMP cell lines established from a mouseheterozygous for T(13.17)1Lub</td>
<td>WMP2: stable karyotype for over 8 months, 23 chromosomes, two pairs of acrocentric chromosomes, 18 metacentric fusion chromosomes, and one large marker chromosome. The marker is the T(13.17)1Lub, identical to that in WMP1. “WMP cell lines contain easily identifiable metacentric fusion chromosomes and are used extensively for gene mapping. …We recommend the use of the WMP2 cell line for future prospective gene mapping in the mouse.”</td>
<td>Liu, Hughes, Heng 2000</td>
</tr>
<tr>
<td>Reference</td>
<td>Type</td>
<td>Description</td>
<td>Notes</td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>------</td>
<td>-------------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>XG1</td>
<td>Human</td>
<td>Multiple myeloma</td>
<td>From a SKY &amp; G-band study of FR4, U266, SKMM1, SKMM2, XG1, XG2, XG4, XG5, XG6, XG7, and 9 tumors from 8 patients. XG1: t(11;14)(q13;32)(cyclin D1 &amp; myeov;IgH), see Janssen et al 2000 Blood 95: 2691-2698 online. XG2: t(11;14)(?;IgH), reported by SKMM2: t(11;14)(q13;32)(cyclin D1 &amp; myeov;IgH), see Janssen et al 2000 Blood 95: 2691-2698 online that the 11q13 breakpoint is at least 750 kb from cyclin D1. XG5: t(11;14)(cyclin D1, myeov;IgH), reported by Janssen, Kuehl, et al 2000 Blood 95: 2691-2698. Abstract Journal article (see also Myeloma SKY.doc). Yoshida et al (1999) reported that by DCFISH (double color FISH), the XG7, SKMM-1 and FR4 cell lines (3 of 17 tested) had t(6p25;14q32)(MUM/IgH) translocations. In XG7 and SKMM-1 lines MUM1 moved to 14q32; in FR4, MUM1 stayed on chr 6 and IgH VH to CH moved to chr 6. They also examined myeloma patient samples. In 8 of 38 cases (20%) MUM1/IgH fusions were found.</td>
<td></td>
</tr>
<tr>
<td>XRPC24</td>
<td>Mouse</td>
<td>Plasmacytoma</td>
<td>SKY confirmed G-band result of t(12;15) and found t(3;6),t(6;3),t(1;X).</td>
<td></td>
</tr>
<tr>
<td>Y98G</td>
<td>Human</td>
<td>Glioblastoma cell line</td>
<td>9 glioblastoma cell lines analyzed (U251, SNB-19, U373-MG, SP101, SP102, Y98G, A172, DBTRG-05MG, YKG-1), first three had very similar karyotypes.</td>
<td></td>
</tr>
<tr>
<td>YKG-1</td>
<td>Human</td>
<td>Glioblastoma cell line</td>
<td>9 glioblastoma cell lines analyzed (U251, SNB-19, U373-MG, SP101, SP102, Y98G, A172, DBTRG-05MG, YKG-1), first three had very similar karyotypes.</td>
<td></td>
</tr>
<tr>
<td>YSK-21</td>
<td>Human</td>
<td>myeloid cell line</td>
<td>first report of a leukemia cell line with t(8;21)(q22;q22)(AML1/MTG8), aberrant TP53, and aberrant TP73. Unbalanced der(1)(t(1;17)(p36;q21) with deletion of one allele of TP73 (1p36) and demethylation of another TP73 allele.</td>
<td></td>
</tr>
<tr>
<td>Zitzelsberger</td>
<td>Human</td>
<td>Thyroid</td>
<td>Chernobyl (See also S48T, Htori-3).</td>
<td></td>
</tr>
<tr>
<td>ZR75</td>
<td>Human</td>
<td>Breast</td>
<td>Also used at CSHL courses for Her-Ried, Schröck &amp;</td>
<td></td>
</tr>
</tbody>
</table>

Rao 1998
Liyanage 1996
Kubota et al 2001
Kubota et al 2001
Inokuchi et al 2001
Zitzelsberger 1999 (Cancer Res.)
<table>
<thead>
<tr>
<th>Cell Line</th>
<th>Origin</th>
<th>Diagnosis</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZR-75-30</td>
<td>Human</td>
<td>Breast carcinoma</td>
<td>Davidson, Edwards 2000 (20 breast carcinoma cell lines on web site)</td>
</tr>
</tbody>
</table>
## Clinical Results (published literature plus data from tables below)

