



Universiteit  
Leiden  
The Netherlands

**The human genome; you gain some, you lose some**  
Kriek, M.

**Citation**

Kriek, M. (2007, December 6). *The human genome; you gain some, you lose some*. Retrieved from <https://hdl.handle.net/1887/12479>

Version: Corrected Publisher's Version

License: [Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden](#)

Downloaded from: <https://hdl.handle.net/1887/12479>

**Note:** To cite this publication please use the final published version (if applicable).

## CURRICULUM VITAE

Naam: Marjolein Kriek  
Geboortedatum: 22-11-1973  
Geboorte plaats: Leiden (Academisch Ziekenhuis Leiden)

### *School*

Eindexamen atheneum aan het Visser 't Hooft lyceum te Leiden (1992).

### *Studies*

- 18 August 2000  
Behalen van de artsenbul aan de Universiteit Leiden.
- 17 september 2002  
Doctoraal examen van de studie Biomedische Wetenschappen aan de Universiteit Leiden.

### *Wetenschappelijk onderzoek*

- 1995 Zes maanden stage bij vakgroep Moleculaire Carcinogenese aan Universiteit Leiden o.l.v. Prof. Dr van der Eb en Dr Zantema.  
Titel onderzoek:  
*“Association of proteins influenced by the Adenovirus E1A oncoprotein”.*
- 1998 Drie maanden stage bij vakgroep Klinische Epidemiologie in het L.U.M.C. o.l.v. Prof. Dr Rosendaal en Drs Sramek.  
Titel onderzoek:  
*“Mortality in carriers of Hemophilia”.*  
Dit onderzoek leidde tot een tweede auteurschap in de Lancet.
- 2001 Eindvakstage Biomedische Wetenschappen (9 maanden) bij de vakgroep Humane en Klinische Genetica o.l.v. Prof. Breuning  
Titel onderzoek:  
*“Screening for mutations in mentally retarded patients using MAPH”.*  
Dit onderzoek vormde de basis van het huidige proefschrift.

2002 Begonnen aan promotie onderzoek getiteld; “The human genome; you gain some, you lose some”, onder leiding van Prof. M.H.Breuning, Prof. G-J B. Van Ommen en dr. J.T. den Dunnen: Aanvankelijk als AGNIO, vanaf 1 januari 2003 is dit omgezet in een AGIKO traject op basis van ZONMW-subsidie (AGIKO-fellowship 940-37-032).

*Klinische ervaring*

2000 Half jaar als AGNIO gewerkt op de afdeling Klinische Genetica (LUMC)

1 april 2005 tot heden

In opleiding tot klinisch geneticus op de afdeling Klinische Genetica (LUMC)

## LIST OF PUBLICATIONS

### 2002

White S, Kalf M, Liu Q, Villerius M, Engelsma D, Kriek M, Vollebregt E, Bakker B, van Ommen GJ, Breuning MH *et al.* Comprehensive detection of genomic duplications and deletions in the DMD gene, by use of multiplex amplifiable probe hybridization. *Am J Hum Genet.* 2002 Aug;71(2):365-74.

### 2003

Sramek A, Kriek M, Rosendaal FR. Decreased mortality of ischaemic heart disease among carriers of haemophilia. *Lancet.* 2003 Aug 2;362(9381):351-4

### 2004

Kriek M, White SJ, Bouma MC, Dauwerse HG, Hansson KB, Nijhuis JV, Bakker B, van Ommen GJ, den Dunnen JT, Breuning MH. Genomic imbalances in mental retardation. *J Med Genet.* 2004 Apr;41(4):249-55

White SJ, Vink GR, Kriek M, Wuyts W, Schouten J, Bakker B, Breuning MH, den Dunnen JT. Two-color multiplex ligation-dependent probe amplification: detecting genomic rearrangements in hereditary multiple exostoses. *Hum Mutat.* 2004 Jul;24(1):86-92.

### 2006

Rosenberg C, Knijnenburg J, Bakker E, Vianna-Morgante AM, Sloos W, Otto PA, Kriek M, Hansson K, Krepischi-Santos AC, Fiegler H, Carter NP, Bijlsma EK, van Haeringen A, Szuhai K, Tanke HJ. Array-CGH detection of micro rearrangements in mentally retarded individuals: clinical significance of imbalances present both in affected children and normal parents. *J Med Genet.* 2006 Feb;43(2):180-6.

Kriek M, White SJ, Szuhai K, Knijnenburg J, van Ommen GJ, den Dunnen JT, Breuning MH. Copy number variation in regions flanked (or unflanked) by duplicons among patients with developmental delay and/or congenital malformations; detection of reciprocal and partial Williams-Beuren duplications.

*Eur J Hum Genet.* 2006 Feb;14(2):180-9

van der Knaap MS, Kriek M, Overweg-Plandsoen WC, Hansson KB, Madan K, Starreveld JS, Schotman-Schram P, Barkhof F, Lesnik Oberstein SA. Cerebral white matter abnormalities in 6p25 deletion syndrome.

*AJNR Am J Neuroradiol.* 2006 Mar;27(3):586-8

Kriek M, Szuhai K, Kant SG, White SJ, Dauwerse H, Fiegler H, Carter NP, Knijnenburg J, den Dunnen JT, Tanke HJ, Breuning MH, Rosenberg C. A complex rearrangement on chromosome 22 affecting both homologues; haplo-insufficiency of the Cat eye syndrome region may have no clinical relevance.

*Hum Genet.* 2006 Aug;120(1):77-84.

Lesnik Oberstein SA, Kriek M, White SJ, Kalf ME, Szuhai K, den Dunnen JT, Breuning MH, and Hennekam RC. Peters Plus Syndrome Is Caused by Mutations in *B3GALTL*, a Putative Glycosyltransferase.

*Am J Hum Genet.* 2006 Aug; 79(3):562-6.

Rosenberg C, Krepischi-Santos ACV, Knijnenburg J, Kok F, Otto PA, Tanke HJ, Kriek M, Zangrande Vieira LC, Nascimento RMP, Vianna-Morgante AM. X-chromosome segmental imbalances as a cause of recessive mental retardation syndromes.

*J Med Genet.* 2006 Feb;43(2):180-6.

## 2007

Kant SG, Kriek M, Walenkamp MJE, Hansson KBM, van Rhijn A, Clayton-Smith J, Wit JM, Breuning MH. Tall stature and duplication of the insulin-like growth factor I receptor gene.

*Eur J Med Genet.* 2007 Jan-Feb;50(1):1-10.

Kriek M, Konijnenburg J, White SJ, Rosenberg C, den Dunnen JT, van Ommen GJ, Tanke HJ, Breuning MB, Szuhai K. Diagnosis of genetic abnormalities in developmentally delayed patients: A new strategy combining MLPA and Array-CGH.  
*Am J Med Genet A*. 2007 Mar 15;143(6):610-4.

Harteveld CL, Kriek M, Bijlsma EK, Erjavec Z, Balak D, Phylipsen M, Voskamp A, di Capua E, White SJ and Giordano PC. Telomeric deletions of 16p causing alpha-thalassemia and mental retardation characterized by multiplex ligation-dependent probe amplification.  
*Human Genet*. 2007 Jun 28; [Epub ahead of print]

Kriek M, Ruivenkamp CAL, Ariyurek Y, Kalf ME, Knijnenburg J, van Haeringen A, Genuardi M, Rosenberg C, Sanders SR., White SJ, Szuhai K, Breuning MH, den Dunnen JT. Comparison of four genome-wide platforms using overlapping interstitial 2p alterations.  
*Submitted*



