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Bioinformation and molecule of the month: Multiple interactive pathways for a single gene, NF-kB

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This Editorial is divided into two parts. 1. A summary of what is under the *Bioinformation aegis*; 2. An example of a highly networked gene, NF-kB.

The *Bioinformation Aegis*:
Bioinformation (Online ISSN 0973-2063; Print ISSN 0973-8894) is a peer-reviewed journal that grows in leaps and bounds as the global scientific endeavor advances. *Bioinformation* publishes original biological research that utilizes mathematical and computational analysis. The fields in such analyses range from biochemistry and cell biology to genetics, epigenetics, systems biology, and brain imaging, from agriculture to tissue engineering and transplantation, from nanotechnology to evolution, and from basic research to clinical medicine, infectious disease, immunology, molecular structure, molecular therapy, and vaccines. This work is further often analyzed from the vantage point of data cleaning, analysis, representation, storage, retrieval, and knowledge extraction. Developing databases, datasets, prediction models, and computer programs fall under the purview of *Bioinformation* as well. Research articles published in *Bioinformation* demonstrate novelty, relevance, and coherence.

Global scientific advances are accelerating, research and clinical studies are expanding, topics of study are increasing, as are publications, journals, and books. E-publishing has participated in this intellectual revolution, and has widened the already expanding scope and reach. Moreover, novel fields increase contemporaneously, e.g. nanotechnology and nanomedicine, imaging and genetics, vaccines for cancer, microorganisms (e.g. bacteria and parasites), and viruses (e.g. HIV, HCV, HBV, and arboviruses), as well as genetic engineering. Genetic engineering in agriculture is ubiquitous; genetic engineering in humans and animals is in progress. All this work requires concomitant development of fields including bioinformatics and modes of analysis. It is among the goals of *Bioinformation* to continue to promote and be the venue of all these advances and improvements.

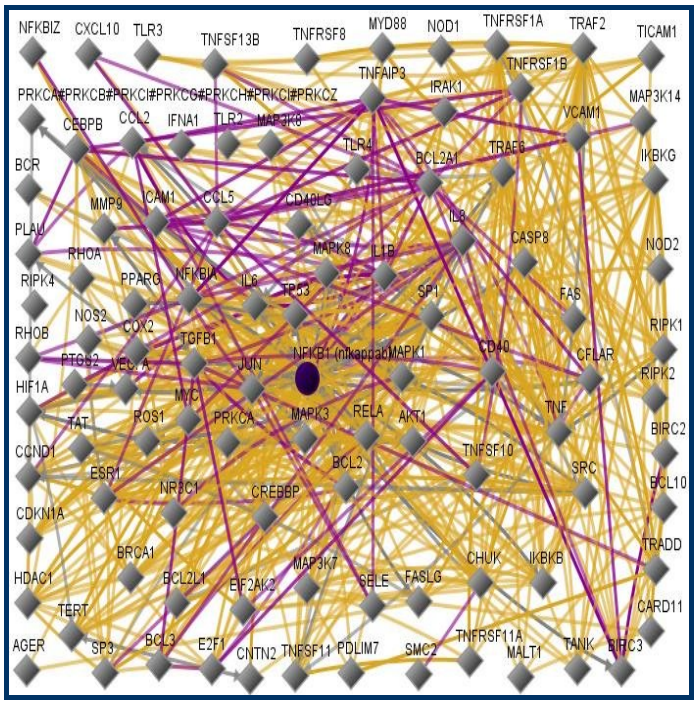

Figure 1: NF-kB interactions. In this figure, interactions - line-color are Regulation- beige, Co-expression - purple and Physical interaction-brown. (GenePro SA Biosciences,

http://www.sabiosciences.com/)http://www.panomics.com/NFkBhuman.htm

NF-kB, a highly networked gene:

The example selected for this Editorial is the gene, NF-kB (Nuclear Factor *kappa*-light-chain-enhancer of activated B cells). NF-kB is a central gene that is expressed in eukaryotic cells. It is a transcription factor and interacts with the promoters and gene products of many gene pathways. Thus, it is central in gene control and expression and is highly utilized throughout eukaryotic evolution. It is important, for example, for treatment of cancer and due to its function in immunology. It is also involved in the control of expression of many mammalian viruses. More than 12 years ago, a list was published of some 114 genes with which NF-kB interacts. Please see **Table 1 (see supplementary material).** A current view extends the interactions of NF-kB including 99 genes as indicated in (**Figure 1).**