<table>
<thead>
<tr>
<th>Cell line or Diagnosis</th>
<th>G-band</th>
<th>SKY</th>
<th>Comments</th>
<th>Source (assume et al)</th>
</tr>
</thead>
<tbody>
<tr>
<td>infant Acute Basophilic Leukemia (ABL)</td>
<td>SKY helped make diagnosis.</td>
<td></td>
<td></td>
<td>See table 4, this document.</td>
</tr>
<tr>
<td>Acute Lymphocytic Leukemia (ALL)</td>
<td>3 ALL cases in Israel</td>
<td></td>
<td></td>
<td>See table 4, this document.</td>
</tr>
<tr>
<td>B-ALL</td>
<td>Analyzed six cases of (human) B-ALL and NHL (each?), and two multiple myeloma cell lines.</td>
<td></td>
<td></td>
<td>Hilgenfeld et al (1999)</td>
</tr>
<tr>
<td>Acute Monoblastic Leukemia (AMoL)</td>
<td></td>
<td></td>
<td></td>
<td>See table 4, this document.</td>
</tr>
<tr>
<td>Acute myeloid leukemia (AML)</td>
<td>DEL(5)(Q31) t(5;12) der(7)t(1;7) der(7;12) der(11)t(1;11) der(21;22)</td>
<td></td>
<td></td>
<td>Ried et al (1998) review, figure 2.</td>
</tr>
<tr>
<td>Secondary AML</td>
<td></td>
<td></td>
<td></td>
<td>See table 4, this document.</td>
</tr>
<tr>
<td>Club feet</td>
<td>46,XY, add(5)(p15.1) der(5)t(1;5)(q42;p15)</td>
<td>Only aberration</td>
<td>Shepard 99 abstract</td>
<td></td>
</tr>
<tr>
<td>Desmoplastic Sarcoma</td>
<td></td>
<td></td>
<td></td>
<td>See table 5, this document.</td>
</tr>
<tr>
<td>Developmental delay</td>
<td>47,XX,+r r=r(10)</td>
<td>Only aberration</td>
<td>Shepard 99 abstract</td>
<td></td>
</tr>
<tr>
<td>Ewing sarcoma</td>
<td></td>
<td></td>
<td></td>
<td>Jeison 1999 – See table 5, this document.</td>
</tr>
<tr>
<td>Ewing Sarcoma of the skull (case 1)</td>
<td>t(11;22)(EWS/FLI1) &quot;immunohistochemistry, cytogenetic analysis (translocation 11;22), spectral karyotyping and RT-PCR (demonstration of a EWS/FLI1 fusion transcript). …&quot;</td>
<td></td>
<td></td>
<td>Carlotti et al 1999</td>
</tr>
<tr>
<td>Ewing Sarcoma of the skull (case 2)</td>
<td>t(11;22)(EWS/FLI1) &quot;immunohistochemistry, cytogenetic analysis (translocation 11;22), spectral karyotyping and RT-PCR (demonstration of a EWS/FLI1 fusion transcript). …&quot;</td>
<td></td>
<td></td>
<td>Carlotti et al 1999</td>
</tr>
<tr>
<td>Fanconi</td>
<td></td>
<td></td>
<td></td>
<td>See table 4, this</td>
</tr>
<tr>
<td>Condition</td>
<td>Karyotype</td>
<td>Notes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------</td>
<td>----------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K562</td>
<td>CML cell line</td>
<td>“pleural effusion of a patient with chronic myelogenous leukemia (CML) in blast crisis… One or two presumably Philadelphia-derived chromosomes, composed of amplified BCR:ABL fusion genes, were detected repeatedly [1,14,17– 20].: (Naumann et al 2001).</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Naumann et al (2001) write, “The different K562 karyotype characterizations differ partly regarding their set of markers, however they share many cytogenetic features such as at least one acrocentric marker chromosome composed of amplified BCR:ABL fusion genes, a great number of other markers, and a near triploid chromosome number. Thus, the K562 karyotype has remained relatively stable over a period of nearly three decades of subculturing. It is probable that there exist different sublines of K562, which differ slightly in their marker set.” (note: Naumann et al cite Gribble et al 2000 in a footnote as a new paper).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lipoblastoma</td>
<td>46,XY, -8, -13, +mar, add(16)(q22), +r mar=del(13)(q12), ins(16;8)(q22;q11.2q24), r=r(8)</td>
<td>Shepard 99 abstract</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malignant peripheral nerve sheath (MPST)</td>
<td>One case from Israel.</td>
<td>See table 5, this document.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Multiple congenital abnormalities (death postnatal day 12)

- Supernumery marker chromosome 15: der(15) inv dup(15q25-qter), resulting in partial tetrasomy 15 [FISH after SKY]
-著作权者 Huang et al 1998

### Multiple myeloma

- 50 (more!) cases: 50 more cases (see also Sawyer et al 1998 paper), yielding additional new recurrent chromosome aberrations found by SKY.
- 著作権者 Sawyer et al 1999 (ASH1999 abstract)

### Multiple myeloma

- 50 cases: SKY corrected the G-banding results in 48 of the 50 cases (the other two were both normal karyotypes and probably did not have any tumor cells).
- 著作権者 Sawyer et al 1999

### Multiple myeloma

- Analyzed several clinical cases and cell lines
- 著作権者 Rao et al 1998

### Multiple myeloma

- Analyzed six cases of (human) B-ALL and NHL (each?), and two multiple myeloma cell lines.

### Neuroblastoma

- 3 cases.
- 請参考第5表，此文件

### Non-Hodgkin lymphoma (NHL)

- Analyzed six cases of (human) B-ALL and NHL (each?), and two multiple myeloma cell lines.

### Osteogenic Sarcoma

- One case from Israel.
- 請參考第5表，此文件

### Primary central nervous system lymphoma (PCNS lymphoma)

- 46,XX add(1)(q44)
  - add(6)(p25)
  - del(7)(q22q36)
  - del(9)(p13p24)
  - -12
  - -14
  - mar1
  - mar2
  - mar3 [17 called normal]
- All chr 1 (dup(1)) t(6;12)
  - same t(3 and 5;9)
  - [see marker 2 i.d.]
  - [see marker 3 i.d.]
  - [see marker 1 i.d.]
  - t(5;14)
  - t(5;12)
  - t(12)
  - t(15;17)
- (GM) Identified 3 markers, found three translocations mis-called by G-banding, identified the add(1) material as same.
- 著作権者 Zattara-Cannoni et al 1998

### Primary Prostate cancer cell line

- -
- Study also included DU 145, LN CaP and PC-3 cell lines.
- 著作権者 M. Augustus et al (submitted, see PC-3 for details)

### Primitive neuroectodermal tumor (PNET)

- t(12;15)(p13;q25q26)(TEL;?)
- SKY defined "a novel translocation t(12;15)(p13;q25q26) in a primitive
neuroectodermal tumor. (ETV6/TEL fusion).

Rhabdomyosarcoma
SKY result lead to change in diagnosis from lymphoma to rhabdomyosarcoma.
Jeison 1999 – See table 5, this document.