## REFERENCES

- Aitman TJ, Dong R, Vyse TJ, Norsworthy PJ, Johnson MD, Smith J, Mangion J, Robertson-Lowe C, Marshall AJ, Petretto E, Hodges MD, Bhangal G, Patel SG, Sheehan-Rooney K, Duda M, Cook PR, Evans DJ, Domin J, Flint J, Boyle JJ, Pusey CD, Cook HT (2006) Copy number polymorphism in Fcgr3 predisposes to glomerulonephritis in rats and humans. *Nature* 439:851-855
- Amos-Landgraf JM, Ji Y, Gottlieb W, Depinet T, Wandstrat AE, Cassidy SB, Driscoll DJ, Rogan PK, Schwartz S, Nicholls RD (1999) Chromosome breakage in the Prader-Willi and Angelman syndromes involves recombination between large, transcribed repeats at proximal and distal breakpoints. *Am J Hum Genet* 65:370-386
- Anderlid BM, Schoumans J, Anneren G, Sahlen S, Kyllerman M, Vujic M, Hagberg B, Blennow E, Nordenskjold M (2002) Subtelomeric rearrangements detected in patients with idiopathic mental retardation. *Am J Med Genet* 107:275-284
- Armengol L, Pujana MA, Cheung J, Scherer SW, Estivill X (2003) Enrichment of segmental duplications in regions of breaks of synteny between the human and mouse genomes suggest their involvement in evolutionary rearrangements. *Hum Mol Genet* 12:2201-2208
- Armour JA, Sismani C, Patsalis PC, Cross G (2000) Measurement of locus copy number by hybridisation with amplifiable probes. *Nucl Acids Res* 28:605-609
- Bailey JA, Gu Z, Clark RA, Reinert K, Samonte RV, Schwartz S, Adams MD, Myers EW, Li PW, Eichler EE (2002a) Recent segmental duplications in the human genome. *Science* 297:1003-1007
- Bailey JA, Liu G, Eichler EE (2003) An Alu transposition model for the origin and expansion of human segmental duplications. *Am J Hum Genet* 73:823-834
- Bailey JA, Yavor AM, Viggiano L, Misceo D, Horvath JE, Archidiacono N, Schwartz S, Rocchi M, Eichler EE (2002b) Human-specific duplication and mosaic transcripts: the recent paralogous structure of chromosome 22. *Am J Hum Genet* 70:83-100
- Baker E, Hinton L, Callen DF, Altree M, Dobbie A, Eyre HJ, Sutherland GR, Thompson E, Thompson P, Woollatt E, Haan E (2002) Study of 250 children with idiopathic mental retardation reveals nine cryptic and diverse subtelomeric chromosome anomalies. *Am J Med Genet* 107:285-293
- Bayes M, Magano LF, Rivera N, Flores R, Perez Jurado LA (2003) Mutational mechanisms of Williams-Beuren syndrome deletions. *Am J Hum Genet* 73:131-151
- Bi W, Park SS, Shaw CJ, Withers MA, Patel PI, Lupski JR (2003) Reciprocal crossovers and a positional preference for strand exchange in recombination events resulting in deletion or duplication of chromosome 17p11.2. *Am J Hum Genet* 73:1302-1315
- Biesecker LG (2002) The end of the beginning of chromosome ends. *Am J Med Genet* 107:263-266
- Blonden LAJ, Grootsholten PM, Den Dunnen JT, Bakker E, Abbs SJ, Bobrow M, Boehm C *et al.* (1991) 242 breakpoints in the 200-kb deletion-prone P20 region of the DMD-gene are widely spread. *Genomics* 10:631-639
- Bocian E, Helias-Rodzewicz Z, Suchenek K, Obersztyń E, Kutkowska-Kazmierczak A, Stankiewicz P, Kostyk E, Mazurczak T (2004) Subtelomeric rearrangements: results from FISH studies in 84 families with idiopathic mental retardation. *Med Sci Monit* 10:CR143-CR151
- Bonifacio S, Centrone C, Da Prato L, Scordo MR, Estienne M, Torricelli F (2001) Use of primed in situ labeling (PRINS) for the detection of telomeric deletions associated with mental retardation. *Cytogenet Cell Genet* 93:16-18
- Borgione E, Giudice ML, Galesi O, Castiglia L, Failla P, Romano C, Ragusa A, Fichera M (2001) How



- microsatellite analysis can be exploited for subtelomeric chromosomal rearrangement analysis in mental retardation. *J Med Genet* 38:E1
- Boue A, Boue J (1977) [Role of chromosome abnormalities in reproduction failures]. *J Gynecol Obstet Biol Reprod*(Paris) 6:5-21
- Breuning MH, Dauwerse HG, Fugazza G, Saris JJ, Spruit L, Wijnen H, Tommerup N, van der Hagen CB, Imaizumi K, Kuroki Y, . (1993) Rubinstein-Taybi syndrome caused by submicroscopic deletions within 16p13.3. *Am J Hum Genet* 52:249-254
- Bruder CE, Hirvela C, Tapia-Paez I, Fransson I, Segraves R, Hamilton G, Zhang XX *et al.* (2001) High resolution deletion analysis of constitutional DNA from neurofibromatosis type 2 (NF2) patients using microarray-CGH. *Hum Mol Genet* 10:271-282
- Bugge M, Bruun-Petersen G, Brondum-Nielsen K, Friedrich U, Hansen J, Jensen G, Jensen PK, Kristoffersson U, Lundsteen C, Niebuhr E, Rasmussen KR, Rasmussen K, Tommerup N (2000) Disease associated balanced chromosome rearrangements: a resource for large scale genotype-phenotype delineation in man. *J Med Genet* 37:858-865
- Bundey S, Thake A, Todd J (1989) The recurrence risks for mild idiopathic mental retardation. *J Med Genet* 26:260-266
- Butler MG (1995) High resolution chromosome analysis and fluorescence in situ hybridization in patients referred for Prader-Willi or Angelman syndrome. *Am J Med Genet* 56:420-422
- Buzhov BT, Lemmers RJ, Tournev I, Dikova C, Kremensky I, Petrova J, Frants RR, Van Der Maarel SM (2005) Genetic confirmation of facioscapulohumeral muscular dystrophy in a case with complex D4Z4 rearrangements. *Hum Genet* 116:262-266
- Carr DH (1971) Chromosomes and abortion. *Adv Hum Genet* 2:201-257
- Caspersson T, Lomakka G, Zech L (1972) The 24 fluorescence patterns of the human metaphase chromosomes - distinguishing characters and variability. *Hereditas* 67:89-102
- Chance PF, Abbas N, Lensch MW, Pentao L, Roa BB, Patel PI, Lupski JR (1994) Two autosomal dominant neuropathies result from reciprocal DNA duplication/deletion of a region on chromosome 17. *Hum Mol Genet* 3:223-228
- Chen KS, Manian P, Koeuth T, Potocki L, Zhao Q, Chinault AC, Lee CC, Lupski JR (1997) Homologous recombination of a flanking repeat gene cluster is a mechanism for a common contiguous gene deletion syndrome. *Nat Genet* 17:154-163
- Cheung J, Estivill X, Khaja R, MacDonald JR, Lau K, Tsui LC, Scherer SW (2003a) Genome-wide detection of segmental duplications and potential assembly errors in the human genome sequence. *Genome Biol* 4:R25
- Cheung J, Estivill X, Khaja R, MacDonald JR, Lau K, Tsui LC, Scherer SW (2003b) Genome-wide detection of segmental duplications and potential assembly errors in the human genome sequence. *Genome Biol* 4:R25
- Cheung VG, Nowak N, Jang W, Kirsch IR, Zhao S, Chen XN, Furey TS *et al.* (2001) Integration of cytogenetic landmarks into the draft sequence of the human genome. *Nature* 409:953-958
- Clarkson B, Pavenski K, Dupuis L, Kennedy S, Meyn S, Nezarati MM, Nie G, Weksberg R, Withers S, Quercia N, Teebi AS, Teshima I (2002) Detecting rearrangements in children using subtelomeric FISH and SKY. *Am J Med Genet* 107:267-274
- Coe BP, Ylstra B, Carvalho B, Meijer GA, MacAulay C, Lam WL (2007) Resolving the resolution of array CGH. *Genomics*
- Colleaux L, Rio M, Heuertz S, Moindrault S, Turleau C, Ozilou C, Gosset P, Raoult O, Lyonnet S, Cormier-Daire V, Amiel J, Le Merrer M, Picq M, de Blois MC, Prieur M, Romana S, Cornelis