Table 1 (see supplementary material) lists descriptions and functions of genes in that table. As noted in the (**Figure 1)** legend, interactions of NF-kB are indicated that involve regulation, co-expression, and actual physical interaction. Molecular processes in this figure include apoptosis, immunology, transcription, chromatin, and regulation of the NF-kB gene itself. Additional interactions are not shown because of the excessive overlapping information that would result in the figure. These include down-regulation, up-regulation, predicted protein interaction, and predicted transcription factor interactions. Similarly, only 100 genes are shown since more than that would make the figure illegible.

In summary then, this journal, *Bioinformation*, has a wide array of bioinformatics in its purview. This Editorial provides a simple scenario of the complexity of molecular information available, already in the literature, even for a single molecule.

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Supplementary material:

Table 1: NF-kB interactions, http://www.panomics.com/NFkBhuman.htm

Sl. no	Abbreviations	Description
1	a1 acid GP	Human alpha-1 acid glycoprotein mRNA, complete cds.
2	A1AT	Human alpha-1-antitrypsin mRNA, complete cds.
3	A20	Human tumor necrosis factor alpha inducible protein A20 mRNA, complete cds.
4	ACTB	Homo sapiens actin, beta (ACTB), mRNA.
5	ADORA1	Homo sapiens A1 adenosine receptor mRNA, complete cds.
6	AGER	Homo sapiens advanced glycosylation end product-specific receptor (AGER), mRNA.
7	AGT	Human angiotensinogen mRNA, complete CDS.
8	AhRR	Homo sapiens dioxin receptor repressor (AHRR), mRNA.
9	ALOX12	Human cell 12-lipoxygenase mRNA, complete cds.
10	APOC3	Homo sapiens apolipoprotein C-III (APOC3), mRNA.
11	BCL2A1	Homo sapiens BCL2-related protein A1 (BCL2A1), mRNA.
12	BCL-xl	H. sapiens bcl-xL mRNA.
13	BDKRB1	Homo sapiens bradykinin receptor B1 (BDKRB1), mRNA.
14	BGN	Homo sapiens biglycan (BGN), mRNA.
15	BLR1	Homo sapiens BLR1 gene for Burkitt's lymphoma receptor 1.
16	CCND3	Human D3-type cyclin (CCND3) mRNA, complete cds.
17	CCR5	Human CC chemokine receptor 5 mRNA, complete cds.
18	CD23	Homo sapiens Fc fragment of IgE, low affinity II, receptor for (CD23A) (FCER2), mRNA.
19	CD48	Human pan-leukocyte antigen (CD48) mRNA, complete cds.
20	CD62	Homo sapiens selectin P (granule membrane protein 140kD, antigen CD62) (SELP), mRNA.
21	CD69	Homo sapiens early activation antigen CD69 mRNA, complete cds.
22	CD80	Homo sapiens CD80 antigen (CD28 antigen ligand 1, B7-1 antigen) (CD80), mRNA.
23	CD95	MRNA for Fas (Apo-1, CD95).
24	c-myb	Homo sapiens v-myb myeloblastosis viral oncogene homolog (avian) (MYB), mRNA.