Small Blue Cell Tumor
+1-4mar
mar1=del(16)(p11.2)
Mar2=del(21)(q22.1)
See abstract for complete karyotype
Shepard 99 abstract

Synovial sarcoma
SKY result lead to change in diagnosis from Ewing to Synovial.
Cohen et al 1997

Synovial sarcoma
In two of the three synovial sarcoma cases in table 5, SKY results lead to change in diagnosis from Ewing to Synovial.
Jeison 1999 – See table 5, this document.

Wilm’s tumor
1 case from Israel.
See table 5, this document.

Wolf-Hirshhorn syndrome
slightly abnormal band 4p16.3 by hi-res G-banding
der(4)t(4;8)
Text mentions that ~10% of W-H are translocations; 90%
are del(4).
Ried et al 1998 fig 1.

Note: The table above does not include all references and emphasizes SKY refinement, not complete karyotypes.

Additional cases:
Schröck et al (1997) Hum. Genet. Table 1: 16 clinical (pre-/post-natal) cases from 7 labs.

Clinical SKY in Israel: Pre-natal and Post-natal Diagnosis

<table>
<thead>
<tr>
<th>Case</th>
<th>Cell type</th>
<th>G-banding results</th>
<th>SKY results</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Amniocentesis</td>
<td>47,XY,+mar</td>
<td>47,XY,+der(15)</td>
<td>Termination of pregnancy</td>
</tr>
<tr>
<td>2</td>
<td>Amniocentesis</td>
<td>47,XY+mar</td>
<td>47,XY,+der(8)</td>
<td>Termination of pregnancy</td>
</tr>
<tr>
<td>3</td>
<td>Amniocentesis</td>
<td>47,XX,+mar</td>
<td>47,XX,+der(18)</td>
<td>Termination of pregnancy</td>
</tr>
<tr>
<td>4</td>
<td>Amniocentesis</td>
<td>47,XY,+mar</td>
<td>47,XY,+der(Y)</td>
<td>Pregnancy continues</td>
</tr>
<tr>
<td>5</td>
<td>Amniocentesis</td>
<td>47,XY,+mar</td>
<td>47,XY,+der(18)</td>
<td>Termination of pregnancy</td>
</tr>
<tr>
<td>6</td>
<td>Amniocentesis</td>
<td>47,XX,+mar</td>
<td>47,XX,+der(15)</td>
<td>Termination of pregnancy</td>
</tr>
<tr>
<td>7</td>
<td>Amniocentesis</td>
<td>46,XY,add(18)</td>
<td>46,XY,+der(18)t(11;18)</td>
<td>Unbalanced traslocation Termination of pregnancy</td>
</tr>
<tr>
<td>8</td>
<td>Amniocentesis</td>
<td>46,XY,add(11)?</td>
<td>46,XY,+der(11)add(11)</td>
<td>Pregnancy continues</td>
</tr>
<tr>
<td>9</td>
<td>Amniocentesis</td>
<td>47,XX,+mar</td>
<td>47,XX,+? Marker seen in DAPI only</td>
<td>Conclusion: marker contains only satellite DNA, recommended to continue the pregnancy</td>
</tr>
<tr>
<td>10</td>
<td>Lymphocytes</td>
<td>46,XY,t(1;?)</td>
<td>46,XY,t(1;5)</td>
<td>Couple - multiple abortions</td>
</tr>
<tr>
<td>11</td>
<td>Lymphocytes</td>
<td>47,XY,+mar</td>
<td>47,XY,+der(5)</td>
<td>Mental retardation</td>
</tr>
<tr>
<td>12</td>
<td>Lymphocytes</td>
<td>46,XX / 47,XX,+mar</td>
<td>46,XX / 47,XX,+4</td>
<td>Familial marker</td>
</tr>
<tr>
<td>13</td>
<td>Lymphocytes</td>
<td>46,X,+der(X)t(X;?)</td>
<td>46,X,+der(X)t(2;X)</td>
<td>14 years old girl – Charge disease (see also Lev et al 2000, case of an 11 y.o. girl).</td>
</tr>
<tr>
<td>No.</td>
<td>Diagnosis</td>
<td>G-banding results</td>
<td>SKY results</td>
<td>After SKY</td>
</tr>
<tr>
<td>-----</td>
<td>-------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>1</td>
<td>ALL</td>
<td>46,XY,der(1)t(1;18),del(12) / 46,XY,der(1)t(1;18),add 12</td>
<td>46,XY,der(1)t(1;18),del(12) / 46,XX,der(1)t(1;18),der(12)t(8;12)</td>
<td>ALL</td>
</tr>
<tr>
<td>2</td>
<td>ALL</td>
<td>48,XY,der(1)t(1;12),+5,del(6),-8,-9,-12,-14,+mar1,2,3,4,5</td>
<td>48,XY,der(1)t(1;12),+5,del(6),der(8)t(8;17),der(9)t(9;12),idic(9),der(12)t(1;9;12),der(12)t(1;9;12),der(14)t(6;14)</td>
<td>ALL</td>
</tr>
<tr>
<td>3</td>
<td>Fanconi Anemia</td>
<td>46,XY,der(7)</td>
<td>41,XX,-1,5,-8,-11,t(9;17),t(1;9),+dmin(8),t(1;9),+dmin(8),ring(1)</td>
<td>Fanconi Anemia</td>
</tr>
<tr>
<td>4</td>
<td>Secondary AML</td>
<td>41,XX,+m,-1,-5,-8,-9,-11,add(15)?,add(17)?,+dmin / 41,XX,+m,-1,-5,-8,-9,-11,add(15)?,add(17)?,+dmin,+ring</td>
<td>46,XY,der(9)t(9;21), der(12)t(12;17),del(17),der(21)t(12;21)(TEL;AML).</td>
<td>Secondary AML</td>
</tr>
<tr>
<td>5</td>
<td>ALL</td>
<td>46,XY,der(12),del(17)</td>
<td>46,XY,der(9)t(9;21), der(12)t(12;17),del(17),der(21)t(12;21)(TEL;AML).</td>
<td>ALL, Good</td>
</tr>
</tbody>
</table>
| 6   | AMoL              | 1) 47,XX,+8,del(9)  
2) 47,XX,+8,del(9),der(11)t(1;11)  
3) 46,XX,add(7)(p22),-13,-22,+mar1,+mar(2) | 1) 47,XX,+8,del(9),t(10;11)  
2) 47,XX,+8,del(9),t(10;11),der(11)t(1;11)  
3) 46,XX,der(7)t(3;7),t(9;10),t(10;11) | Poor prognosis, based on the t(12;21)(TEL-AML1). Stark 1999. Acute Monoblastic Leukemia (AMoL) rare type of infant Acute Basophilic |
| 7   | ?                 | 47,X,-X,der(6),t(6;?),der(11)t(11;?),+13,                                         | 47,X,der(6)t(6;X),der(11)t(11;X),+13,                                         |                     |