- F, Vekemans M, Munnich A (2001) A novel automated strategy for screening cryptic telomeric rearrangements in children with idiopathic mental retardation. *Eur J Hum Genet* 9:319-327
- Conrad DF, Andrews TD, Carter NP, Hurles ME, Pritchard JK (2006) A high-resolution survey of deletion polymorphism in the human genome. *Nat Genet* 38:75-81
- Dauwerse JG, Wiegant JCAG, Raap AK, Breuning MH, Van Ommen GJB (1992) Multiple colors by fluorescence in situ hybridization using ratio-labelled DNA probes create a molecular karyotype. *Hum Mol Genet* 1:593-598
- De Vries BB, Pfundt R, Leisink M, Koolen DA, Vissers LE, Janssen IM, Reijmersdal S, Nillesen WM, Huys EH, Leeuw N, Smeets D, Sistermans EA, Feuth T, Ravenswaaij-Arts CM, van Kessel AG, Schoenmakers EF, Brunner HG, Veltman JA (2005) Diagnostic genome profiling in mental retardation. *Am J Hum Genet* 77:606-616
- De Vries BB, van den Ouweland AM, Mohkamsing S, Duivenvoorden HJ, Mol E, Gelsema K, van Rijn M, Halley DJ, Sandkuijl LA, Oostra BA, Tibben A, Niermeijer MF (1997) Screening and diagnosis for the fragile X syndrome among the mentally retarded: an epidemiological and psychological survey. Collaborative Fragile X Study Group. *Am J Hum Genet* 61:660-667
- Delach JA, Rosengren SS, Kaplan L, Greenstein RM, Cassidy SB, Benn PA (1994) Comparison of high resolution chromosome banding and fluorescence in situ hybridization (FISH) for the laboratory evaluation of Prader-Willi syndrome and Angelman syndrome. *Am J Med Genet* 52:85-91
- Den Dunnen JT, Bakker E, Klein-Breteleer EG, Pearson PL, Van Ommen GJB (1987) Direct detection of more than 50% Duchenne muscular dystrophy mutations by field-inversion gels. *Nature* 329:640-642
- Edelmann L, Pandita RK, Morrow BE (1999) Low-copy repeats mediate the common 3-Mb deletion in patients with velo-cardio-facial syndrome. *Am J Hum Genet* 64:1076-1086
- Edelmann L, Pandita RK, Spiteri E, Funke B, Goldberg R, Palanisamy N, Chaganti RS, Magenis E, Shprintzen RJ, Morrow BE (1999) A common molecular basis for rearrangement disorders on chromosome 22q11. *Hum Mol Genet* 8:1157-1167
- Eichler EE (2001a) Recent duplication, domain accretion and the dynamic mutation of the human genome. *Trends Genet* 17:661-669
- Eichler EE (2001b) Segmental duplications: what's missing, misassigned, and misassembled--and should we care? *Genome Res* 11:653-656
- Eichler EE (2006) Widening the spectrum of human genetic variation. *Nat Genet* 38:9-11
- Eichler EE, Lu F, Shen Y, Antonacci R, Jurecic V, Doggett NA, Moyzis RK, Baldini A, Gibbs RA, Nelson DL (1996) Duplication of a gene-rich cluster between 16p11.1 and Xq28: a novel pericentromeric-directed mechanism for paralogous genome evolution. *Hum Mol Genet* 5:899-912
- Einfeld SL (1984) Clinical assessment of 4500 developmentally delayed individuals. *J Ment Defic Res* 28 (Pt 2):129-142
- Elwood JH, Darragh PM (1981) Severe mental handicap in Northern Ireland. *J Ment Defic Res* 25:147-155
- Engels H, Ehrbrecht A, Zahn S, Bosse K, Vrolijk H, White S, Kalscheuer V, Hoovers JM, Schwanitz G, Propping P, Tanke HJ, Wiegant J, Raap AK (2003) Comprehensive analysis of human subtelomeres with combined binary ratio labelling fluorescence in situ hybridisation. *Eur J Hum Genet* 11:643-651
- Ensenauer RE, Adeyinka A, Flynn HC, Michels VV, Lindor NM, Dawson DB, Thorland EC, Lorentz CP, Goldstein JL, McDonald MT, Smith WE, Simon-Fayard E, Alexander AA, Kulharya AS, Ketterling RP, Clark RD, Jalal SM (2003) Microduplication 22q11.2, an emerging syndrome: clinical, cytogenetic, and molecular analysis of thirteen patients. *Am J Hum Genet* 73:1027-1040

- Fan YS, Siu VM, Jung JH, Xu J (2000) Sensitivity of multiple color spectral karyotyping in detecting small interchromosomal rearrangements. *Genet Test* 4:9-14
- Fan YS, Zhang Y, Speevak M, Farrell S, Jung JH, Siu VM (2001) Detection of submicroscopic aberrations in patients with unexplained mental retardation by fluorescence in situ hybridization using multiple subtelomeric probes. *Genet Med* 3:416-421
- Flint J, Knight S (2003) The use of telomere probes to investigate submicroscopic rearrangements associated with mental retardation. *Curr Opin Genet Dev* 13:310-316
- Flint J, Wilkie AO (1996) The genetics of mental retardation. *Br Med Bull* 52:453-464
- Flint J, Wilkie AO, Buckle VJ, Winter RM, Holland AJ, McDermid HE (1995) The detection of subtelomeric chromosomal rearrangements in idiopathic mental retardation. *Nat Genet* 9:132-140
- Florijn RJ, Blonden LAJ, Vrolijk H, Wiegant J, Vaandrager JW, Baas F, Den Dunnen JT, Tanke HJ, Van Ommen GJB, Raap AK (1995) High-resolution FISH for genomic DNA mapping and colour bar-coding of large genes. *Hum Mol Genet* 4:831-836
- Ford M, Fried M (1986) Large inverted duplications are associated with gene amplification. *Cell* 45:425-430
- Francke U (1999) Williams-Beuren syndrome: genes and mechanisms. *Hum Mol Genet* 8:1947-1954
- Francke U, Ochs HD, De Martinville B, Giacalone J, Lindgren V, Distech C, Pagon RA, Hofker MH, Van Ommen GJB, Pearson PL, Wedgwood R (1985) Minor Xp21 chromosome deletion in a male associated with expression of Duchenne muscular dystrophy, chronic granulomatous disease, retinitis pigmentosa and McLeod syndrome. *Am J Hum Genet* 37:250-267
- Fredman D, White SJ, Potter S, Eichler EE, Den Dunnen JT, Brookes AJ (2004) Complex SNP-related sequence variation in segmental genome duplications. *Nat Genet* 36:861-866
- Friedman JM, Baross A, Delaney AD, Ally A, Arbour L, Asano J, Bailey DK *et al.* (2006) Oligonucleotide microarray analysis of genomic imbalance in children with mental retardation. *Am J Hum Genet* 79:500-513
- Gibbons B, Datta P, Wu Y, Chan A, Al Armour J (2006) Microarray MAPH: accurate array-based detection of relative copy number in genomic DNA. *BMC Genomics* 7:163
- Giglio S, Calvari V, Gregato G, Gimelli G, Camanini S, Giorda R, Ragusa A, Gueneri S, Selicorni A, Stumm M, Tonnes H, Ventura M, Zollino M, Neri G, Barber J, Wiczorek D, Rocchi M, Zufardi O (2002) Heterozygous submicroscopic inversions involving olfactory receptor-gene clusters mediate the recurrent t(4;8)(p16;p23) translocation. *Am J Hum Genet* 71:276-285
- Giles RH, Petrij F, Dauwse HG, Den Hollander AI, Lushnikova T, Van Ommen GJB, Goodman RH, Deaven LL, Doggett NA, Peters DJ, Breuning MH (1997) Construction of a 1.2-Mb contig surrounding, and molecular analysis of, the human CREB-binding protein (CBP/CREBBP) gene on chromosome 16p13.3. *Genomics* 42:96-114
- Gonzalez E, Kulkarni H, Bolivar H, Mangano A, Sanchez R, Catano G, Nibbs RJ, Freedman BI, Quinones MP, Bamshad MJ, Murthy KK, Rovin BH, Bradley W, Clark RA, Anderson SA, O'connell RJ, Agan BK, Ahuja SS, Bologna R, Sen L, Dolan MJ, Ahuja SK (2005) The influence of CCL3L1 gene-containing segmental duplications on HIV-1/AIDS susceptibility. *Science* 307:1434-1440
- Gribble SM, Prigmore E, Burford DC, Porter KM, Ng BL, Douglas EJ, Fiegler H, Carr P, Kalaitzopoulos D, Clegg S, Sandstrom R, Temple IK, Youings SA, Thomas NS, Dennis NR, Jacobs PA, Crolla JA, Carter NP (2005) The complex nature of constitutional *de novo* apparently balanced translocations in patients presenting with abnormal phenotypes. *J Med Genet* 42:8-16
- Groot PC, Mager WH, Henriquez NV, Pronk JC, Arwert F, Planta RJ, Eriksson AW, Frants RR (1990) Evolution of the human alpha-amylase multigene family through unequal, homologous, and inter- and intrachromosomal crossovers. *Genomics* 8:97-105