25	c-myc	Homo sapiens v-myc myelocytomatosis viral oncogene homolog (avian) (MYC), mRNA.
26	COX-2	Homo sapiens cyclooxygenase-2 (Cox-2) mRNA, complete cds.
27	c-rel	Homo sapiens v-rel avian reticulo-endotheliosis viral oncogene homolog (REL), mRNA.
28	CSF-1	Human macrophage-specific colony-stimulating factor (CSF-1) mRNA, complete cds.
29	CSF2	Homo sapiens colony stimulating factor 2 (granulocyte-macrophage) (CSF2), mRNA.
30	CSF3	Homo sapiens colony stimulating factor 3 (granulocyte) (CSF3), mRNA.
31	CYC-D1	Human cyclin D (cyclin D1) mRNA, complete cds.
32	DDH1	Human dihydrodiol dehydrogenase mRNA, complete cds.
33	ELAM-1	Human endothelial leukocyte adhesion molecule 1 (ELAM-1) mRNA, complete cds.
34	F8	Human coagulation factor VIII: C mRNA, complete cds.
35	Fas-L	Human mRNA for Fas ligand, complete cds.
36	FB	Human complement factor B mRNA, complete cds.
37	FTH	Human ferritin H chain mRNA, complete cds.
38	GAD65	Human glutamate decarboxylase (GAD65) mRNA, complete cds.
39	Gal1-R	Homo sapiens galanin receptor (Gal1-R) mRNA, complete cds.
40	GAL-3	Homo sapiens mRNA for galectin-3, complete cds.
41	GAPDH	Homo sapiens glyceraldehyde-3-phosphate dehydrogenase (GAPD), mRNA.
42	GRO1	Homo sapiens GRO1 oncogene (melanoma growth stimulating activity, alpha) (GRO1), mRNA.
43	GSTP1	Homo sapiens glutathione S-transferase pi (GSTP1), mRNA.
44	HAS1	Human hyaluronan synthase mRNA, complete cds.
45	HLA-G1	Human lymphocyte antigen (HLA-G1) mRNA, complete cds.
46	HMG-14	Human non-histone chromosomal protein HMG-14 mRNA, complete cds.
47	HMOX1	Homo sapiens heme oxygenase (decycling) 1 (HMOX1), mRNA.
48	ICAM-1	Human intercellular adhesion molecule-1 (ICAM-1) mRNA, complete cds.
49	IFNb	Human interferon-beta mRNA, complete cds.
50	IFNg	Human immune interferon (IFN-gamma) gene, complete cds.
51	IGFBP1	Homo sapiens insulin-like growth factor binding protein 1 (IGFBP1), mRNA.
52	IGFBP-2	Human mRNA for insulin-like growth factor binding protein (IGFBP-2).
53	IL10	Human interleukin 10 (IL10) gene, complete cds.
54	IL11	Human interleukin 11 mRNA, complete cds.
55	IL12	Homo sapiens interleukin 12, P40 mRNA, complete cds.
56	IL15	Homo sapiens interleukin 15 precursor (IL-15) mRNA, complete cds.
57	IL1-a	Human gene for interleukin 1 alpha (IL-1 alpha).
58	IL1b	Human interleukin 1-beta (IL1B) mRNA, complete cds.
59	IL1RN	Homo sapiens interleukin 1 receptor antagonist (IL1RN), mRNA.
60	IL2	Human interleukin 2 (IL2) mRNA, complete cds.
61	IL2-Ra	Human interleukin-2 receptor mRNA (short form), complete cds.
62	IL6	Human interleukin 6 mRNA, complete cds.
63	IL8	Human interleukin 8 (IL8) gene, complete cds.
64	IL9	Human IL9 protein gene, complete cds.