Clinical SKY in Israel: Diagnosis of Leukemias

Work performed at Cancer Cytogenetics Laboratory & Pediatric Hematology and Oncology Center, Schneider Children’s Medical Center of Israel, Petah Tikva, Israel. Data received from Dr. Irit Bar-Am, Applied Spectral Imaging, Ltd., September 7, 1999.
<table>
<thead>
<tr>
<th></th>
<th>Diagnosis</th>
<th>G-banding results</th>
<th>SKY results</th>
<th>Diagnosis after SKY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ewing Sarcoma</td>
<td>45,X,Y,der(X), t(1;22), -22</td>
<td>45,t(X;18)Y,Y, t(1;22), -22</td>
<td>Synovial Sarcoma</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Jeison 1999</td>
</tr>
<tr>
<td>2</td>
<td>Neuroblastoma</td>
<td>45,X,Y, der(1)t(1;5), del(5p), -5, del(9q), -10, -13, del(20q), +m1,+m2,+m3</td>
<td>45,X,Y, der(1)t(1;5), der(4)t(4;19), del(5p), der(5)t(5;22), der(10)t(10;20), der(11)t(11;22), der(13)t(4;13), der(19)t(19;11;22), der(20)t(5;20), -22.</td>
<td>Ewing Sarcoma</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Jeison 1999</td>
</tr>
<tr>
<td>3</td>
<td>Ewing Sarcoma</td>
<td>47,X,Y, der(2)t(2;18), +15, del(18q)</td>
<td>47,der(X)t(X;18)Y,Y, der(2)t(X;2), +15, del(18q)</td>
<td>Synovial Sarcoma</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Jeison 1999</td>
</tr>
<tr>
<td>4</td>
<td>Synovial Sarcoma</td>
<td>47,X,Y,+14,t(X;18)</td>
<td>47,X,Y,+14,t(X;18), t(3;14)</td>
<td>Synovial Sarcoma</td>
</tr>
<tr>
<td>5</td>
<td>Lymphoma</td>
<td>68,XYY, -1, -10, -11, -13, -13, +20, +21, +22, +hsr(m), +mx2</td>
<td>68,XYY, hsr(1), der(13)t(1;13)x2</td>
<td>Rhabdomyosarcoma</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Jeison 1999</td>
</tr>
<tr>
<td>6</td>
<td>Desmoplastic Sarcoma</td>
<td>42,X,Y,del(1p), 3p?, -4, add(13q), -16, -17, -17, +m , -18</td>
<td>42,X,Y,der(1)t(1;17), der(3)t(3;17), -4, der(13)t(4;13), -16, der(17)t(1;17), -18</td>
<td>Desmoplastic Sarcoma</td>
</tr>
<tr>
<td>7</td>
<td>Neuroblastoma</td>
<td>47,XX, -3?, +m1,+m2,+dmin</td>
<td>46,XX, der(2)t(3;15), -3, der(6)t(3;6), der(15)t(6;15)x2, +der(15)t(6;15), der(19)t(1;19), -21</td>
<td>Neuroblastoma</td>
</tr>
<tr>
<td>8</td>
<td>Neuroblastoma</td>
<td>45,X-Y, t(5;?),del(6q), -8, -14, -19, +m1,+m2,+m3,+m4</td>
<td>43,X-Y, der(5)t(5;6), del(9q), -11, der(14),t(1;14), -17, der(19)(9;19)</td>
<td>Neuroblastoma</td>
</tr>
<tr>
<td>Type</td>
<td>Cases</td>
<td>Findings</td>
<td>Cryptic translocation</td>
<td></td>
</tr>
<tr>
<td>------------------------------</td>
<td>-------------</td>
<td>---------------------------------------------------------------------------</td>
<td>---------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Clinical cases 25</strong></td>
<td>16</td>
<td>SKY identified the origin of the markers and translocations</td>
<td>t(1;5) in a couple with multiple abortions</td>
<td></td>
</tr>
<tr>
<td><strong>8 with normal G-banding</strong></td>
<td></td>
<td>Normal with SKY</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1 postnatal – Normal by G-banding</strong></td>
<td></td>
<td>der (6)t(6;21) in a born baby (Down syndrome)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pediatric solid tumor 19</strong></td>
<td></td>
<td>In each case SKY identified the origin of markers and complex translocations</td>
<td>In 4 cases SKY identified a translocation that changed the diagnosis</td>
<td></td>
</tr>
<tr>
<td><strong>Leukemias 13</strong></td>
<td></td>
<td>In each case SKY identified the origin of markers</td>
<td>In two cases (t(12;21) and t(10;11)) SKY identified a translocation that changed the diagnosis</td>
<td></td>
</tr>
</tbody>
</table>

Work performed at Cancer Cytogenetics Laboratory & Pediatric Hematology and Oncology Center, Schneider Children’s Medical Center of Israel, Petah Tikva, Israel. Data received from Dr. Irit Bar-Am, Applied Spectral Imaging, Ltd., September 7, 1999.