- Gustavson KH, Holmgren G, Blomquist HK (1987) Chromosomal aberrations in mildly mentally retarded children in a northern Swedish county. *Ups J Med Sci Suppl* 44:165-168
- Hall H, Hunt P, Hassold T (2006) Meiosis and sex chromosome aneuploidy: how meiotic errors cause aneuploidy; how aneuploidy causes meiotic errors. *Curr Opin Genet Dev* 16:323-329
- Harada N, Harchwell E, Okamoto N, Tsukahara M, Kurosawa K, Kawame H, Kondoh T, Ohashi H, Tsukino R, Kondoh Y, Shimokawa O, Ida T, Nagai T, Fukushima Y, Yoshiura K, Niikawa N, Matsumoto N (2004) Subtelomere specific microarray based comparative genomic hybridisation: a rapid detection system for cryptic rearrangements in idiopathic mental retardation. *J Med Genet* 41:130-136
- Harteveld CL, Voskamp A, Phylipsen M, Akkermans N, Den Dunnen JT, White SJ, Giordano PC (2005) Nine unknown rearrangements in 16p13.3 and 11p15.4 causing alpha- and beta-thalassaemia characterised by high resolution multiplex ligation-dependent probe amplification. *J Med Genet* 42:922-931
- Heath KE, Day IN, Humphries SE (2000) Universal primer quantitative fluorescent multiplex (UPQFM) PCR: a method to detect major and minor rearrangements of the low density lipoprotein receptor gene. *J Med Genet* 37:272-280
- Helias-Rodzewicz Z, Bocian E, Stankiewicz P, Obersztyń E, Kostyk E, Jakubow-Durska K, Kutkowska-Kazmierczak A, Mazurczak T (2002) Subtelomeric rearrangements detected by FISH in three of 33 families with idiopathic mental retardation and minor physical anomalies. *J Med Genet* 39:e53
- Herr A, Grutzmann R, Matthaei A, Artelt J, Schrock E, Rump A, Pilarsky C (2005) High-resolution analysis of chromosomal imbalances using the Affymetrix 10K SNP genotyping chip. *Genomics* 85:392-400
- Herrmann BG, Barlow DP, Lehrach H (1987) A large inverted duplication allows homologous recombination between chromosomes heterozygous for the proximal t complex inversion. *Cell* 48:813-825
- Higgs DR, Hill AV, Bowden DK, Weatherall DJ, Clegg JB (1984) Independent recombination events between the duplicated human alpha globin genes; implications for their concerted evolution. *Nucleic Acids Res* 12:6965-6977
- Hollox EJ, Atia T, Cross G, Parkin T, Armour JA (2002) High throughput screening of human subtelomeric DNA for copy number changes using multiplex amplifiable probe hybridisation (MAPH). *J Med Genet* 39:790-795
- Horvath JE, Schwartz S, Eichler EE (2000) The mosaic structure of human pericentromeric DNA: a strategy for characterizing complex regions of the human genome. *Genome Res* 10:839-852
- Hulley BJ, Hummel M, Wenger SL (2003) Screening for cryptic chromosomal abnormalities in patients with mental retardation and dysmorphic facial features using telomere FISH probes. *Am J Med Genet A* 117:302-303
- Iafate AJ, Feuk L, Rivera MN, Listewnik ML, Donahoe PK, Qi Y, Scherer SW, Lee C (2004) Detection of large-scale variation in the human genome. *Nat Genet* 36:949-951
- Inoue K, Dewar K, Katsanis N, Reiter LT, Lander ES, Devon KL, Wyman DW, Lupski JR, Birren B (2001) The 1.4-Mb CMT1A duplication/HNPP deletion genomic region reveals unique genome architectural features and provides insights into the recent evolution of new genes. *Genome Res* 11:1018-1033
- Jacobs PA, Baikie AG, Court Brown WM, Strong JA (1959) The somatic chromosomes in mongolism. *Lancet* 1:710

- Jalal SM, Harwood AR, Sekhon GS, Pham LC, Ketterling RP, Babovic-Vuksanovic D, Meyer RG, Ensenauer R, Anderson MH, Jr., Michels VV (2003) Utility of subtelomeric fluorescent DNA probes for detection of chromosome anomalies in 425 patients. *Genet Med* 5:28-34
- Ji Y, Eichler EE, Schwartz S, Nicholls RD (2000) Structure of chromosomal duplicons and their role in mediating human genomic disorders. *Genome Res* 10:597-610
- Klopocki E, Schulze H, Strauss G, Ott CE, Hall J, Trotier F, Fleischhauer S, Greenhalgh L, Newbury-Ecob RA, Neumann LM, Habenicht R, Konig R, Seemanova E, Megarbane A, Ropers HH, Ullmann R, Horn D, Mundlos S (2007) Complex inheritance pattern resembling autosomal recessive inheritance involving a microdeletion in thrombocytopenia-absent radius syndrome. *Am J Hum Genet* 80:232-240
- Knight SJ, Horsley SW, Regan R, Lawrie NM, Maher EJ, Cardy DL, Flint J, Kearney L (1997) Development and clinical application of an innovative fluorescence in situ hybridization technique which detects submicroscopic rearrangements involving telomeres. *Eur J Hum Genet* 5:1-8
- Knight SJ, Regan R, Nicod A, Horsley SW, Kearney L, Homfray T, Winter RM, Bolton P, Flint J (1999) Subtle chromosomal rearrangements in children with unexplained mental retardation. *Lancet* 354:1676-1681
- Komura D, Shen F, Ishikawa S, Fitch KR, Chen W, Zhang J, Liu G, Ihara S, Nakamura H, Hurler ME, Lee C, Scherer SW, Jones KW, Shaper MH, Huang J, Aburatani H (2006) Genome-wide detection of human copy number variations using high-density DNA oligonucleotide arrays. *Genome Res* 16:1575-1584
- Koolen DA, Nillesen WM, Versteeg MH, Merckx GF, Knoers NV, Kets M, Vermeer S, van Ravenswaaij CM, de Kovel CG, Brunner HG, Smeets D, De Vries BB, Sistermans EA (2004) Screening for subtelomeric rearrangements in 210 patients with unexplained mental retardation using multiplex ligation dependent probe amplification (MLPA). *J Med Genet* 41:892-899
- Koolen DA, Vissers LE, Pfundt R, de Leeuw N, Knight SJ, Regan R, Kooy RF, Reyniers E, Romano C, Fichera M, Schinzel A, Baumer A, Anderlid BM, Schoumans J, Knoers NV, van Kessel AG, Sistermans EA, Veltman JA, Brunner HG, De Vries BB (2006) A new chromosome 17q21.31 microdeletion syndrome associated with a common inversion polymorphism. *Nat Genet* 38:999-1001
- Krantz ID, McCallum J, DeScipio C, Kaur M, Gillis LA, Yaeger D, Jukofsky L, Wasserman N, Bottani A, Morris CA, Nowaczyk MJ, Toriello H, Bamshad MJ, Carey JC, Rappaport E, Kawauchi S, Lander AD, Calof AL, Li HH, Devoto M, Jackson LG (2004) Cornelia de Lange syndrome is caused by mutations in NIPBL, the human homolog of *Drosophila melanogaster* Nipped-B. *Nat Genet* 36:631-635
- Kriek M, White SJ, Szuhai K, Knijnenburg J, van Ommen GJ, Den Dunnen JT, Breuning MH (2006) Copy number variation in regions flanked (or unflanked) by duplicons among patients with developmental delay and/or congenital malformations; detection of reciprocal and partial Williams-Beuren duplications. *Eur J Hum Genet* 14:180-189
- Kurahashi H, Shaikh T, Takata M, Toda T, Emanuel BS (2003) The constitutional t(17;22): another translocation mediated by palindromic AT-rich repeats. *Am J Hum Genet* 72:733-738
- Kurahashi H, Shaikh TH, Hu P, Roe BA, Emanuel BS, Budarf ML (2000) Regions of genomic instability on 22q11 and 11q23 as the etiology for the recurrent constitutional t(11;22). *Hum Mol Genet* 9:1665-1670
- Kuwano A, Mutirangura A, Dittrich B, Buiting K, Horsthemke B, Saitoh S, Niikawa N, Ledbetter SA, Greenberg F, Chinault AC, . (1992) Molecular dissection of the Prader-Willi/Angelman syndrome region (15q11-13) by YAC cloning and FISH analysis. *Hum Mol Genet* 1:417-425