65	IRF1	Homo sapiens interferon regulatory factor 1 (IRF1), mRNA.
66	IRF-2	Human mRNA for interferon regulatory factor-2 (IRF-2).
67	JUN-B	Human jun-B mRNA for JUN-B protein.
68	LAMB2	LAMB2 mRNA for beta2 laminin.
69	LMP-2	Human proteasome-related (LMP-2) mRNA, complete cds.
70	Lox-1	Homo sapiens oxidized low-density lipoprotein receptor mRNA, complete cds.
71	LYZ	Homo sapiens lysozyme (renal amyloidosis) (LYZ), mRNA.
72	MAD-3	Homo sapiens MAD-3 mRNA encoding IkB-like activity, complete cds.
73	MAdCAM-1	Human mucosal addressin cell adhesion molecule-1 (MAdCAM-1) mRNA, complete cds.
74	MCP-1	mRNA for monocyte chemoattractant protein 1 (MCP-1).
75	MDR-1	Homo sapiens P-glycoprotein (mdr1) mRNA, complete cds.
76	MIP-2g	Homo sapiens chemokine MIP-2 gamma (MIP-2 gamma) mRNA, complete cds.
77	MMP1	Homo sapiens matrix metalloproteinase 1 (interstitial collagenase) (MMP1), mRNA.
78	MMP-3	Human matrix metalloproteinase-3 (MMP-3) mRNA, complete cds.
79	MMP9	Homo sapiens matrix metalloproteinase 9 (gelatinase B, 92kD gelatinase, 92kD type IV collagenase) (MMP9), mRNA.
80	Mn-SOD	Human mRNA for mangano-superoxide dismutase (Mn-SOD).
81	MSX1	Homo sapiens msh homeo box homolog 1 (Drosophila) (MSX1), mRNA.
82	MTS1	MTS1=multiple tumor suppressor 1/cyclin-dependent kinase 4 inhibitor p16 (cosmid c5 region, exon 2) [human, melanoma cell line, Genomic Mutant, 457 nt].
83	NFKB1	Homo sapiens nuclear factor of kappa light polypeptide gene enhancer in B-cells 1 (p105) (NFKB1), mRNA.
84	NFKB2	Homo sapiens nuclear factor of kappa light polypeptide gene enhancer in B-cells 2 (p49/p100) (NFKB2), mRNA.
85	NOS	Human inducible nitric oxide synthase (NOS) mRNA, complete cds.
86	NPYY1	Human neuropeptide Y receptor Y1 (NPYY1) mRNA, exon 2-3 and complete cds.
87	p53	Human p53 cellular tumor antigen mRNA, complete cds.
88	PAFR1	Homo sapiens mRNA for platelet-activating factor receptor, complete cds.
89	PAX8	Human paired box homeotic protein (PAX8) mRNA, complete cds.
90	PDGF-B	Human mRNA for platelet-derived growth factor B chain (PDGF-B).
91	PENK	Homo sapiens proenkephalin (PENK), mRNA.
92	PRG1	PRG1 gene.
93	PTGIS	Human mRNA for prostacyclin synthase, complete cds.
94	PTX3	Homo sapiens pentaxin-related gene, rapidly induced by IL-1 beta (PTX3), mRNA.
95	RANTES	Human T cell-specific protein (RANTES) mRNA, complete cds.
96	SAA	Human serum amyloid A gene, complete cds.
97	SCYA11	Human eotaxin precursor mRNA, complete cds.
98	SCYB11	Homo sapiens small inducible cytokine subfamily B (Cys-X-Cys), member 11 (SCYB11), mRNA.
99	TAP1	Homo sapiens peptide transporter (TAP1) mRNA, complete cds.
100	TCRB	Human T-cell receptor active beta-chain (DJC-region) mRNA from Jurkat cell line (clone JUR-beta-2).
. 101	TGM1	Homo sapiens trans-glutaminase 1 (K polypeptide epidermal type I, protein-glutamine-gamma-glutamyl-transferase) (TGM1), mRNA.
. 102	THBS2	Human thrombospondin 2 (THBS2) mRNA, complete cds.
. 103	TNC	mRNA for tenascin-C, 7560bp.
. 104	TNF	Human mRNA for tumor necrosis factor.
. 105	TNFb	Human mRNA for lymphotoxin (TNF-beta), complete cds.
. 106	TNF-R	TNF-R mRNA for tumor necrosis factor receptor type 1.
. 107	TNSFS5	Homo sapiens tumor necrosis factor (ligand) superfamily, member 5 (hyper-IgM syndrome) (TNFSF5), mRNA.
. 108	UBC	Homo sapiens ubiquitin C (UBC), mRNA.
. 109	UGT8	Homo sapiens UDP glycosyl-transferase 8 (UDP-galactose ceramide galactosyl-transferase) (UGT8), mRNA.
. 110	UPAR	Human urokinase-type plasminogen activator receptor mRNA, complete cds.
. 111	VCAM-1	Human mRNA for vascular cell adhesion molecule 1 (VCAM-1).
. 112	VEGFC	Homo sapiens vascular endothelial growth factor C (VEGFC), mRNA.
. 113	VIM	Human vimentin gene, complete cds.
. 114	WT1	Homo sapiens Wilms tumor 1 (WT1), mRNA.