Summary of Clinical SKY in Israel
Molecular Profiling of Cell lines

The table below lists 60 cell lines that have been extensively studied for drug sensitivities by the National Cancer Institute. The table below is from Figure 2 of Scherf et al (2000), who analyzed gene expression changes in the NCI60 series for a panel of drugs. Dr. Ilan Kirsch, Genetics Department, Medicine Branch, Division of Clinical Sciences, National Cancer Institute (NCI), wrote me that his group has SKY’d "about a third to a half of them (ovarian, leukemia, colon, breast, renal primarily)." I point this out to avoid duplications and to see how molecular cytogenetics compares to expression microarrays (sometimes known as “molecular profiling”) in biological impact.

NCI60 Series of Cell Lines

<table>
<thead>
<tr>
<th>Type</th>
<th>Cell line</th>
<th>SKY’d?</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>BR</td>
<td>MDA-MB-231</td>
<td>(Estrogen receptor negative?).</td>
<td></td>
</tr>
<tr>
<td>BR</td>
<td>HS 578T</td>
<td>Estrogen receptor negative.</td>
<td></td>
</tr>
<tr>
<td>BR</td>
<td>BT-549</td>
<td>Estrogen receptor negative.</td>
<td></td>
</tr>
<tr>
<td>BR</td>
<td>T47D</td>
<td>Estrogen receptor positive.</td>
<td></td>
</tr>
<tr>
<td>BR</td>
<td>MDA-MB-435*</td>
<td>*signatures of melanotic melanoma.</td>
<td></td>
</tr>
<tr>
<td>CNS</td>
<td>SNB-75</td>
<td>p53 wild-type (O’Connor et al 1997).</td>
<td></td>
</tr>
<tr>
<td>CNS</td>
<td>SF-539</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CNS</td>
<td>SF-268</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CNS</td>
<td>SF-295</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CNS</td>
<td>U251</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CNS</td>
<td>SNB-19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO</td>
<td>COLO 205</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO</td>
<td>HCC-2998</td>
<td></td>
<td></td>
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<tr>
<td>Category</td>
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<td>Reference</td>
<td></td>
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<tr>
<td>----------</td>
<td>-----------</td>
<td>-----------</td>
<td></td>
</tr>
<tr>
<td>CO</td>
<td>HT29</td>
<td>CSHL</td>
<td>Ried/Schröck CSHL courses. Goodison/Arden/McNamara unpublished.</td>
</tr>
<tr>
<td>CO</td>
<td>KM12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO</td>
<td>HCT-15</td>
<td>UCSD</td>
<td>High expression of ABCB1 (MDR1).</td>
</tr>
<tr>
<td>CO</td>
<td>SW-620</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO</td>
<td>HCT-116</td>
<td></td>
<td>p53 wild-type (O'Connor et al 1997).</td>
</tr>
<tr>
<td>LC (lung)</td>
<td>NCI-H522</td>
<td></td>
<td>Non-small cell lung cancers</td>
</tr>
<tr>
<td>LC</td>
<td>NCI-H23</td>
<td></td>
<td></td>
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<tr>
<td>LC</td>
<td>NCI-H322M</td>
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<tr>
<td>LC</td>
<td>HOP-92</td>
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<tr>
<td>LC</td>
<td>HOP-62</td>
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<tr>
<td>LC</td>
<td>NCI-H226</td>
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</tr>
<tr>
<td>LC</td>
<td>EKVX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LC</td>
<td>A549/ATCC</td>
<td></td>
<td>p53 wild-type (O'Connor et al 1997).</td>
</tr>
<tr>
<td>LC</td>
<td>NCI-H460</td>
<td></td>
<td>p53 wild-type (O'Connor et al 1997).</td>
</tr>
<tr>
<td>LE</td>
<td>CCRF-CEM</td>
<td></td>
<td>ALL: acute lymphoblastic leukemia (derived).</td>
</tr>
<tr>
<td>LE</td>
<td>HL-60(TB)</td>
<td>Liang</td>
<td></td>
</tr>
<tr>
<td>LE</td>
<td>RPMI-8226</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LE</td>
<td>SR</td>
<td>p53 wild-type (O'Connor et al 1997).</td>
<td></td>
</tr>
<tr>
<td>ME (melanoma)</td>
<td>UACC-257</td>
<td></td>
<td>p53 wild-type (O'Connor et al 1997).</td>
</tr>
<tr>
<td>ME</td>
<td>SK-MEL-28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME</td>
<td>MALME-3M</td>
<td></td>
<td>p53 wild-type (O'Connor et al 1997).</td>
</tr>
<tr>
<td>ME</td>
<td>SK-MEL-2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME</td>
<td>M14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME</td>
<td>UACC-62</td>
<td></td>
<td>p53 wild-type (O'Connor et al 1997).</td>
</tr>
<tr>
<td>ME</td>
<td>SK-MEL-5</td>
<td></td>
<td>p53 wild-type (O'Connor et al 1997).</td>
</tr>
<tr>
<td>ME</td>
<td>LOX IMVI</td>
<td>&quot;Did not cluster with other ME's.&quot; p53 wild-type (O'Connor et al 1997).</td>
<td></td>
</tr>
<tr>
<td>OV (ovarian)</td>
<td>SK-OV-3</td>
<td>Roschke</td>
<td>(SKOV-3) A.V. Roschke (ASHG1999).</td>
</tr>
</tbody>
</table>
low level amplification of 3q26 including human telomerase RNA component (hTR) in OVCAR-3.