- Lam AC, Lam ST, Lai KK, Tong TM, Chau TC (2006) High rate of detection of subtelomeric aberration by using combined MLPA and subtelomeric FISH approach in patients with moderate to severe mental retardation. *Clin Biochem* 39:196-202
- Lamont MA, Dennis NR (1988) Aetiology of mild mental retardation. *Arch Dis Child* 63:1032-1038
- Landegent JE, Jansen in dW, van Ommen GJ, Baas F, de Vijlder JJ, Van Duijn P, Van der PM (1985) Chromosomal localization of a unique gene by non-autoradiographic in situ hybridization. *Nature* 317:175-177
- Laurendeau I, Bahuau M, Vodovar N, Larramendy C, Olivi M, Bieche I, Vidaud M, Vidaud D (1999) TaqMan PCR-based gene dosage assay for predictive testing in individuals from a cancer family with INK4 locus haploinsufficiency. *Clin Chem* 45:982-986
- Lauritsen JG, Jonasson J, Therkelsen AJ, Lass F, Lindsten J, Petersen GB (1972) Studies on spontaneous abortions. Fluorescence analysis of abnormal karyotypes. *Hereditas* 71:160-163
- Leana-Cox J, Pangkanon S, Eanet KR, Curtin MS, Wulfsberg EA (1996) Familial DiGeorge/velocardio-facial syndrome with deletions of chromosome area 22q11.2: report of five families with a review of the literature. *Am J Med Genet* 65:309-316
- Lejeune J, Turpin R, Gautier M (1959) [Mongolism; a chromosomal disease (trisomy)]. *Bull Acad Natl Med* 143:256-265
- Li R, Zhao ZY (2004) Two subtelomeric chromosomal deletions in forty-six children with idiopathic mental retardation. *Chin Med J (Engl.)* 117:1414-1417
- Liu G, Zhao S, Bailey JA, Sahinalp SC, Alkan C, Tuzun E, Green ED, Eichler EE (2003) Analysis of primate genomic variation reveals a repeat-driven expansion of the human genome. *Genome Res* 13:358-368
- Locke DP, Archidiacono N, Misceo D, Cardone MF, Deschamps S, Roe B, Rocchi M, Eichler EE (2003) Refinement of a chimpanzee pericentric inversion breakpoint to a segmental duplication cluster. *Genome Biol* 4:R50
- Lucci-Cordisco E, Zollino M, Baglioni S, Mancuso I, Lecce R, Gurrieri F, Crucitti A, Papi L, Neri G, Genuardi M (2005) A novel microdeletion syndrome with loss of the MSH2 locus and hereditary non-polyposis colorectal cancer. *Clin Genet* 67:178-182
- Lupski JR, Montes De Oca-Luna R, Slaugenhaupt S, Pentao L, Guzzetta V, Trask B, Saucedo-Cardenas O, Barker DF, Killian JM, Garcia CA, Chakravarti A, Patel PI (1991) DNA duplication associated with Charcot-Marie-Tooth disease type 1a. *Cell* 66:219-232
- Lupski JR (1998) Genomic disorders: structural features of the genome can lead to DNA rearrangements and human disease traits. *Trends Genet* 14:417-422
- Lupski JR (2007) Structural variation in the human genome. *N Engl J Med* 356:1169-1171
- Lupski JR, Wise CA, Kuwano A, Pentao L, Parke JT, Glaze DG, Ledbetter DH, Greenberg F, Patel PI (1992) Gene dosage is a mechanism for Charcot-Marie-Tooth disease type 1A. *Nat Genet* 1:29-33
- McCarroll SA, Hadnott TN, Perry GH, Sabeti PC, Zody MC, Barrett JC, Dallaire S, Gabriel SB, Lee C, Daly MJ, Altshuler DM (2006) Common deletion polymorphisms in the human genome. *Nat Genet* 38:86-92
- McDonald AD (1973) Severely retarded children in Quebec: prevalence, causes, and care. *Am J Ment Defic* 78:205-215
- Mefford HC, Trask BJ (2002) The complex structure and dynamic evolution of human subtelomeres. *Nat Rev Genet* 3:91-102
- Menten B, Maas N, Thienpont B, Buysse K, Vandesompele J, Melotte C, de Ravel T, Van Vooren S, Ba-

- likova I, Backx L, Janssens S, De Paepe A, De Moor B, Moreau Y, Marynen P, Fryns JP, Mortier G, Devriendt K, Speleman F, Vermeesch JR (2006) Emerging patterns of cryptic chromosomal imbalance in patients with idiopathic mental retardation and multiple congenital anomalies: a new series of 140 patients and review of published reports. *J Med Genet* 43:625-633
- Miller SA, Dykes DD, Polesky HF (1988) A simple salting out procedure for extracting DNA from human nucleated cells. *Nucleic Acids Res* 16:1215
- Ming JE, Geiger E, James AC, Ciprero KL, Nimmakayalu M, Zhang Y, Huang A, Vaddi M, Rappaport E, Zackai EH, Shaikh TH (2006) Rapid detection of submicroscopic chromosomal rearrangements in children with multiple congenital anomalies using high density oligonucleotide arrays. *Hum Mutat* 27:467-473
- Miyake N, Shimokawa O, Harada N, Sosonkina N, Okubo A, Kawara H, Okamoto N, Kurosawa K, Kawame H, Iwakoshi M, Kosho T, Fukushima Y, Makita Y, Yokoyama Y, Yamagata T, Kato M, Hiraki Y, Nomura M, Yoshiura K, Kishino T, Ohta T, Mizuguchi T, Niikawa N, Matsumoto N (2006) BAC array CGH reveals genomic aberrations in idiopathic mental retardation. *Am J Med Genet A* 140:205-211
- Morris CA, Thomas IT, Greenberg F (1993) Williams syndrome: autosomal dominant inheritance. *Am J Med Genet* 47:478-481
- Murray A, Youings S, Dennis N, Latsky L, Linehan P, McKechnie N, Macpherson J, Pound M, Jacobs P (1996) Population screening at the FRAXA and FRAXE loci: molecular analyses of boys with learning difficulties and their mothers. *Hum Mol Genet* 5:727-735
- Nederlof PM, Robinson D, Abuknesha R, Wiegant J, Hopman AH, Tanke HJ, Raap AK (1989) Three-color fluorescence in situ hybridization for the simultaneous detection of multiple nucleic acid sequences. *Cytometry* 10:20-27
- Nederlof PM, Van Der Flier S, Wiegant J, Raap AK, Tanke HJ, Ploem JS, Van der ploeg M (1990) Multiple fluorescence in situ hybridization. *Cytometry* 11:126-131
- Nobile C, Toffolatti L, Rizzi F, Simionati B, Nigro V, Cardazzo B, Patarnello T, Valle G, Danieli GA (2002) Analysis of 22 deletion breakpoints in dystrophin intron 49. *Hum Genet* 110:418-421
- Novelli A, Ceccarini C, Bernardini L, Zuccarello D, Caputo V, Digilio MC, Mingarelli R, Dallapiccola B (2004) High frequency of subtelomeric rearrangements in a cohort of 92 patients with severe mental retardation and dysmorphism. *Clin Genet* 66:30-38
- Palomares M, Delicado A, Lapunzina P, Arjona D, Aminoso C, Arcas J, Martinez BA, Fernandez L, Lopez P, I (2006) MLPA vs multiprobe FISH: comparison of two methods for the screening of subtelomeric rearrangements in 50 patients with idiopathic mental retardation. *Clin Genet* 69:228-233
- Peiffer DA, Le JM, Steemers FJ, Chang W, Jenniges T, Garcia F, Haden K, Li J, Shaw CA, Belmont J, Cheung SW, Shen RM, Barker DL, Gunderson KL (2006) High-resolution genomic profiling of chromosomal aberrations using Infinium whole-genome genotyping. *Genome Res* 16:1136-1148
- Pentao L, Wise CA, Chinault AC, Patel PI, Lupski JR (1992) Charcot-Marie-Tooth type 1A duplication appears to arise from recombination at repeat sequences flanking the 1.5 Mb monomer unit. *Nat Genet* 2:292-300
- Peoples R, Franke Y, Wang YK, Perez-Jurado L, Paperna T, Cisco M, Francke U (2000) A physical map, including a BAC/PAC clone contig, of the Williams-Beuren syndrome--deletion region at 7q11.23. *Am J Hum Genet* 66:47-68
- Petrij F, Giles RH, Dauwse HG, Saris JJ, Hennekam RC, Masuno M, Tommerup N, van Ommen GJ, Goodman RH, Peters DJ. (1995) Rubinstein-Taybi syndrome caused by mutations in the transcriptional co-activator CBP. *Nature* 376:348-351

- Pickard BS, Hollox EJ, Malloy MP, Porteous DJ, Blackwood DH, Armour JA, Muir WJ (2004) A 4q35.2 subtelomeric deletion identified in a screen of patients with co-morbid psychiatric illness and mental retardation. *BMC Med Genet* 5:21
- Pinkel D, Segraves R, Sudar D, Clark S, Poole I, Kowbel D, Collins C, Kuo WL, Chen C, Zhai Y, Dairkee SH, Ljung BM, Gray JW, Albertson DG (1998) High resolution analysis of DNA copy number variation using comparative genomic hybridization to microarrays. *Nat Genet* 20:207-211
- Popp S, Schulze B, Granzow M, Keller M, Holtgreve-Grez H, Schoell B, Brough M, Hager HD, Tariverdian G, Brown J, Kearney L, Jauch A (2002) Study of 30 patients with unexplained developmental delay and dysmorphic features or congenital abnormalities using conventional cytogenetics and multiplex FISH telomere (M-TEL) integrity assay. *Hum Genet* 111:31-39
- Potocki L, Bi W, Treadwell-Deering D, Carvalho CM, Eifert A, Friedman EM, Glaze D, Krull K, Lee JA, Lewis RA, Mendoza-Londono R, Robbins-Furman P, Shaw C, Shi X, Weissenberger G, Withers M, Yatsenko SA, Zackai EH, Stankiewicz P, Lupski JR (2007) Characterization of Potocki-Lupski Syndrome (dup(17)(p11.2p11.2)) and Delineation of a Dosage-Sensitive Critical Interval That Can Convey an Autism Phenotype. *Am J Hum Genet* 80:633-649
- Potocki L, Chen KS, Park SS, Osterholm DE, Withers MA, Kimonis V, Summers AM, Meschino WS, Anyane-Yeboah K, Kashork CD, Shaffer LG, Lupski JR (2000) Molecular mechanism for duplication 17p11.2- the homologous recombination reciprocal of the Smith-Magenis microdeletion. *Nat Genet* 24:84-87
- Prooijen-Knegt AC, Van Hoek JF, Bauman JG, Van Duijn P, Wool IG, Van der PM (1982) In situ hybridization of DNA sequences in human metaphase chromosomes visualized by an indirect fluorescent immunocytochemical procedure. *Exp Cell Res* 141:397-407
- Raap AK, Florijn RJ, Blonden LAJ, Wiegant J, Vaandrager JW, Vrolijk H, Den Dunnen JT, Tanke HJ, Van Ommen GJB (1996) FiberFISH as a DNA mapping tool. *Methods* 9:67-73
- Raap AK, Tanke HJ (2006) COmbined Binary RATIO fluorescence in situ hybridization (COBRA-FISH): development and applications. *Cytogenet. Genome Res* 114:222-226
- Rauch A, Hoyer J, Guth S, Zweier C, Kraus C, Becker C, Zenker M, Huffmeier U, Thiel C, Ruschendorf F, Nurnberg P, Reis A, Trautmann U (2006) Diagnostic yield of various genetic approaches in patients with unexplained developmental delay or mental retardation. *Am J Med Genet A* 140:2063-2074
- Rauch A, Ruschendorf F, Huang J, Trautmann U, Becker C, Thiel C, Jones KW, Reis A, Nurnberg P (2004) Molecular karyotyping using an SNP array for genomewide genotyping. *J Med Genet* 41:916-922
- Rauen KA, Albertson DG, Pinkel D, Cotter PD (2002) Additional patient with del(12)(q21.2q22): further evidence for a candidate region for cardio-facio-cutaneous syndrome? *Am J Med Genet* 110:51-56
- Redon R, Ishikawa S, Fitch KR, Feuk L, Perry GH, Andrews TD, Fiegler H *et al.* (2006) Global variation in copy number in the human genome. *Nature* 444:444-454
- Reiter LT, Hastings PJ, Nelis E, De Jonghe P, Van Broeckhoven C, Lupski JR (1998) Human meiotic recombination products revealed by sequencing a hotspot for homologous strand exchange in multiple HNPP deletion patients. *Am J Hum Genet* 62:1023-1033
- Reiter LT, Murakami T, Koeuth T, Pentao L, Muzny DM, Gibbs RA, Lupski JR (1996) A recombination hotspot responsible for two inherited peripheral neuropathies is located near a mariner transposon-like element. *Nat Genet* 12:288-297
- Ried T, Mahler V, Vogt P, Blonden LAJ, Van Ommen GJB, Cremer T, Cremer M (1990) Direct carrier



- detection by in situ suppression hybridization with cosmid clones of the Duchenne/Becker muscular dystrophy locus. *Hum Genet* **85**:581-586
- Riegel M, Baumer A, Jamar M, Delbecq K, Herens C, Verloes A, Schinzel A (2001) Submicroscopic terminal deletions and duplications in retarded patients with unclassified malformation syndromes. *Hum Genet* **109**:286-294
- Rio M, Molinari F, Heuertz S, Ozilou C, Gosset P, Raoul O, Cormier-Daire V, Amiel J, Lyonnet S, Le Merrer M, Turleau C, de Blois MC, Prieur M, Romana S, Vekemans M, Munnich A, Colleaux L (2002) Automated fluorescent genotyping detects 10% of cryptic subtelomeric rearrangements in idiopathic syndromic mental retardation. *J Med Genet* **39**:266-270
- Rodriguez-Revenga L, Badenas C, Sanchez A, Mallolas J, Carrio A, Pedrinaci S, Barrionuevo JL, Mila M (2004) Cryptic chromosomal rearrangement screening in 30 patients with mental retardation and dysmorphic features. *Clin Genet* **65**:17-23
- Rooms L, Reyniers E, van Luijk R, Scheers S, Wauters J, Ceulemans B, Van Den EJ, Van Bever Y, Kooy RF (2004a) Subtelomeric deletions detected in patients with idiopathic mental retardation using multiplex ligation-dependent probe amplification (MLPA). *Hum Mutat* **23**:17-21
- Rooms L, Reyniers E, van Luijk R, Scheers S, Wauters J, Kooy RF (2004b) Screening for subtelomeric rearrangements using genetic markers in 70 patients with unexplained mental retardation. *Ann Genet* **47**:53-59
- Rooms L, Reyniers E, Wuylts W, Storm K, van Luijk R, Scheers S, Wauters J, Van Den EJ, Biervliet M, Eyskens F, van Goethem G, Laridon A, Ceulemans B, Courtens W, Kooy RF (2006) Multiplex ligation-dependent probe amplification to detect subtelomeric rearrangements in routine diagnostics. *Clin Genet* **69**:58-64
- Ropers HH (2007) New perspectives for the elucidation of genetic disorders. *Am J Hum Genet* **81**:199-207
- Rosenberg C, Florijn RJ, Blonden LAJ, Van Ommen GJB, Den Dunnen JT (1995) High resolution DNA fiber FISH on yeast artificial chromosomes: direct visualization of replication forks. *Nat Genet* **10**:477-479
- Rosenberg C, Knijnenburg J, Bakker E, Vianna-Morgante AM, Sloos W, Otto PA, Kriek M, Hansson K, Krepischi-Santos AC, Fiegler H, Carter NP, Bijlsma EK, Van Haeringen A, Szuhai K, Tanke HJ (2006) Array-CGH detection of micro rearrangements in mentally retarded individuals: clinical significance of imbalances present both in affected children and normal parents. *J Med Genet* **43**:180-186
- Rosenberg MJ, Killoran C, Dziadzio L, Chang S, Stone DL, Meck J, Aughton D, Bird LM, Bodurtha J, Cassidy SB, Graham JM, Jr., Grix A, Guttmacher AE, Hudgins L, Kozma C, Michaelis RC, Pauli R, Peters KF, Rosenbaum KN, Tift CJ, Wargowski D, Williams MS, Biesecker LG (2001) Scanning for telomeric deletions and duplications and uniparental disomy using genetic markers in 120 children with malformations. *Hum Genet* **109**:311-318
- Rossi E, Piccini F, Zollino M, Neri G, Caselli D, Tenconi R, Castellan C, Carrozzo R, Danesino C, Zuffardi O, Ragusa A, Castiglia L, Galesi O, Greco D, Romano C, Pierluigi M, Perfumo C, Di Rocco M, Faravelli F, Dagna BF, Bonaglia M, Bedeschi M, Borgatti R (2001) Cryptic telomeric rearrangements in subjects with mental retardation associated with dysmorphism and congenital malformations. *J Med Genet* **38**:417-420
- Samonte RV, Eichler EE (2002b) Segmental duplications and the evolution of the primate genome. *Nat Rev Genet* **3**:65-72
- Sanders SR, Dawson AJ, Vust A, Hryshko M, Tomiuk M, Riordan D, Prasad C (2003) Interstitial deletion of chromosome 2p16.2p21. *Clin Dysmorphol* **12**:183-185