<table>
<thead>
<tr>
<th>Cell line type</th>
<th>Abbreviation</th>
<th>p53 status</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>OV</td>
<td>OVCAR-5</td>
<td>Roschke</td>
<td>A.V. Roschke (ASHG1999).</td>
</tr>
<tr>
<td>OV</td>
<td>OVCAR-8</td>
<td>Roschke</td>
<td>(OVCAR-8) A.V. Roschke (ASHG1999).</td>
</tr>
<tr>
<td>REenal</td>
<td>SN12C</td>
<td></td>
<td>High expression of ABCB1 (MDR1).</td>
</tr>
<tr>
<td>RE</td>
<td>CAKI-1</td>
<td></td>
<td>p53 wild-type (O'Connor et al 1997).</td>
</tr>
<tr>
<td>RE</td>
<td>786-0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RE</td>
<td>RXF 393</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RE</td>
<td>TK-10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RE</td>
<td>ACHN</td>
<td></td>
<td>High expression of ABCB1 (MDR1). p53 wild-type (O'Connor et al 1997).</td>
</tr>
<tr>
<td>RE</td>
<td>A498</td>
<td></td>
<td>p53 wild-type (O'Connor et al 1997).</td>
</tr>
<tr>
<td>UnKnown</td>
<td>NCI/ADR-Res</td>
<td></td>
<td>High expression of ABCB1 (MDR1), that had been selected for adriamycin resistance. (Is this an MCF7 derivative?).</td>
</tr>
</tbody>
</table>

Cell line type abbreviations and clustering (Fig 2 of U. Scherf et al 2000).

BR breast origin (BR) appeared most heterogeneous. The breast cell lines positive for the oestrogen receptor, T-47D and MCF7, appeared together and grouped with the colon lines, whereas the breast cell lines negative for the oestrogen receptor, HS578T and BT-549, clustered with CNS malignancies. *Two cell lines (MDA MB435 and MDA-N) with the gene expression and drug sensitivity signatures of melanotic melanoma, but derived from a pleural effusion of a patient with breast cancer.

CO colon cancer lines (CO; 7/7 clustered together).

CNS lines (CNS; 6/6).

LC Non-small-cell lung cancer cells (LC) clustered on two different branches.

LE leukemias (LE; 6/6).

ME melanoma lines (ME; 7/8)

RE renal carcinoma lines (RE; 7/8),

OV ovarian lines (OV; 4/6).

UK unknown NCI/ADR-Res is of unknown origin (UK).


Original characterization of the NCI panel was:

The status of the p53 gene in the 60 cell lines was determined by:

---

**ISCN Nomenclature**

I found online at [http://www.dsmz.de/mutz/mutzcyto.htm](http://www.dsmz.de/mutz/mutzcyto.htm) the following information (the official terminology is in Mitelman 1991 and contains additional items.

“The DSMZ Catalogue of Human and Animal Cell Lines follows standard nomenclature systems (1,2). Some frequently used abbreviations are explained as follows: abr, abnormally banded region; cen, centromere; colon single (:), break (in detailed descriptions); colon double (::), breakage and reunion (in detailed description); add, additional material of unknown origin; del, deletion; der, derivative chromosome; dic, dicentric; dir, direct; dmin, double minute; dup, duplication; hsr, homogeneously staining region; ins, insertion; inv, inversion; mar, marker chromosome; min, minute; minus (-), loss of; p, short arm; Ph, Philadelphia chromosome; plus (+), gain of; psu, pseudo; q, long arm; question mark (?), questionable chromosome identification; r, ring chromosome; rcp, reciprocal; s, satellite; semicolon (;), separates chromosomes/regions in structural rearrangements involving more than one chromosome; t, translocation; ter, terminal.

**References:**

The following excellent web page by Jeff Shaw, M.S., Genetic Counselor, lists many of the ISCN terms, with a focus on constitutional abnormalities (pre-natal and post-natal clinical cytogenetics).

**Chromosome Deletion Outreach, Inc.**
[http://members.aol.com/cdousa/intro.htm](http://members.aol.com/cdousa/intro.htm)

**Below are a few of the codes used in the standard nomenclature.**
- **add** = Addition material of unknown origin
- **del** = Deletion
- **de novo** = A chromosome abnormality which has not been inherited
- **der** = Derivative Chromosome
- **dic** = Dicentric
- **dup** = Duplication
\[
\text{fra} = \text{Fragile Site} \\
\text{idic} = \text{Isodicentric chromosome} \\
\text{ins} = \text{Insertion} \\
\text{inv} = \text{Inversion} \\
\text{i or iso} = \text{Isochromosome} \\
\text{mar} = \text{Marker chromosome} \\
\text{mat} = \text{Maternal origin} \\
\text{Minus sign} (-) = \text{Loss} \\
\text{mos} = \text{Mosaic} \\
\text{p} = \text{Short arm of chromosome} \\
\text{pat} = \text{Paternal origin} \\
\text{Plus sign} (+) = \text{Gain} \\
\text{q} = \text{Long arm of chromosome} \\
\text{r} = \text{Ring chromosome} \\
\text{rcp} = \text{Reciprocal} \\
\text{rea} = \text{Rearrangement} \\
\text{rec} = \text{Recombinant chromosome} \\
\text{rob} = \text{Robertsonian translocation} \\
\text{t} = \text{translocation} \\
\text{tel} = \text{Telomere (end of chromosome arm)} \\
\text{ter} = \text{Terminal end of chromosome} \\
\text{upd} = \text{Uniparental disomy} \\
? = \text{Uncertain}
\]

It is important to note that most chromosome abnormalities occur as an accident in the egg or sperm. Therefore every cell in the body would have the abnormality. Some abnormalities can happen after conception and individuals can have a mosaicism (some cells with the abnormality and some without). Chromosome abnormalities can be inherited from a parent, like a translocation, or be 'de novo' (new in that individual).

**How are Chromosomes and Chromosome Abnormalities Labeled?**

In 1960 the first meeting to propose a standard system of naming the chromosomes took place. Since that time this method of describing chromosomes and chromosome abnormalities has been revised and added to several times. It has produced an International Standard of Cytogenetic Nomenclature. This allows one lab to 'write out' the chromosome findings. Any other lab will know what they have found without looking at the karyotype.