- Schoumans J, Ruivenkamp C, Holmberg E, Kyllerman M, Anderlid BM, Nordenskjöld M (2005) Detection of chromosomal imbalances in children with idiopathic mental retardation by array based comparative genomic hybridisation (array-CGH). *J Med Genet* 42:699-705
- Schouten JP, McElgunn CJ, Waaijer R, Zwijnenburg D, Diepvens F, Pals G (2002) Relative quantification of 40 nucleic acid sequences by multiplex ligation-dependent probe amplification. *Nucleic Acids Res* 30:e57
- Shrock E, Veldman T, Padilla-Nash H, Ning Y, Spurbeck J, Jalal S, Shaffer LG, Papenhausen P, Kozma C, Phelan MC, Kjeldsen E, Schonberg SA, O'Brien P, Biesecker L, du MS, Ried T (1997) Spectral karyotyping refines cytogenetic diagnostics of constitutional chromosomal abnormalities. *Hum Genet* 101:255-262
- Sebat J, Lakshmi B, Malhotra D, Troge J, Lese-Martin C, Walsh T, Yamrom B *et al.* (2007) Strong Association of *De novo* Copy Number Mutations with Autism. *Science*
- Sebat J, Lakshmi B, Troge J, Alexander J, Young J, Lundin P, Maner S, Massa H, Walker M, Chi M, Navin N, Lucito R, Healy J, Hicks J, Ye K, Reiner A, Gilliam TC, Trask B, Patterson N, Zetterberg A, Wigler M (2004) Large-scale copy number polymorphism in the human genome. *Science* 305:525-528
- Shaffer LG, Lupski JR (2000) Molecular mechanisms for constitutional chromosomal rearrangements in humans. *Annu Rev Genet* 34:297-329
- Shaikh TH, Kurahashi H, Saitta SC, O'Hare AM, Hu P, Roe BA, Driscoll DA, McDonald-McGinn DM, Zackai EH, Budarf ML, Emanuel BS (2000) Chromosome 22-specific low copy repeats and the 22q11.2 deletion syndrome: genomic organization and deletion endpoint analysis. *Hum Mol Genet* 9:489-501
- Sharp AJ, Hansen S, Selzer RR, Cheng Z, Regan R, Hurst JA, Stewart H, Price SM, Blair E, Hennekam RC, Fitzpatrick CA, Segraves R, Richmond TA, Guiver C, Albertson DG, Pinkel D, Eis PS, Schwartz S, Knight SJ, Eichler EE (2006) Discovery of previously unidentified genomic disorders from the duplication architecture of the human genome. *Nat Genet* 38:1038-1042
- Sharp AJ, Locke DP, McGrath SD, Cheng Z, Bailey JA, Vallente RU, Pertz LM, Clark RA, Schwartz S, Segraves R, Oseroff VV, Albertson DG, Pinkel D, Eichler EE (2005) Segmental duplications and copy-number variation in the human genome. *Am J Hum Genet* 77:78-88
- Shaw CJ, Bi W, Lupski JR (2002) Genetic proof of unequal meiotic crossovers in reciprocal deletion and duplication of 17p11.2. *Am J Hum Genet* 71:1072-1081
- Shaw-Smith C, Pittman AM, Willatt L, Martin H, Rickman L, Gribble S, Curley R, Cumming S, Dunn C, Kalaitzopoulos D, Porter K, Prigmore E, Krepischi-Santos AC, Varela MC, Koiffmann CP, Lees AJ, Rosenberg C, Firth HV, de Silva R, Carter NP (2006) Microdeletion encompassing MAPT at chromosome 17q21.3 is associated with developmental delay and learning disability. *Nat Genet*
- She X, Jiang Z, Clark RA, Liu G, Cheng Z, Tuzun E, Church DM, Sutton G, Halpern AL, Eichler EE (2004) Shotgun sequence assembly and recent segmental duplications within the human genome. *Nature* 431:927-930
- She X, Liu G, Ventura M, Zhao S, Misceo D, Roberto R, Cardone MF, Rocchi M, Green ED, Archidiacono N, Eichler EE (2006) A preliminary comparative analysis of primate segmental duplications shows elevated substitution rates and a great-ape expansion of intrachromosomal duplications. *Genome Res* 16:576-583
- Shuber AP, Grondin VJ, Klinger KW (1995) A simplified procedure for developing multiplex PCRs. *Genome Res* 5:488-493

- Sismani C, Armour JA, Flint J, Girgalli C, Regan R, Patsalis PC (2001) Screening for subtelomeric chromosome abnormalities in children with idiopathic mental retardation using multiprobe telomeric FISH and the new MAPH telomeric assay. *Eur J Hum Genet* 9:527-532
- Slager RE, Newton TL, Vlangos CN, Finucane B, Elsea SH (2003) Mutations in RAI1 associated with Smith-Magenis syndrome. *Nat Genet* 33:466-468
- Slater HR, Bailey DK, Ren H, Cao M, Bell K, Nasioulas S, Henke R, Choo KH, Kennedy GC (2005) High-Resolution Identification of Chromosomal Abnormalities Using Oligonucleotide Arrays Containing 116,204 SNPs. *Am J Hum Genet* 77:709-726
- Snijders AM, Nowak N, Segraves R, Blackwood S, Brown N, Conroy J, Hamilton G, Hindle AK, Huey B, Kimura K, Law S, Myambo K, Palmer J, Ylstra B, Yue JP, Gray JW, Jain AN, Pinkel D, Albertson DG (2001) Assembly of microarrays for genome-wide measurement of DNA copy number. *Nat Genet* 29:263-264
- Snijders AM, Nowee ME, Fridlyand J, Piek JM, Dorsman JC, Jain AN, Pinkel D, van Diest PJ, Verheijen RH, Albertson DG (2003) Genome-wide-array-based comparative genomic hybridization reveals genetic homogeneity and frequent copy number increases encompassing CCNE1 in fallopian tube carcinoma. *Oncogene* 22:4281-4286
- Snijders AM, Pinkel D, Albertson DG (2003) Current status and future prospects of array-based comparative genomic hybridisation. *Brief Funct Genomic Proteomic* 2:37-45
- Solinas-Toldo S, Lampel S, Stilgenbauer S, Nickolenko J, Benner A, Dohner H, Cremer T, Lichter P (1997) Matrix-based comparative genomic hybridization: biochips to screen for genomic imbalances. *Genes Chromosomes Cancer* 20:399-407
- Somerville MJ, Mervis CB, Young EJ, Seo EJ, del Campo M, Bamforth S, Peregrine E, Loo W, Lilley M, Perez-Jurado LA, Morris CA, Scherer SW, Osborne LR (2005) Severe expressive-language delay related to duplication of the Williams-Beuren locus. *N Engl J Med* 353:1694-1701
- Southern EM (1975) Detection of specific sequences among DNA fragments separated by gel electrophoresis. *J Mol Biol* 98:503-517
- Speicher MR, Gwyn BS, Ward DC (1996) Karyotyping human chromosomes by combinatorial multi-fluor FISH. *Nat Genet* 12:368-375
- Stankiewicz P, Park SS, Inoue K, Lupski JR (2001) The evolutionary chromosome translocation 4;19 in Gorilla gorilla is associated with microduplication of the chromosome fragment syntenic to sequences surrounding the human proximal CMT1A-REP. *Genome Res* 11:1205-1210
- Stoppa-Lyonnet D, Carter PE, Meo T, Tosi M (1990) Clusters of intragenic Alu repeats predispose the human C1 inhibitor locus to deleterious rearrangements. *Proc Natl Acad Sci U.S.A.* 87:1551-1555
- Tanke HJ, Wiegant J, van Gijlswijk RP, Bezrookove V, Pattenier H, Heetebrij RJ, Talman EG, Raap AK, Vrolijk J (1999) New strategy for multi-colour fluorescence in situ hybridisation: COBRA: COmbined Binary RAtio labelling. *Eur J Hum Genet* 7:2-11
- Taylor JS, Raes J (2004) Duplication and divergence: the evolution of new genes and old ideas. *Annu Rev Genet* 38:615-643
- Telenius H, Carter NP, Bebb CE, Nordenskjold M, Ponder BA, Tunnacliffe A (1992) Degenerate oligonucleotide-primed PCR: general amplification of target DNA by a single degenerate primer. *Genomics* 13:718-725
- Ting JC, Ye Y, Thomas GH, Ruczinski I, Pevsner J (2006) Analysis and visualization of chromosomal abnormalities in SNP data with SNPscan. *BMC Bioinformatics* 7:25
- Trask BJ, Friedman C, Martin-Gallardo A, Rowen L, Akinbami C, Blankenship J, Collins C, Giorgi D, Iadonato S, Johnson F, Kuo WL, Massa H, Morrish T, Naylor S, Nguyen OT, Rouquier S, Smith

- T, Wong DJ, Youngblom J, van den EG (1998) Members of the olfactory receptor gene family are contained in large blocks of DNA duplicated polymorphically near the ends of human chromosomes. *Hum Mol Genet* 7:13-26
- Turner G, Webb T, Wake S, Robinson H (1996) Prevalence of fragile X syndrome. *Am J Med Genet* 64:196-197
- Tyson C, Harvard C, Locker R, Friedman JM, Langlois S, Lewis ME, Van Allen M, Somerville M, Arbour L, Clarke L, McGilivray B, Yong SL, Siegel-Bartel J, Rajcan-Separovic E (2005) Submicroscopic deletions and duplications in individuals with intellectual disability detected by array-CGH. *Am J Med Genet A* 139:173-185
- Ullmann R, Turner G, Kirchoff M, Chen W, Tonge B, Rosenberg C, Field M, Vianna-Morgante AM, Christie L, Krepischi-Santos AC, Banna L, Brereton AV, Hill A, Bisgaard AM, Muller I, Hultschig C, Erdogan F, Wiczorek G, Ropers HH (2007) Array CGH identifies reciprocal 16p13.1 duplications and deletions that predispose to autism and/or mental retardation. *Hum Mutat* 28:674-682
- Urban Z, Helms C, Fekete G, Csiszar K, Bonnet D, Munnich A, Donis-Keller H, Boyd CD (1996) 7q11.23 deletions in Williams syndrome arise as a consequence of unequal meiotic crossover. *Am J Hum Genet* 59:958-962
- Valentijn LJ, Bolhuis PA, Zorn I, Hoogendijk JE, Van Den Bosch N, Hessels GW, Stanton VP, Husman DE, Fischbeck KH, Ross DA, Nicholson GA, Meershoek EJ, Dauwerse HG, Van Ommen GJB, Baas F (1992) The peripheral myelin gene PMP22/GAS3 is duplicated in Charcot-Marie-Tooth disease type 1A. *Nat Genet* 1:166-170
- van Geel M, Dickson MC, Beck AF, Bolland DJ, Frants RR, Van Der Maarel SM, De Jong PJ, Hewitt JE (2002) Genomic analysis of human chromosome 10q and 4q telomeres suggests a common origin. *Genomics* 79:210-217
- van Karnebeek CD, Koevoets C, Sluijter S, Bijlsma EK, Smeets DF, Redeker EJ, Hennekam RC, Hoovers JM (2002) Prospective screening for subtelomeric rearrangements in children with mental retardation of unknown aetiology: the Amsterdam experience. *J Med Genet* 39:546-553
- van Ommen GJ (2005) Frequency of new copy number variation in humans. *Nat Genet* 37:333-334
- van Ommen GJ, Verkerk JM, Hofker MH, Monaco AP, Kunkel LM, Ray P, Worton R, Wieringa B, Bakker E, Pearson PL (1986) A physical map of 4 million bp around the Duchenne muscular dystrophy gene on the human X-chromosome. *Cell* 47:499-504
- van Overveld PG, Lemmers RJ, Deidda G, Sandkuijl L, Padberg GW, Frants RR, Van Der Maarel SM (2000) Interchromosomal repeat array interactions between chromosomes 4 and 10: a model for subtelomeric plasticity. *Hum Mol Genet* 9:2879-2884
- Veltman JA (2006) Genomic microarrays in clinical diagnosis. *Curr Opin Pediatr* 18:598-603
- Veltman JA, Schoenmakers EF, Eussen BH, Janssen I, Merckx G, van Cleef B, van Ravenswaaij CM, Brunner HG, Smeets D, van Kessel AG (2002) High-throughput analysis of subtelomeric chromosome rearrangements by use of array-based comparative genomic hybridization. *Am J Hum Genet* 70:1269-1276
- Vissers LE, De Vries BB, Osoegawa K, Janssen IM, Feuth T, Choy CO, Straatman H, Van D, V, Huys EH, Van Rijk A, Smeets D, Ravenswaaij-Arts CM, Knoers NV, Van DB, I, De Jong PJ, Brunner HG, van Kessel AG, Schoenmakers EF, Veltman JA (2003) Array-based comparative genomic hybridization for the genomewide detection of submicroscopic chromosomal abnormalities. *Am J Hum Genet* 73:1261-1270
- Vissers LE, van Ravenswaaij CM, Admiraal R, Hurst JA, De Vries BB, Janssen IM, van der Vliet WA,

- Huys EH, De Jong PJ, Hamel BC, Schoenmakers EF, Brunner HG, Veltman JA, van Kessel AG (2004) Mutations in a new member of the chromodomain gene family cause CHARGE syndrome. *Nat Genet* 36:955-957
- Vissers LE, Veltman JA, van Kessel AG, Brunner HG (2005) Identification of disease genes by whole genome CGH arrays. *Hum Mol Genet* 14 Suppl 2:R215-R223
- Waldman AS, Liskay RM (1988) Dependence of intrachromosomal recombination in mammalian Cells on uninterrupted homology. *Mol Cell Biol* 8:5350-5357
- Walter S, Sandig K, Hinkel GK, Mitulla B, Ounap K, Sims G, Sitska M, Utermann B, Viertel P, Kalscheuer V, Bartsch O (2004) Subtelomere FISH in 50 children with mental retardation and minor anomalies, identified by a checklist, detects 10 rearrangements including a *de novo* balanced translocation of chromosomes 17p13.3 and 20q13.33. *Am J Med Genet A* 128:364-373
- Weiss MM, Snijders AM, Kuipers EJ, Ylstra B, Pinkel D, Meuwissen SG, van Diest PJ, Albertson DG, Meijer GA (2003) Determination of amplicon boundaries at 20q13.2 in tissue samples of human gastric adenocarcinomas by high-resolution microarray comparative genomic hybridization. *J Pathol* 200:320-326
- White S, Kalf M, Liu Q, Villerius M, Engelsma D, Kriek M, Vollebregt E, Bakker B, van Ommen GJ, Breuning MH, Den Dunnen JT (2002) Comprehensive detection of genomic duplications and deletions in the DMD gene, by use of multiplex amplifiable probe hybridization. *Am J Hum Genet* 71:365-374
- White SJ, Vink GR, Kriek M, Wuyts W, Schouten J, Bakker B, Breuning MH, Dunnen JT (2004) Two-color multiplex ligation-dependent probe amplification: Detecting genomic rearrangements in hereditary multiple exostoses. *Hum Mutat* 24:86-92
- Wiegant J, Kalle W, Mullenders L, Brookes S, Hoovers JM, Dauwerse JG, van Ommen GJ, Raap AK (1992) High-resolution in situ hybridization using DNA halo preparations. *Hum Mol Genet* 1:587-591
- Wilke K, Duman B, Horst J (2000) Diagnosis of haploidy and triploidy based on measurement of gene copy number by real-time PCR. *Hum Mutat* 16:431-436
- Yobb TM, Somerville MJ, Willatt L, Firth HV, Harrison K, MacKenzie J, Gallo N, Morrow BE, Shaffer LG, Babcock M, Chernos J, Bernier F, Sprysak K, Christiansen J, Haase S, Elyas B, Lilley M, Bamforth S, McDermid HE (2005) Microduplication and triplication of 22q11.2: a highly variable syndrome. *Am J Hum Genet* 76:865-876
- Yunis JJ (1976) High resolution of human chromosomes. *Science* 191:1268-1270
- Zhang L, Lu HH, Chung WY, Yang J, Li WH (2005) Patterns of segmental duplication in the human genome. *Mol Biol Evol* 22:135-141
- Zweier C, Peippo MM, Hoyer J, Sousa S, Bottani A, Clayton-Smith J, Reardon W, Saraiva J, Cabral A, Gohring I, Devriendt K, de Ravel T, Bijlsma EK, Hennekam RC, Orrico A, Cohen M, Dreweke A, Reis A, Nurnberg P, Rauch A (2007) Haploinsufficiency of TCF4 causes syndromal mental retardation with intermittent hyperventilation (Pitt-Hopkins syndrome). *Am J Hum Genet* 80:994-1001