Here Are some examples:

- **46,XX** - Normal Female Karyotype
- **46,XY** - Normal Male Karyotype
  These descriptions say there are 46 chromosomes and that it is a male or female.
- **46,XX,del(14)(q23)**
  Female with 46 chromosomes with a deletion of chromosome 14 on the long arm (q) at band 23.
- **46,XY,dup(14)(q22q25)**
  Male with 46 chromosomes with a duplication of chromosome 14 on the long arm (q) involving bands 22 to 25.
- **46,XX,r(7)(p22q36)**
  Female with 46 chromosomes with a 7 chromosome ring. The end of the short arm (p22) has fused to the end of the long arm (q36) forming a circle or 'ring'.
- **47,XY,+21**
Male with 47 instead of 46 chromosomes and the extra chromosome is a 21. (Down Syndrome)

What is a Chromosome Inversion?

(see http://members.aol.com/cdousa/intro.htm for picture of pericentric and paracentric inversions)

An inversion consists of two breaks in one chromosome. The area between the breaks is inverted (turned around), and then reinserted and the breaks then unite to the rest of the chromosome. If the inverted area includes the centromere it is called a pericentric inversion. If it does not, it is called a paracentric inversion.

Notice that in a pericentric inversion one break is in the short arm and one in the long arm. Therefore an example of a cytogenetic nomenclature might read 46,XY,inv(3)(p23q27). A paracentric inversion does not include the centromere and an example might be 46,XY,inv(1)(p12p31).

When a parent has an inversion there is an increased risk for offspring with an incorrect amount of genetic material. This can lead to babies with birth defects and/or abnormal development or an increased risk for miscarriage. The possible pregnancy outcomes for an individual with an inversion is rather complicated and depends on how big the inversion is, where it is, and what type of inversion is present, paracentric or pericentric. There are many inversions that occur in the general population that are called normal variants. Including Inv(9) and Inv(2). These inversions are not related to an increased risk of birth defects and/or developmental difficulties.

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24-Color Karyotyping with filters: M-FISH, Rx-FISH, COBRA-FISH, armFISH, mBand, M-TEL Publications

The number of SKY publications exceeds the number of M-FISH publications, in spite of the nominally lower cost of a filter based system and the several months head start M-FISH had in terms of 1996 publication dates (the patent dates are a different story!). Considering how much money David Ward, BioRad (the late and unlamented “genescope”), Michael Speicher, Vysis, Applied Imaging, PSI, MetaSystems, Leica, Cross-species color banders and the ‘COBRA-FISHers’ have spent on M-FISH, the achievement of Applied Spectral Imaging, Thomas Ried and Evelin Schröck is even more remarkable. I am of course a big fan of SKY, and in the past was consequently somewhat “anti-M-FISH”, and am happy to make my biases clear. Since moving to CHLA in March 2000 I’ve become less biased but purchasing a SKY™ system for the image core facility I manage was a “no-brainer” (in fact, in January 2001 CHLA was the first customer to get the new SD-300/VDS spectral imager).

While I do not claim an exhaustive list of publications, here are the M-FISH papers I have found to date. If I’m missing any, please email me the references (gmcnamara@chla.usc.edu). In general new M-FISH papers can be found by searching medline for “24 color FISH”, “M-FISH”, “multiplex and FISH”, Speicher MR, “COBRA and Tanke”, “mFISH”, “cross-species color banding”, “RxFISH”, “mBand”, “armFISH”, mTEL (and then screening out irrelevant hits like M-FISH being metaphase FISH). Actually RxFISH is a seven color banding method, not 24-color/24-chromosome method (but we’ll cite RxFISH papers anyway). Searching Medline with either “molecular cytogenet*” or “molecular karyotyp*” finds some SKY, some mFISH and some CGH papers. When searching Medline for M-FISH papers you will find at least one where it means Metaphase-FISH. Even in ‘Y2K’ most mFISH papers are on technology development and fail to provide an ISCN style karyotype (i.e. Azofeifa et al 2000). Note the lack of mouse papers (until Jentsch et al and Langer et al in mid-2001).

Publications (newest papers at the top of the list)


A. van Bokhoven, M. Varella-Garcia, C. Korch, G.J. Miller (2001) TSU-Pr1 and JCA-1 cells are derivatives of T24 bladder carcinoma cells and are not of prostatic origin. *Cancer Res.* 61: 6340-6304. PMID: 11522622. [SKY on T24, M-FISH on TSU-Pr1 and JCA-1].


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K. Michalova, Z. Zemanova, J. Brezinova (2001) [No title available]. *Cas Lek Cesk.* 140:99-103. Czech. kyra@vfn.cz [mFISH and mBAND].


J. Azofeifa, C. Fauth, J. Kraus, C. Maierhofer, S. Langer, A. Bolzer, J. Reichman, S. Schuffenhauer, M.R. Speicher (2000) An optimized probe set for the detection of small interchromosomal aberrations by use of 24-color FISH. *Am J Hum Genet.* 66: 1684-1688. (The “M8-FISH” 8-fluor probe set was theorized as being optimal but the authors only really did “M7-FISH”).


M.E. Law, S.M. Jalal (1999) Utility of multicolor fluorescent in situ hybridization in clinical cytogenetics. Genetics In Medicine 1: 181-186. journal table of contents abstract (See also Schwartz 1999 editorial in the same issue). (Note: The article is not in medline. It includes one result using the Vysis SpectraVysion™ M-FISH instrument and reagent -- the authors were beta testers for Vysis. Mark Law told the author that after publication he had intermittent successes/failures using successive Vysis 24-color kits).


Reviews (See also SKY reviews).


M-FISH Web Sites

David C. Ward, Yale University [http://info.med.yale.edu/bbs/faculty/war_da.html](http://info.med.yale.edu/bbs/faculty/war_da.html)

RxFISH and SKY at CMGS (MRC) [http://www.ich.bpmf.ac.uk/cmgs/mfishsky.htm](http://www.ich.bpmf.ac.uk/cmgs/mfishsky.htm)

Applied Imaging Corp. [www.aicorp.com](http://www.aicorp.com)
Roland Eils  http://www.iwr.uni-heidelberg.de/groups/bioinf/  Eils group molecular cytogenetics analysis

Michael Speicher  Speicher lab, LMU-University of Munich


Manuel R. Teixeira, Francesca Micci, Claudia U. Dietrich & Sverre Heim  Chromosomal rearrangements in leukaemias with incomplete G-band karyotypes  Manuscript In Press (Genes, Chromosomes and Cancer July 99) abstract from Spoken Poster: 6th European Conference on Cytogenetics And Molecular Genetics of Human Solid Tumors, Saarbruken, Germany 1998


Petek E; Emberger W; Kroisle PM; and Wagner K  Detailed characterization of a complex chromosomal rearrangement in a patient with microcephaly and early onset spasticity  Poster Abstract: ASGG 98, Austria

Yang, Fengtang; O'Brien, PCM; Rens, W; Ferguson-Smith, M  Karyotype evolution in mammals revealed by comparative chromosome painting  Spoken Poster at BSHG 1998, UK

J.Chiesa, J. Agenor , O. Rousseau , M. Hoffet, F. Deschamps , P. Mares , J-P. Bureau  Prenatal diagnosis of partial trisomy 1Q using multicolor chromosome barcode by fluorescence in situ hybridization  Spoken Poster presented at ACLF 98, France

S. Müller  Cross-Species Color Banding (CSC-banding): Technical Aspects  Spoken Poster presented at ASHG 97, USA

Note: CytoCell Multi-Probe reagents are not included because their products do not screen a single metaphase.

Related Topics: Cell Culture

This section contains references to papers and books that I think have valuable points to make about cell culture as it relates to G-banding and molecular cytogenetics.


“It has been argued that LL cell lines are genetically unstable (both cyogenetically and molecular genetically). For instance, cell lines are supposed to acquire numerical and structural chromosomal alterations and various types of mutations (e.g. point mutations) in vitro. We present evidence that while nearly 100% of all LL cell lines indeed carry genetic alterations, these alterations appear to be stable rather than unstable.” (abstract).

“…422 human hematopoietic cell lines were examined at the DSMZ from 1989 to 2000. … a staggering 30% of the cell lines examined were found to be mycoplasma-positive”. (p. 892).

“Using a combination of DNA fingerprinting and cytogenetic analysis, it was found that 42:222 (19%) cell lines from the original source and 14:112 (12.5%) cell lines from a secondary source were cross-contaminated with another hematopoietic cell line (total: 56/334 = 16.8%). The DSMZ website www.dsmz.de/mutz/mutzmisi.htm lists the hematopoietic cell lines that were cross-contaminated at the original source and for which it is known that no correct culture under that name exists. In most instances, the karyotype in the original publication corresponds already to the karyotype of the cross-contaminating cell line.” (p. 894).

The authors have a nice discussion about chromosome instability (CI), see pp. 897 and 900-906 (SKY result of HDLM-2 in fig. 6 and in MacLeod et al 2000).

“…among 429 well-characterized cell lines (excluding sister cell lines, subclones, EBV B-LCLs, Burkitt’s lymphoma- and ATLL-derived cell lines) for which karyotypes have been published, only two (0.5%) showed a normal karyotype without any structural or numerical aberrations.” (p. 885)
of 429 leukemia/lymphoma cell lines had cytogenetic abnormalities.


H.G. Drexler, W.G. Dirks, R.A.F. MacLeod (1999) False human hematopoietic cell lines: cross-contaminations and misinterpretations. Leukemia 13: 1601–1607. (updated in Fig. 4 of Drexler et al 2000 (see above) and at www.dsmz.de/mutz/mutzmisi.htm).


Here is an interesting review on mistaken identity:


A recent study has uncovered an astonishingly high level of misidentification of laboratory cell lines. Short tandem repeat (STR) profiling was used to examine 253 human cell lines and revealed that 36% were of a different type, or from a different species to that claimed. STR profiling is commonly used in forensic science and uses standard oligonucleotide primers to amplify polymorphic STR loci in the sample of interest. Automated analysis of the PCR products generates a numerical code specific for the sample. The authors suggest that STR profiling should provide the basis for an international reference standard for human cell lines and that all cell lines should be authenticated at the time they are being used [Masters J.R. et al. (2001) Proc. Natl. Acad. Sci. U. S. A. 98, 8012–8017]. The misidentification of cell lines might have been extremely costly in terms of wasted time, effort and money. First author John Masters of University College London, UK, describes the situation as a 'scandal', and UK newspaper The Observer claims that breast cancer cells have been mistakenly used in liver cancer research and that some colon cancer research has been carried out using cell lines from cervical tumours. However, with the mandatory testing of cell lines, which costs about $200 per sample, this problem could quickly be minimized, assuring the quality of published data.


For an exchange about a possible misidentification of three glioblastoma cell lines by Kubota et al (2001), see:


Related Topics: Cytogenetic Slide Preparation

This section contains references to papers and books that I think have valuable points to make about preparing microscope slide specimens as it relates to G-banding and molecular cytogenetics.

Henegariu et al (2001) discuss optimization of slide preparation for G-banding and interphase and metaphase FISH/MFISH/SKY. Some of the interesting points are 1. drop height is irrelevant, brand of formamide is important (that is, quality of formamide is important).

An interesting paper that takes advantage of the fact that green fluorescent protein (GFP) is stable in 8 M urea at 50 C and that 8 M urea at 50 C acts as a hybridization buffer, present a protocol for combining mRNA FISH with GFP fluorescence: