## Identification and Characterization of 177 Unreported Genes Associated with Liver Regeneration

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The mammalian liver has a very strong regeneration capacity after partial hepatectomy (PH). To further learn the genes participating in the liver regeneration (LR), 551 cDNAs selected from subtracted cDNA libraries of the regenerating rat liver were screened by microarray, and their expression profiles were studied by cluster and generalization analyses. Among them, 177 genes were identified unreported and up- or down-regulated more than twofold at one or more time points after PH, of which 62 genes were down-regulated to less than 0.5; 99 genes were up-regulated to 2–10 folds, and 16 genes were either up- or down-regulated at different time points during LR. By using BLAST and GENSCAN, these genes were located on responsible chromosomes with 131 genes on the long arms of the chromosomes. The cluster and generalization analyses showed that the gene expression profiles are similar in 2 and 4, 12 and 16, 96 and 144 h respectively after PH, suggesting that the actions of the genes expressed in the same profiles are similar, and those expressed in different profiles have less similarity. However, the types, characteristics and functions of the 177 genes remain to be further studied.

Key words: Partial hepatectomy (PH), subtracted cDNA libraries, complementary DNA microarray, liver regeneration (LR), cluster analysis

### Introduction

In the healthy adult rat liver, liver is a quiescent organ with >90% of the cells present in the G<sub>0</sub> stage of the cell cycle, and their division index is very low (about 1/100600; ref. 1-3). However, adult hepatocytes have enormous ability to proliferate in response to liver injury. After 70% partial hepatectomy (PH), hepatocytes in remained liver enter the cell cycle in a highly synchronized manner and undergo 1 to 2 times of cell division, then re-differentiate and rebuild the structure and function of the liver (4, 5). In the different phases of the liver regeneration (LR), the physiological and biochemical actions of different kinds of liver cells are different, and the categories and amounts of the expressed genes in the regenerating liver are various (6, 7). It means that PH leads to an orchestrated regenerative response, activating a cascade of cell signaling events, which are necessary for cell cycle progression of hepatocytes and liver regeneration (8).

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It has been suggested that liver regeneration must be involved in numerous genes (9, 10). For this, we applied suppressive subtractive hybridization, largescale gene expression analysis, complementary DNA microarrays and bioinformatics to confirm how many genes are involved in liver regeneration after PH (11, 12).

#### Results

#### The genes expressed in liver regeneration

3,205 expressed sequence tags (ESTs) that were expressed highly and specifically in the regenerating rat liver after PH were screened by suppression subtractive hybridization (SSH). 551 of them were selected to make cDNA microarray, of which 177 genes were identified unreported and up- or down-regulated more than twofold at one or more time points. Accord-

This is an open access article under the CC BY license (<u>http://creativecommons.org/licenses/by/4.0/</u>). Geno. Prot. Bioinfo. Vol. 2 No. 2 May 2004 ing to their expression characteristics at different time points during LR, the genes were categorized into six groups: (1) expressed in the immediate early phase (IEP, 2–4 h after PH), of which expression of 23 genes were altered. Among them, 15 were up-regulated, 5 down, and 3 showed either up or down at different time points; (2) expressed in the early phase (EP, 4–8) h after PH), of which expression of 38 genes were altered. Among them, 17 were up-regulated, 18 down, and 3 either up or down at different time points; (3)expressed in the intermediate phase (IP, 12–24 h after PH), of which expression of 65 genes were altered. Among them, 39 were up-regulated, 22 down, and 4 either up or down at different time points; (4) expressed in the early-late phase (ELP, 24–36 h after PH), of which expression of 20 genes were altered. Among them, 12 were up-regulated, 3 down, and 5 either up or down at different time points; (5) expressed in the late phase (LP, 48–72 h after PH), of which expression of 27 genes were altered. Among them, 16 were up-regulated and 10 down, and 1 either up or down at different time points; (6) expressed in the terminal phase (TP, 96–144 h after PH), of which expression of 4 genes were altered. Among them, 4 were down-regulated (Figure 1). These results showed that 62 genes were down-regulated, 99 genes up to 2–10 folds, and 16 genes either up or down at different time points during LR.

# Chromosome location of the genes expressed in liver regeneration

The chromosome location of the 177 genes was analyzed by using BLAST (http://www.ncbi.nlm.nih.gov/BLAST/) and GENSCAN (http://genes.mit.edu/GENSCAN.html/) (Table 1). These results showed that 131 genes were located on the long arms of the chromosomes, 25 genes were on the short arms, while the chromosome location of 21 genes was not clear.

Table 1 Chromosome Location and Expression of the Genes Related with Liver Regeneration

Chr.	Gene	es in (	Chr.						Th	ne ez	xpress	ed ger	nes i	n LR	after 1	PH				
No.	Total	long	short	2-	-4 h (I	EP)	4	-8 h (l	EP)	12	2-24 h	(IP)	24-	36 h (	ELP)	48	-72 h	(LP)	96-144 h	(TP)
		$\operatorname{arm}$	$\operatorname{arm}$	up	$\operatorname{down}$	both	up	$\operatorname{down}$	both	up	$\operatorname{down}$	both	up	down	both	up	down	both	up down	both
1	19	16	3		1		3	4		3	4	1		1		1			1	
2	15	15		1	1			3		5	3	1			1					
3	8	6	2				1			2	1		2				1		1	
4	8	8		1			1	1		3			1			1				
5	8	8					1			6	1									
6	6	6		1				1		1					1		1		1	
7	8	8		2	1	1				2					1		1			
8	7	7								1	2		1			3				
9	8	8					2	1	2	1			1				1			
10	11	11		1			2	1		3	2				1			1		
11	5	4	1					2			1		1			1				
12	2	2		1			1													
13	9	5	4		2		1		1		1			1	1	1	1			
14	3	1	2							2	1									
15	6	2	4				3			1				1		1				
16	4	3	1	2						1	1									
17	2	0	2								1		1							
18	5	2	3	1			1									3				
19	8	6	2	1		1				2	1		2				1			
20	3	2	1							1	1		1							
Х	11	11				1		2		2	2	1	1		2					
Υ																				
N/A	21	N/A	N/A	4			1	3		3		1	1			3	4		1	
total	177	131	25	15	5	3	17	18	3	39	22	4	12	3	5	16	10	1	4	



Fig. 1 Genes expressed at different time points of liver regeneration.

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# Structure of the expressed genes in liver regeneration

showed that 52 genes were made up of  $\geq 10$  extrons, 102 genes  $\leq 9$  extrons, while the structure of 23 genes was unclear.

The structure of the 177 genes was analyzed by using BLAST and GENSCAN (Table 2). These results

Table	2 Structure	and Expre	ssion Diffe	rences of the	Genes	Related	with Live	r Regeneration
								0

No.	Gene description	Chromo-	Section	ORF	Extron	Genebank	Genebank	Hours	Fold
		some				number	number	after	difference
		location				of CDS	of EST	$_{\rm PH}$	
1	BAC CH230-7A22	1	95964-195965	2151	E5	AC095402	AA818122	8-36	0.1
2	LRRP Ab1-346	1p11	35486309-35586309	2421	E11	AY325159	CD052213	12-36	0.3
3	BAC CH230-329D3	1p12	18210650 - 18310650	6129	E14	AC112406	BQ401082	8-72	2.4
4	BAC CH230-372C24	1q12	72808754-73167679	2262	E4	AC127734	AW917420	8-16	0.1
5	BAC CH230-203P11	1q12	68519037-68619038	309	E2	AY310139	CB816795	24-36	2.5
6	LRRP Ab2-440	1q21	78488239-78946203	N/A	N/A	N/A	N/A	4-12	0.3
7	LRRP Aa2-028	1q21	95484635 - 95584636	2514	E17	AY325132	CD052171	12-24	2.1
8	RIKEN cDNA 4930408O21	1q33	173267794 - 173367795	936	E5	$\rm XM\_219288$	CB964404	96 - 144	0.5
9	MGC5178	1q33	$179502812 \hbox{-} 179602813$	738	E4	$\rm XM\_215073$	BE095889	12 - 16	0.4
10	LRRP Aa2-174	1q34	185927807 - 186027808	2865	E19	AY325165	CD670576	12 - 72	0.1
11	LRRP Cc1-38	1q35	$185945986 { cdot} 186045987$	2865	E19	AY325244	BE098106	36-72	0.2
12	LRRP Ab1-108	1q37	201292805 - 20139280	972	E6	AY325138	CD052183	8-96	2.9
13	LRRP Cc1-9	1q37	$201346364 \hbox{-} 201446365$	1695	E16	AY325242	CB751508	16 - 144	2.5
14	LRRP Ab2-051	1q41	$213006712\hbox{-}213106713$	1851	E2	AY325175	$\mathrm{CD670497}$	16-72	0.3, 2.1
15	LRRPAb2-132	1q41	215148584 - 215248584	1038	E6	AY325192	$\mathrm{CD670514}$	8-48	0.1
16	D930042H13	1q42	214871327 - 214971327	966	$\mathbf{E8}$	$\rm NM\_172442$	CD670570	8-36	0.3
17	LRRP Ac2-067	1q43	230720781 - 230820781	762	E5	AY321330	CB964401	8-24	2.5
18	LRRP Ab2-001	1q43	230945845 - 231045845	1116	$\mathbf{E8}$	AY325174	CD670489	12-48	0.2
19	LOC119392	1q53	255352678 - 255452678	756	E4	$\rm XM\_215260$	BI285953	72	2.1
20	KIAA1376	2q11	7086551 - 7186552	1245	$\mathbf{E8}$	$\rm XM\_226239$	BQ200976	8	0.4
21	CTD-2328C19	2q12	23663004 - 23763004	279	E3	AC091858	$\rm CF110743$	36-96	0.4, 2.5
22	LRRP Cb1-739	2q12	28737280 - 28837281	780	E1	AY325235	$\rm CF110557$	12-36	
23	BAC CH230-206C20	2q16	53411577- $53511577$	1638	E4	AC106505	CF384944	12 - 144	0.3
24	RP23-35D4	2q16	54688414 - 54788414	384	E3	AC127371	CB717217	16-72	0.4, 2.8
25	LRRP Ac2-061	2q21	71157011 - 71257011	2253	E10	AY321329	CB923478	2-16	7.6
26	LRRP Ab2-225	2q22	77263574- $77363574$	738	E5	AY325197	$\mathrm{CD670526}$	8-36	0.3
27	RP23-100C5	2q23	88129644 - 88229644	438	E3	AL731707	BC668831	12 - 24	3.0
28	AW558171	2q31	$147145999  extsf{-}147245999$	2220	E6	$\rm XM\_227217$	CA507527	16-36	0.3
29	BAC CH230-155H4	2q32	$162097483 \hbox{-} 162197484$	5064	E22	AC124926	CB964413	16	2.2
30	LRRP Ab1-216	2q33	$63860581 \hbox{-} 170111343$	1512	E9	AY325153	CF384935	12-72	6.8
31	LRRP Ac2-125	2q34	$180815021 \hbox{-} 180915022$	2640	E17	AY321335	CD373009	8-36	0.3
32	129/SvJ BAC, citb585c7	2q34	$188600812 \hbox{-} 188700813$	228	E2	AF532116	BF282779	2 - 144	0.2
33	LRRP Ac2-269	2q34	196174105 - 196274105	1047	E10	AY321348	CB964402	24-36	2.2
34	LRRP Ab2-389	2q42	223465222 - 223565223	1266	E8	AY325204	CD670536	24	0.4
35	LRRP Aa2-258	3p11	15074963 - 15174963	570	E4	AY325167	CD670581	48-72	0.4
36	U48828	3p13	1148327 - 1248327	573	E2	$XM_{238608}$	CD052214	12-24	2.8
37	LOC311304	3q34	94195369 - 94295370	510	E1	$\rm XM\_242120$	CD052158	36	2.0
38	LRRP Aa2-296	3q35	$107505568 { ext{-}} 107605569$	624	E4	AY325169	CD670583	8	2.0
39	LRRP Ab2-305	3q41	$133947234 \hbox{-} 134047235$	1173	E10	AY325201	CD670531	12-36	0.4
40	LRRP Ab2-390	3q41	$135162327 \hbox{-} 135262328$	732	E7	AY325205	CD670552	36	2.1
41	RP23-32O9	3q41	$138490626\hbox{-}138590626$	471	E4	AL845325	CB839862	24 - 36	2.8
42	LRRP Ac2-282	3q43	$164743271 { cdot} 164843271$	660	E4	AY321349	CB964409	144	0.5
43	RIKEN cDNA 1600012F09	4q21	39532872 - 39632872	675	E1	$\rm XM\_231479$	$\mathrm{CB751510}$	12 - 16	2.4
44	RIKEN cDNA 2310036D22	4q21	43050065 - 43150066	1047	E7	$\rm XM\_231500$	CB732821	8-36	0.4
45	LRRP Ab2-098	4q22	65863105 - 65963106	1188	E4	AY325190	$\mathrm{CD670511}$	8	
46	LRRP Ab2-427	4q23	69538536-69638536	2601	E15	AY325210	$\mathrm{CD670543}$	12 - 16	2.0
47	LRRP Aa1076	4q24	85692114-85792114	2547	E17	AY318959	$\mathrm{CD670558}$	48-72	2.6

 Table 2 Continued

some         some         number	No.	Gene description	Chromo-	Section	ORF	Extron	Genebank	Genebank	Hours	Fold
location         of CDS         of EST         PH           48         FLZ0305         4q7         85510415-5561041.         333         E4         AL731062         D010472         3c-142         2.9           50         KIAAL230         4q4         191055072-191155073         2082         E24         XLM.220530         CD940457         CPT34901         8-144         4.5           50         KIAAL230         5q11         2144642-5246454         366         E3         AUL202530         CD940550         12.144         0.3           51         KRPP Col-60         5q21         25524631         498         E2         AV318964         CD60550         2.144         0.3           55         LRRP Col-60         5q32         1256080891-256096845         N/A         N/A         CP39456         1.6-22         2.4           56         LRRP Ab1-20         5q66         165504091-156644091         1176         E11         AV325548         CD60557         3.6-2         2.4         2.3           57         LRRP Ab1-20         6q13         2382438-23924388         1422         E30         AV321545         CD60557         3.6-2         2.4         2.3           50         LRRP Ab1-20			some				number	number	after	difference
48         FL20305         4.273         85310415-56510415         333         E4         ALT7102         D0106472         2.44         2.9           50         KIAA1230         4q.44         191055672-191155073         2082         E24         XM.235118         G0079166         2.12         2.9           50         KIAA1230         4q.44         191055672-191155073         2082         E24         XM.237102         C91444         4.4         4.5           51         LRRP ALD17         5-911         2140947-1544098         600         E3         AC104021         AL55500         2.144         0.3           51         LRRP ALD17         5-922         6512461-552468         408         E2         AV318046         C65453         2.4         2.1           51         REP2 ALD107         5-935         1050689-105009584         1706         F11         AV32512         C0507206         6.4         2.1         2.4         2.1           52         LRRP AL-1000         6q.14         35506160         1131         E3         AV32513         C0507217         7.6         0.1         2.3           61         RRP AL-1000         6q.14         35506150-63965397         3738         E2			location				of CDS	of EST	$_{\rm PH}$	
49         MGC10946         4044         190105072-19115307         2005         XIII A23201         B.0.7         2.9.           51         BAC CH230-4L11         5         15031-115032         612         22         AC094527         CF384931         8.144         4.5           51         BAC CH230-4L11         5         15031-115032         612         22         AC094527         CF384931         8.144         4.5           52         RVIL-281N10         5q11         24704845-2490484         306         E3         AC10102         CF31437         2.4         2.1           55         LRRP A.0207         5q22         65624681         MO8         E2         AY319964         CD65250         6-6.2         2.1           56         RP23-167D16         5q33         165089451409-168044019         788         24         AY32151         CD05220         16-34         2.5           51         IRRP A-0000         6q11         35606159-35706160         1131         E3         AY32151         CD05221         19-9         2.4         2.5           52         IRRP A-1340         6q21         12509381-12400381         1388         EA         AY32151         CD05217         7.2         2.6 <td>48</td> <td>FLJ20356</td> <td>4q27</td> <td>85510415-85610415</td> <td>333</td> <td>E4</td> <td>AL731692</td> <td>BQ196472</td> <td>36-144</td> <td>2.7</td>	48	FLJ20356	4q27	85510415-85610415	333	E4	AL731692	BQ196472	36-144	2.7
50         IXAA1230         40,4         19.065672.19115673         202         224         XA.232536         CB941691         12.44         2.6           51         BACC CESAL604         5,11         14.18097-154.8008         600         E3         XM.237702         CF111181         2.4         2.0           53         RP11-281N10         5,21         27.0645.244031-65524631         406         E2         XM.237702         CF111181         2.1         2.1           55         LRRP A0107         5,32         150680891-150600819         AN         X/A         CP591086         6.7         2.4           56         RP2-476D16         5,33         15060189-15710610         381         E3         AV32152         CD67057         3.6-72         0.4.2           50         LRRP A0-2400         6q14         35060159-35716160         1131         E3         AV32150         CD67057         3.6-72         0.4.2           61         RP2-1-6060         6q13         2394342-12401044         1.386         E9         AV32150         CD67017         7.0         0.4           62         LRPA A0.1370         6q21         2371357-6517163         1.386         E9         AV321515         CD60717         7.2	49	MGC10946	4q44	186152493-186252493	519	E7	XM_232511	BQ079186	2-12	2.9
51         BAC CHE280-4.11         5         15031-1150/2         612         22         AC090427         CF34303         8-144         4.5           53         RP11-281N10         5q11         2740845-2840845         306         E3         AC104021         AL454500         21-14         0.3           54         LRRP Au1027         5q22         65242631-6524631         408         E2         AY18964         CD553537         24-2         2.1           55         LRRP Au1027         5q32         15068059-15060699         176         H1         X322240         CD531337         2.4         2.1           56         LRRP Au1000         6q13         2382438-2392438         14232         E30         AY32135         CD67057         6.67         0.4, 2.3           50         LRRP Au-0600         6q14         3506159-5570610         1131         E3         AY32135         CD69211         1.2.0         6.7         2.4         2.3           51         LRRP Au-0610         6q32         12303841-124005441         188         E5         AY32135         CD69211         1.2.0         7.2         8.1           52         LRRP Au-0406         6q32         123003841-124003441         1834         E5	50	KIAA1230	4q44	191055672-191155673	2082	E24	XM_232536	CB964405	12-48	2.6
52         NA-031706         5q.11         244807-1484088         60         E3         XL237702         CFL11.8         24         2.0           53         ILRP AaL027         5q.22         65242631-65524631         408         E2         AV318961         CD67055         2.1-3         2.1           55         ILRP AaL027         5q.32         126596859-12666689         I/T6         E11         AY322240         CB64374         2.4         2.1           56         RP2-Ar70516         5q.35         15068954-15006901         381         E2         AY318961         CP59048         16-32         2.4           59         ILRP Ac1-060         6q.13         2382438-2302438         1423         E30         AY318958         CB670557         3.6-72         0.4,2.3           61         RP2-Ar6060         6q.14         5301357.6471385         738         E3         AY31896         CD67057         3.6-72         0.4,2.3           61         RP2-Ar6060         6q.12         2373157.647138         1388         E3         AY31150         CD63217         7.2         0.4           61         LRPA Ab1-321         7q.2         6385616-398567         1352         E9         AY22153         CD60210 <td< td=""><td>51</td><td>BAC CH230-4L11</td><td>5</td><td>15031-115032</td><td>612</td><td>E2</td><td>AC094527</td><td>CF384931</td><td>8-144</td><td>4.5</td></td<>	51	BAC CH230-4L11	5	15031-115032	612	E2	AC094527	CF384931	8-144	4.5
53         PP11-281N10         51         PP11-281N10         521         PP14-281N10         521         PP14-281N10         521         PP14-281N10         521         PP14-281N10         521         PP14-281N10         S21         PP14-281N10         S21         PP14-281N10         S21         PP14-281N10         S21         PP14-281N10         PP14-281N10        <	52	NM-031706	5q11	1448097-1548098	690	E3	XM_237702	CF111181	24	2.0
54         LRRP A.1027         5q2         6524630-16552631         048         E2         AY318064         CPG5948         0-163         2.4         0           55         LRRP A.1-210         5q35         150869894-150969854         N/A         N/A         CP59418         1-62         2.4           57         LRRP A.1-210         5q36         150869854-150960854         1222         AY32512         CD60154         2.5           58         LRRP A.2-1060         6q13         23824385-23924388         1232         E20         AY318056         CP69416         9.14         4.2           60         LRRP A.1-6307         6q21         6371357-6571135         3738         F2         AC14002         CP32435         8         5.7           61         LRRP A.1-617         6q21         63203341-12401403         138         F2         AY32513         CD05171         7         0.5           64         LRRP A.1-127         7q21         63885461-6395555         372         AY321331         CB96437         16.4         9.5           64         LRRP A.1-127         7q20         63885265-8950555         372         AY321343         CB96437         16.4         8.5           64         LRRP A.1	53	RP11-281N10	5q11	2740845-2840845	396	E3	AC104021	AI454500	12 - 144	0.3
55         LRRP Cc1-6         5q3         12650899-126606999         1176         E11         AY325240         CB734         2.4         2.1           56         RP23-476D16         5q36         168544139-168644019         766         E9         AY32512         CD05200         1-636         2.5           57         LRRP Ab1-200         6q34         18702169-187126190         381         E25         AY325247         BE11         2.6         2.4         2.5         2.5         2.5         2.5         2.5         2.5         2.5         2.5         2.5         2.5         2.5         2.5	54	LRRP Aa1027	5q22	65424631 - 65524631	408	E2	AY318964	CD670556	24 - 36	2.1
56         RP23-470D16         5q36         150860854-150960954         N/A         N/A<	55	LRRP Cc1-6	5q32	126596899-126696899	1176	E11	AY325240	CB545374	24	2.1
57         LRRP Ab1-210         59.6         16854019-168644019         768         19         AY325152         CD62200         16-14         2.5           18         LRRP Ac1-060         6q.13         3560159-35706160         1131         E3         AY321551         CD670577         76-72         0.4, 2.3           16         RP3-16517         6q.14         35606159-35706160         1131         E3         AY321551         CD605211         2.06         2.7           61         RP3-16517         6q.21         12300381-12400481         1380         E5         AY325153         CD052171         72         0.5           61         LRRP Ab1-061         6q.21         12304381-12400481         1380         E5         AY325153         CD052171         72         0.5           65         LRRP Ab1-021         6q.21         63853646308507         151         S.4332153         L005917         12.4         4.2         6.2           66         LRRP Ac149         7q4         28847622-3076753         481         AY32130         CD05118         7.2         6.4           61         LRRP Ac1-49         7q4         12844571-12854573         1303         E11         AY32130         CD05116         7.14	56	RP23-476D16	5q35	150869854 - 150969854	N/A	N/A	N/A	CF599486	16-72	2.4
58         LRRP Cc2-27         59.         I ar7026189-187126109         3381         E25         AY325247         BE112912         16-14         0.5.           59         LRRP Ac1-060         6q14         32824388-33924388         14232         E30         AY31253         CB605157         36-72         0.4, 2.3           61         RP23-165H7         6q14         65371357-65471358         S738         E2         AC114002         CB96416         96-144         0.4           62         LRRP Ab1-046         6q32         123303841-12400384         1389         E5         AY32135         CD052177         72         0.5           61         LRRP Ab1-021         6q32         12430188-12441049         1836         E9         AY325135         CD052177         72         0.5           61         LRRP Ac1874         7q21         638850463985462         249         E6         AY310161         A952421         12.4         4.9         6.4           61         LRRP Ac1873         7q32         8885268-8985265         37         E3         AY31230         CD052102         2.4         0.4         4.4         0.3         2.1           61         LRRP Ac149         7q33         12844547212854631 <t< td=""><td>57</td><td>LRRP Ab1-210</td><td>5q36</td><td><math>168544019  extsf{-}168644019</math></td><td>768</td><td>E9</td><td>AY325152</td><td>CD052200</td><td>16-36</td><td>2.5</td></t<>	57	LRRP Ab1-210	5q36	$168544019  extsf{-}168644019$	768	E9	AY325152	CD052200	16-36	2.5
59         LRRP Ac1-060         6q.13         23824382-33024385         14232         F30         AY318555         CD70557         36-72         0.4, 2.3           60         LRPA Ac1-300         6q.14         35606159-3570610         1.31         E3         AY321351         CB96416         0.6144         0.4           61         LRPA Ab1-334         6q.31         13134082-11401408         1389         E5         AY32155         CD05211         1.2.0         0.5           61         LRPA Ab1-021         6q.22         12303841-124003841         1389         E5         AY32155         CD05217         7.2         0.5           65         LRPA Ab1-701         7021         63885046-03985041         2349         E6         AY310161         CB923479         12.44         4.9           66         LRPA Ac1873         7022         63885046-03982041         2349         E6         AY310161         CB923479         12.4         4.2         2.0           61         LRPA Ac1-37         7q32         8885066-89907663         372         E3         AY321340         CD05168         3.6         4.0         1.1           1         LRPA Ac1-149         7q33         12844472-12854571         1030         E11	58	LRRP Cc2-27	5q36	187026189-187126190	3381	E25	AY325247	BE112912	16 - 144	2.5
60         LRRP Ac2-300         6,14         35606159-35706160         1131         E3         AY321551         CB69416         9.61.4         0.4           61         RP23-165H7         6,63         113914082-1104083         99         E4         AY325155         CD052177         72         0.5           63         LRRP Ab1-046         6,63         123093841-124003841         1836         F5         AY325155         CD052177         72         0.5           64         LRRP Ab1-021         6,632         124234183-12441040         1836         F5         AY325161         CD052177         72         0.5           65         LRRP Ab1-217         722         63885046-6398542         2349         F6         AY310161         AD395491         4-72         6.0           66         LRRP Ab1-187         7622         63882046-639807626         321         AY321320         CB34379         1-72.96         0.4           70         LRRP Ab1-182         763         12844497-12854437         123         E11         AY325130         CD505108         3-0.4         1.4         0.3         2.1           71         LRRP Ab2-182         763         12844492-128544571         1303         E11         AY325140	59	LRRP Ac1-060	6q13	23824388-23924388	14232	E30	AY318958	CD670557	36-72	0.4, 2.3
61         RP23-163H7         6q21         6571337-65471358         37.8         E2         AC114002         CB03255         C         0.5           62         LRRP Ab1-344         6q31         113914082-114014083         99         E4         AY325135         CD052211         1.2+0         2.7           64         LRRP Ab1-021         6q32         123903841-124003841         388         E5         AY325135         CD05217         7.2         0.5           64         LRRP Ab1-021         7q21         63885461-63985462         2.349         E6         AY310161         CB923477         1.2         0.2           67         LRRP Ac1873         7q22         63885040-63985041         2.34         E6         AY310161         A925421         4.72         6.0           68         LRRP Ac1437         7q32         88895265         307         E1         AY32513         CD65129         2.44         0.1         1.1           1         LRRP Ac1430         7q34         128445721-12854571         1.303         E11         AY32513         CD65057         1.2-16         0.2           1         LRRP Ac1-37         7q35         128445721-128545721         1.303         E11         AY32516         CD6705	60	LRRP Ac2-300	6q14	35606159-35706160	1131	E3	AY321351	CB964416	96-144	0.4
62         LRRP Ab1-334         6q31         113014082-114014083         909         E4         AY325185         CD052117         72         0.5           63         LRRP Ab1-021         6q32         12433183-124410448         185         E5         AY325135         CD052177         72         0.5           64         LRRP Ab1-021         6q32         12433183-124410448         1856         E9         AY321616         CB93479         12.44         4.9           65         LRRP Ac1873         7q22         6385506-63965907         152         E9         AY321616         A932749         12.44         4.9           66         LRRP Ac1873         7q22         63882046-03982041         23.44         E4         AY321343         CB04375         16.48         2.8           67         LRRP Ac1-149         7q34         12844572-128544573         12.03         E11         AY325130         CD05216         3c-14         0.1,21           71         LRRP Ab2-079         8q32         12844572-12854573         12.03         E11         AY325140         CD670506         3c-48         2.0           73         LRRP Ab2-079         8q32         1224457-4522737         3258         E19         AY325141         CT61	61	RP23-165H7	6q21	65371357-65471358	3738	E2	AC114002	CB923455	8	0.5
63         LRRP Ab1-046         6q.32         123903841-124003841         1389         E5         AY325135         CD052177         72         0.5           64         LRRP Ab1-021         6q.32         124231183-12441044         186         E9         AY32674         CB751161         2-72         8.1           65         LRRP Ac1874         7q22         6385506-63965597         1512         E9         AY321513         AD95690         4-72         6.2           66         LRRP Ac1873         7q22         6385206-63965263         489         E4         AY321313         CB96475         6.44         8.2           69         LRRP Ab1-152         7q32         8895265         AY2         E3         AY32130         CD652192         2-48         0.4           71         LRRP Ab1-152         7q32         8284562-237677         1303         E11         AY325103         CD670510         72-16         0.2           74         LRRP Ab2-079         8q32         122447542273         3258         E19         AY325147         CD67050         36-48         2.           74         LRRP Ab2-079         8q32         122447-942427         8420         F33         AY325141         CD670542         24-72 <td>62</td> <td>LRRP Ab1-334</td> <td>6q31</td> <td>113914082-114014083</td> <td>999</td> <td>E4</td> <td>AY325158</td> <td>CD052211</td> <td>12-96</td> <td>2.7</td>	62	LRRP Ab1-334	6q31	113914082-114014083	999	E4	AY325158	CD052211	12-96	2.7
64         LRRP Ab1-021         6q32         124234183-12441049         1836         E9         AY298742         CB751516         1.2.78         8.1           65         LRRP Ac1874         7q21         63885061-63985462         2349         E6         AY30161         A925413         12040         12.144         4.9           66         LRRP Ac1873         7q20         63885060-63985265         372         E3         AY30143         CB06437         16.4         2.8           67         LRRP Ac1-224         7q31         8895265-88995265         372         E3         AY32143         CB06437         16.4         2.8         0.4           70         LRRP Ac1-149         7q34         128444080-128544081         1023         E11         AY32130         CD05118         36.14         0.1         2.1           71         LRRP Ac1-27         7q35         12844572-12854573         1203         E11         AY32518         CD67050         7.1         0.2           72         LRRP Ab2-035         8q32         122340407112454573         1236         H14         1.1         373518         CD67050         7.24         3.2           75         LRRP Ab2-035         8q32         12330371-1245037 <t< td=""><td>63</td><td>LRRP Ab1-046</td><td>6q32</td><td>123903841-124003841</td><td>1389</td><td>E5</td><td>AY325135</td><td>CD052177</td><td>72</td><td>0.5</td></t<>	63	LRRP Ab1-046	6q32	123903841-124003841	1389	E5	AY325135	CD052177	72	0.5
65         LRRP Ac1874         7q21         63885461-63985462         2349         E6         AY310161         CB923479         12-144         4.9           66         LRRP Ab1-217         7q22         63885040-63985041         1512         E9         AY320161         AM32512         1.72         6.0           68         LRRP Ac1873         7q32         63885040-63985041         102         E1         AY321343         CB964375         16.48         2.8           69         LRRP Ab1-152         7q34         128444080-128544081         1023         E11         AY32130         CF384947         7.2-96         0.4           71         LRRP Ac1-149         7q34         12844572-128545721         1303         E11         AY325130         CD670527         12.16         0.3         2.1           73         LRRP Ab2-079         8q22         4644272-4554273         325         E19         AY32518         CD67057         7.2-16         0.3         2.1           74         LRRP Ab2-079         8q32         12330140-11240140         240         E23         AY32514         CD670542         2.2         0.2           75         LRRP Ab2-171         8q32         12330140-11240140         240         E3	64	LRRP Ab1-021	6q32	124234183-124410449	1836	E9	AY298742	CB751516	2-72	8.1
66         LRRP Ab1-217         7q22         63865596-63965597         1512         E9         AY325133         Al059690         4-72         6.2           67         LRRP Ac1873         7q22         63882040-63982041         2349         E6         AY321343         CB964375         16-48         2.8           69         LRRP Ab1-152         7q32         88976262-89076263         489         E4         AY321343         CD052192         2.48         0.4           70         LRRP Ac1-149         7q34         128444080-128544081         1023         E11         AY325143         CD65168         3.61.4         0.1, 2.1           71         LRRP Ac1-149         7q35         128445721-128545721         1203         E11         AY325183         CD670507         712.16         0.2           71         LRRP Ab2-079         8q32         52227696-52327697         140         E10         AY32518         CD670507         71-44         3.1           75         LRRP Ab2-079         8q32         11230404-1124040         2940         E23         AY32518         CD670510         72-144         3.1           76         LRRP Ab2-078         8q32         11235073-112450374         2940         E23         AY32518	65	LRRP Ac1874	7q21	63885461-63985462	2349	E6	AY310161	CB923479	12-144	4.9
67         LRRP Ac1873         7q22         63882040-63982041         2349         E6         AY310161         AA925421         4.72         E.0           68         LRRP Ac2-224         7q31         8895265-8907623         372         E3         AY32143         CB961375         16.48         2.8           69         LRRP Ac1-149         7q34         128444080-128544081         103         E11         AY32130         CD52192         2.48         0.1           71         LRRP Cc1-27         7q35         12844572-128545721         1303         E11         AY325105         CD670527         12.16         0.2           73         LRRP Ab2-232         8q22         4642272-46542273         285         E19         AY32518         CD670527         12.16         0.2           74         LRRP Ab2-079         8q31         9812407-9822497         1806         E11         AY32514         CD670507         72.144         3.1           75         LRRP Ab2-417         8q32         11235973-112453974         290         E33         AY325241         CD670542         24-72         0.2           76         LRRP Ab2-417         8q32         11235973-11245397         546         X         X/432541         CD670543 </td <td>66</td> <td>LRRP Ab1-217</td> <td>7q22</td> <td>63865596-63965597</td> <td>1512</td> <td>E9</td> <td>AY325153</td> <td>AI059690</td> <td>4-72</td> <td>6.2</td>	66	LRRP Ab1-217	7q22	63865596-63965597	1512	E9	AY325153	AI059690	4-72	6.2
68         LRRP Ac2-224         7q31         88895265-88995265         372         E3         AY321343         CB964375         16-48         2.8           69         LRRP Ac1-149         7q34         128444080-128544081         1023         E11         AY32130         CD052102         2.48         0.4           71         LRRP Ac1-149         7q34         128444080-128544081         1023         E11         AY325130         CD052168         36-144         0.1         2.1           72         LRRP Ac1-27         7q35         12844572-128545721         1303         E11         AY325130         CD057057         36-48         2.0           73         LRRP Ab2-079         8q32         5227696-52327697         140         E10         AY32518         CD670510         72-14         3.1           74         LRRP Ab2-095         8q31         98122497-9822497         1896         E11         AY32518         CD670510         72-14         3.1           75         LRRP Ab2-417         8q32         11235073-112450374         940         E23         AY32514         CF10684         72-14         2.3           79         RIKEN CDNA 1110061A24         8q32         122548903-122648903         52         E4	67	LRRP Ac1873	7q22	63882040-63982041	2349	E6	AY310161	AA925421	4-72	6.0
69         LRRP Ab1-152         7.92         8897626-89076263         489         E4         AY325143         CD052192         2.48         0.4           70         LRRP Ac1-149         7,34         128444080-128544081         1023         E11         AY321320         CP384947         72.96         0.4           71         LRRP Cc1-27         7,35         128445721-128545473         1303         E11         AY325140         CD05168         3c1.44         0.3         2.1           73         LRRP Ab2-032         8q.22         46442272-46542273         3258         E19         AY325145         CD670507         12.16         0.2           74         LRRP Ab2-095         8q.31         98122497-9822297         1806         E11         AY325145         CD670507         7.14         2.3           75         LRRP Ab2-075         8q.32         112353073-11245397         1806         E23         AY325241         CD670542         2.47         0.2           76         RIKEN cDNA 1110061A24         8q.32         112543973-11245397         180         XM_236666         CF110981         4         2.7           70         RIKEN cDNA 2110061A14         8q.32         12254890.3122644803         52         XM_237066	68	LRRP Ac2-224	7q31	88895265-88995265	372	E3	AY321343	CB964375	16-48	2.8
70         LRRP Ac1-149         7.03         128444080-128544081         1023         E11         AY321320         CF384947         72-96         0.4           71         LRRP Cc1-27         7q35         12844572-12854573         1203         E11         AY325130         CD652168         36-144         0.1, 2.1           72         LRRP Cc1-28         7q35         12844572-128545721         303         E11         AY325180         CD670507         12-16         0.2           74         LRRP Ab2-079         8q23         52227696-52327697         140         E10         AY325180         CD670507         72-144         3.1           75         LRRP Ab2-079         8q31         98122497-9822497         1896         E11         AY325180         CD670502         24-42         2.2           76         LRRP Ab2-417         8q32         112353973-11245907         2940         E23         AY325214         CD670542         24-72         0.2           78         RIKEN cDNA 1110061A24         8q32         12254903-12264803         552         E4         XM.23666         CF11081         A48         2.7           78         DNA segment (WSU 40         9q12         42045047973204         I04         E9         MM1453	69	LRRP Ab1-152	7q32	88976262-89076263	489	E4	AY325143	CD052192	2-48	0.4
71       LRRP Cc1-27       7q35       128445472-128545473       1203       E11       AY325130       CD052168       36-144       0.1, 2.1         72       LRRP Cc1-28       7q35       128445721-128545721       1303       E11       AY325130       CD052168       36-144       0.3, 2.1         73       LRRP Ab2-032       8q22       4644227-46542273       3258       E10       AY325176       CD670506       36-48       2.0         75       LRRP Ab2-095       8q31       98122497-98222497       1896       E11       AY325189       CD670510       72-144       3.1         76       LRRP Ab2-417       8q32       112350973-112453974       2940       E23       AY325214       CD670564       24-72       0.2         78       RIKEN cDNA 1110061A24       8q32       117805127-117905127       N/A       N/A       MM36687       16-144       3.5         79       RIKEN cDNA 2810051A14       8q32       12787320-17987320       1044       E9       NM145353       CB64340       12-16       2.7         81       DNA segment (WSU 40)       9q21       42495058-555673       348       E3       AY325191       CD670563       8.48       0.3, 2.2         85       LRP Ac1-31	70	LRRP Ac1-149	7q34	128444080-128544081	1023	E11	AY321320	CF384947	72-96	0.4
72       LRRP Cc1-28       7q35       128445721-128545721       1303       E11       AY325243       CB784604       4-48       0.3, 2.1         73       LRRP Ab2-232       8q22       46442272-46542273       3258       E19       AY325198       CD670527       12-16       0.2         74       LRRP Ab2-079       8q33       52227696-52327697       1440       E10       AY325176       CD670510       72-144       3.1         75       LRRP Ab2-095       8q31       912497-9822497       1896       E11       AY32514       CD670510       72-144       3.1         76       LRRP Ab2-417       8q32       112353973+112453974       2940       E23       AY325214       CD670542       24-72       0.2         78       RIKEN cDNA 1110061A24       8q32       117805127-117905127       N/A       N/A       N/A       BM386879       16-144       3.5         79       RIKEN cDNA 1110061A24       8q32       117805127-117905127       N/A       N/A       N/A       BM386879       16-144       3.5         80       DNA segment (WSU 40)       9q12       17887320-17987320       1044       E9       NM.145353       CB964340       12-16       2.7         81       DRA Ac2139 </td <td>71</td> <td>LRRP Cc1-27</td> <td>7q35</td> <td>128445472-128545473</td> <td>1203</td> <td>E11</td> <td>AY325130</td> <td>CD052168</td> <td>36-144</td> <td>0.1, 2.1</td>	71	LRRP Cc1-27	7q35	128445472-128545473	1203	E11	AY325130	CD052168	36-144	0.1, 2.1
73       LRRP Ab2-322       8q2       6442272-46542273       325       E19       AY325198       CD670527       12-16       0.2         74       LRRP Ab2-079       8q23       5227696-53237697       144       E10       AY325189       CD670510       36-48       2.0         75       LRRP Ab2-079       8q31       98122497-98222497       1896       E11       AY325189       CD670512       7.144       3.1         76       LRRP Ab2-417       8q32       112353973-112453974       2940       E23       AY325214       CD670512       2.142       2.0         78       RIKEN cDNA 1110061A24       8q32       112853973-112453974       2940       E23       AY325213       CD670514       448       2.7         79       RIKEN cDNA 2810051A14       8q32       122548903-122648903       552       E4       XM.237046       CB73329       8-144       6.1         81       DNA segment (WSU 49)       9q12       1788732-017987320       1044       E9       NL3237046       CB73329       8-14       6.3       2.3         81       DNA segment (WSU 49)       9q2       51455365155370       348       E3       AY325191       CD670513       8-84       0.3, 2.2         85	72	LRRP Cc1-28	7q35	128445721-128545721	1303	E11	AY325243	CB784604	4-48	0.3, 2.1
74         LRRP Ab2-079         8q.2         5227696-52327697         140         E10         AY325176         CD67050         36-48         2.0           75         LRRP Ab2-005         8q31         98122497-98222497         1806         E11         AY32518         CD670510         72-144         3.1           76         LRRP Ab2-095         8q32         112340140-112440140         2940         E23         AY325214         CD670542         24.7         2.3           77         LRRP Ab2-417         8q32         117805127-117905127         N/A         N/A         MX         MX         MX         MX         MX         MX         2.6         2.7         2.7         2.7         RIKEN cDNA 2810051A4         8q32         122548903-122648903         552         E4         XM236668         CF110981         4.8         2.7           80         DNA segment (WSU 49)         9q12         17887320-17987320         104         E9         NM14533         CB964340         12-16         2.7           81         DNA segment (WSU 49)         9q12         50485632-50585632         2697         E6         AC11140         CD670513         8-48         6.3         2.2           82         LRP Ac2-131         9q2	73	LRRP Ab2-232	8q22	46442272-46542273	3258	E19	AY325198	CD670527	12-16	0.2
175       LRRP Ab2-095       8q31       98122497-98222497       1896       E11       AY325189       CD670510       72-144       3.1         76       LRRP Ab2-417       8q32       112363973-11245397       2940       E23       AY325241       CD670542       24-72       0.2         78       LRRP Ab2-417       8q32       112353973-112453974       2940       E23       AY325241       CD670542       24-72       0.2         78       RIKEN cDNA 1110061A24       8q32       112353973-112453974       2940       E23       AY325180       CD670510       72-144       3.5         79       RIKEN cDNA 2810051A14       8q32       1125458903-122648903       552       E4       NM.23668       CF110981       48       2.7         80       DNA segment (WSU 40)       9q12       17887320-17987320       1044       E9       NM.45333       CB64340       12-16       2.7         81       DNA segment (WSU 40)       9q12       17887320-17987320       1044       E3       AY325140       CD670513       8-48       0.3, 2.2         81       DNA segment (WSU 40)       9q22       5048563250585632       2697       E6       AC111460       CD670513       8-48       0.3, 2.2         81 </td <td>74</td> <td>LRRP Ab2-079</td> <td>8q23</td> <td>52227696-52327697</td> <td>1440</td> <td>E10</td> <td>AY325176</td> <td>CD670506</td> <td>36-48</td> <td>2.0</td>	74	LRRP Ab2-079	8q23	52227696-52327697	1440	E10	AY325176	CD670506	36-48	2.0
76       LRRP Cc1-8       8q32       112340140-112440140       2940       E23       AY325241       CF110684       72-144       2.3         77       LRRP Ab2-417       8q32       112353973-112453974       2940       E23       AY325214       CD670542       24-72       0.2         78       RIKEN cDNA 1110061A24       8q32       112554903-122648903       552       E4       XM.236668       CF110981       48       2.7         80       DNA segment (WSU 94)       9q12       17887320-17987320       1044       E9       NM.143533       CB64340       12-16       2.7         81       DNA segment (WSU 40)       9q21       43247192-43547192       318       E3       AY325222       CB964364       8-36       2.3         83       BAC CH230-211F21       9q22       50485632-50585632       2697       E6       AC111460       CD670562       72       0.4         84       LRRP Ab2-131       9q22       51455369-51555370       3498       E34       AY325140       CD670513       8-48       0.3, 2.2         85       LRRP Ab1-119       9q38       3228794-133383545       1692       E11       AX325162       CD670573       8-60       2.2       2         86	75	LRRP Ab2-095	8q31	98122497-98222497	1896	E11	AY325189	CD670510	72-144	3.1
77       LRR Ab2-417       8.32       112353973-112453974       2940       E23       AY325214       CD670542       24-72       0.2         78       RIKEN cDNA 1110061A24       8.32       117805127-117905127       N/A       N/A       N/A       BM386879       16-144       3.5         79       RIKEN cDNA 2810051A14       8.432       122548903-122648903       552       E4       XM.23668       CF110981       48       2.7         80       DNA segment (WSU 40)       9q21       40291508-40391508       1176       E11       XM.237046       CB73329       8-14       6.1         82       LRR Ac2-193       9q21       40291508-40391508       1176       E11       XM.237046       CD670552       72       0.4         84       LRR Ac2-193       9q22       50485632-50585632       2697       E6       AC111460       CD670513       8-48       0.3, 2.2         85       LRR Ab1-119       9q32       51455369-51555370       349       E33       AY325140       CD051163       8-48       0.3, 2.2         86       rp32-28p17       9q38       13283544-13338355       1692       E11       AY325162       CD670573       8-96       0.2, 2.5         88       LRRP Ac1158 </td <td>76</td> <td>LRRP Cc1-8</td> <td>8q32</td> <td>112340140-112440140</td> <td>2940</td> <td>E23</td> <td>AY325241</td> <td>CF110684</td> <td>72-144</td> <td>2.3</td>	76	LRRP Cc1-8	8q32	112340140-112440140	2940	E23	AY325241	CF110684	72-144	2.3
78       RIKEN cDNA 1110061A24       8q32       117805127-117905127       N/A       N/A       BM386879       16-144       3.5         79       RIKEN cDNA 2810051A14       8q32       122548903-122648903       552       E4       XM_236668       CF110981       48       2.7         80       DNA segment (WSU 94)       9q12       17887320-17987320       1044       E9       NM.145353       CB964340       12-16       2.7         81       DNA segment (WSU 40)       9q21       43447192-43547192       384       E3       AY25222       CB964364       8-36       2.3         83       BAC CH230-211F21       9q22       50485632-50585632       2697       E6       AC111460       CD670513       8-48       0.3, 2.2         84       LRRP Ab2-131       9q23       92287968-92387969       738       E3       AY325140       CD67513       8-46       0.3       2.1         85       LRRP Ab1-119       9q38       93285344-133383545       1692       E11       AY325162       CD670573       8-96       0.2, 2.5         88       LRRP Ac1158       10q11       2351441-2451441       1623       E10       AY310144       CB839868       4-12       2.4         90       LRRP Ac	77	LRRP Ab2-417	8q32	112353973-112453974	2940	E23	AY325214	CD670542	24-72	0.2
79       RIKEN cDNA 2810051A14       8q32       122548903-122648903       552       E4       XM_236668       CF110981       48       2.7         80       DNA segment (WSU 94)       9q12       17887320-17987320       1044       E9       NM.145353       CB964340       12-16       2.7         81       DNA segment (WSU 40)       9q21       40291508-40391508       1176       E11       XM_237046       CB733329       8-144       6.1         82       LRRP Ac2-193       9q21       43447192-43547192       384       E3       AY325222       CB964364       8-36       2.3         83       BAC CH230-211F21       9q22       50485632-50585632       2697       E6       AC111460       CD670562       72       0.4         84       LRRP Ab1-119       9q33       92287668-92387969       738       E3       AY325140       CD670513       8-4       0.3       2.2         85       LRRP Ab1-119       9q38       133283544-133383545       1692       E11       AY325162       CD670573       8-96       0.2, 2.5       5         88       LRP Ac1158       10q11       2351441-2451441       1623       E10       AY310144       CB839886       4-24       4.2	78	RIKEN cDNA 1110061A24	8q32	117805127-117905127	N/A	N/A	N/A	BM386879	16-144	3.5
80       DNA segment (WSU 94)       912       17887320-17987320       104       E9       NM.145353       CB964340       12-16       2.7         81       DNA segment (WSU 40)       9q21       40291508-40391508       1176       E11       XM.237046       CB73329       8-144       6.1         82       LRRP Ac2-193       9q21       43447192-43547192       384       E3       AY325222       CB964364       8-36       2.3         83       BAC CH230-211F21       9q22       50485632-50585632       2697       E6       AC111460       CD670562       72       0.4         84       LRRP Ab2-131       9q22       51455369-51555370       3498       E34       AY325101       CD670513       8-48       0.3, 2.2         85       LRRP Ab1-119       9q38       9287968-92387969       738       E3       AY325140       CD670573       8-96       0.2, 2.5         86       rp32-28p17       9q38       132383544-133383545       1692       E11       AY325162       CD670573       8-96       0.2, 2.5         88       LRRP Ac1158       10q12       235441-245141       1623       E10       AY310144       CB839886       4-2       2.4         90       LRRP Ac1177	79	RIKEN cDNA 2810051A14	8q32	122548903-122648903	552	${ m E4}$	, XM_236668	CF110981	48	2.7
81       DNA segment (WSU 40)       9q21       40291508-40391508       1176       E11       XM_237046       CB733329       8-144       6.1         82       LRRP Ac2-193       9q21       43447192-43547192       384       E3       AY325222       CB964364       8-36       2.3         83       BAC CH230-211F21       9q22       50485632-50585632       2697       E6       AC111460       CD670562       72       0.4         84       LRRP Ab2-131       9q22       51455369-51555370       3498       E34       AY325191       CD670513       8-48       0.3, 2.2         85       LRRP Ab1-119       9q33       92287968-92387969       738       E3       AY325140       CD052186       36       2.1         86       rp32-28p17       9q34       95678996-95778996       2433       E13       AC092530       CB721103       8-24       0.3         87       LRRP Ac1158       10q11       2351441-2451441       1623       E10       AY310144       CB839848       8-12       2.2         89       mKIAA0665       10q12       355594-13695294       2604       E11       XM.20205       CB94385       36-72       0.3, 2.7         91       LRRP Ac1177       10q24	80	DNA segment (WSU 94)	9q12	17887320-17987320	1044	E9	NM_145353	CB964340	12-16	2.7
82       LRRP Ac2-193       9q21       43447192-43547192       384       E3       AY325222       CB964364       8-36       2.3         83       BAC CH230-211F21       9q22       50485632-50585632       2697       E6       AC111460       CD670562       72       0.4         84       LRRP Ab2-131       9q22       51455369-51555370       3498       E34       AY325191       CD670513       8-48       0.3, 2.2         85       LRRP Ab1-119       9q33       92287968-92387969       738       E3       AY325140       CD052186       36       2.1         86       rp32-28p17       9q34       95678996-95778996       2433       E13       AC092530       CB721103       8-24       0.3         87       LRRP Aa2-111       9q38       133283544-133383545       1692       E11       AY325162       CD670573       8-96       0.2, 2.5         88       LRRP Ac1158       10q11       2351441-2451441       1623       E10       AY310144       CB839860       4-24       4.2         90       LRRP Ac1177       10q22       37322101-37422102       189       E2       AY310147       CB839864       48-72       0.4, 3.3         92       Open reading frame 31       1	81	DNA segment (WSU 40)	9q21	40291508-40391508	1176	E11	XM_237046	CB733329	8-144	6.1
83       BAC CH230-211F21       9q22       50485632-50585632       2697       E6       AC111460       CD670562       72       0.4         84       LRRP Ab2-131       9q22       51455369-51555370       3498       E34       AY325191       CD670513       8-48       0.3, 2.2         85       LRRP Ab1-119       9q33       92287968-92387969       738       E3       AY325140       CD652186       36       2.1         86       rp32-28p17       9q34       95678996-95778996       2433       E13       AC092530       CB721103       8-24       0.3         87       LRRP Aa2-111       9q38       133283544-133383545       1692       E11       AY325162       CD670573       8-96       0.2, 2.5         88       LRRP Ac1158       10q11       2351441-2451441       1623       E10       AY310144       CB839838       8-12       2.2         89       mKIAA0665       10q12       13595294-13695294       2604       E11       XM.220262       CA945827       16-36       2.6         90       LRRP Ac1233       10q21       64598506-64698507       1422       E4       AY310149       CB839860       4-24       4.2         91       LRRP Ac1177       10q24	82	LRRP Ac2-193	9q21	43447192-43547192	384	E3	AY325222	CB964364	8-36	2.3
84       LRRP Ab2-131       9q22       51455369-51555370       3498       E34       AY325191       CD670513       8-48       0.3, 2.2         85       LRRP Ab1-119       9q33       92287968-92387969       738       E3       AY325140       CD670513       8-48       0.3         86       rp32-28p17       9q34       96678996-95778996       2433       E13       AC092530       CB721103       8-24       0.3         87       LRRP Aa2-111       9q38       133283544-133383545       1692       E11       AY325162       CD670573       8-96       0.2, 2.5         88       LRRP Ac1158       10q11       2351441-2451441       1623       E10       AY310144       CB839838       8-12       2.2         90       LRRP Ac1233       10q21       64598506-64698507       1422       E4       AY310149       CB839860       4-24       4.2         91       LRRP Ac1177       10q22       37322101-37422102       189       E2       AY310147       CB839846       48-72       0.4, 3.3         92       Open reading frame 31       10q24       60880930-60980931       498       E4       XM_220705       CB964395       36-72       0.3, 2.7         93       LRRP Ch1-727	83	BAC CH230-211F21	9q22	50485632-50585632	2697	E6	AC111460	CD670562	72	0.4
85       LRRP Ab1-119       9q33       92287968-92387969       738       E3       AY325140       CD052186       36       2.1         86       rp32-28p17       9q34       95678996-95778996       2433       E13       AC092530       CB721103       8-24       0.3         87       LRRP Aa2-111       9q38       133283544-133383545       1692       E11       AY325162       CD670573       8-96       0.2, 2.5         88       LRRP Ac1158       10q11       2351441-2451441       1623       E10       AY310144       CB839838       8-12       2.2         90       LRRP Ac1233       10q21       64598506-64698507       1422       E4       AY310149       CB839860       4-24       4.2         91       LRRP Ac1177       10q22       37322101-37422102       189       E2       AY310147       CB839846       48-72       0.4, 3.3         92       Open reading frame 31       10q24       60880930-60980931       498       E4       XM_220705       CB964395       36-72       0.3, 2.7         93       LRRP Aa1018       10q24       62936624-63036624       1473       E8       AY318963       CD670555       24-72       10.1         94       LRRP Aa1018	84	LRRP Ab2-131	9q22	51455369-51555370	3498	E34	AY325191	CD670513	8-48	0.3, 2.2
86       rp32-28p17       9q34       95678996-95778996       2433       E13       AC092530       CB721103       8-24       0.3         87       LRRP Aa2-111       9q38       133283544-133383545       1692       E11       AY325162       CD670573       8-96       0.2, 2.5         88       LRRP Ac1158       10q11       2351441-2451441       1623       E10       AY310144       CB839838       8-12       2.2         90       LRRP Ac1233       10q12       13595294-13695294       2604       E11       XM.220262       CA945827       16-36       2.6         90       LRRP Ac1233       10q21       64598506-64698507       1422       E4       AY310149       CB839860       4-24       4.2         91       LRRP Ac1177       10q22       37322101-37422102       189       E2       AY310147       CB839846       48-72       0.4, 3.3         92       Open reading frame 31       10q24       60880930-60980931       498       E4       XM_220705       CB964395       36-72       0.3, 2.7         93       LRRP Cb1-727       10q24       61101964-61201964       2049       E17       AY325234       CD052159       8-12       0.4         94       LRRP Aa1018	85	LRRP Ab1-119	9q33	92287968-92387969	738	E3	AY325140	CD052186	36	2.1
87LRRP A2-1119q38133283544-1333835451692E11AY325162CD6705738-960.2, 2.588LRRP Ac115810q112351441-24514411623E10AY310144CB8398388-122.289mKIAA066510q1213595294-136952942604E11XM_220262CA94582716-362.690LRRP Ac123310q2164598506-646985071422E4AY310149CB8398604-244.291LRRP Ac117710q2237322101-37422102189E2AY310147CB83984648-720.4, 3.392Open reading frame 3110q2460880930-60980931498E4XM_220705CB96439536-720.3, 2.793LRRP Cb1-72710q2461101964-612019642049E17AY325234CD0521598-120.494LRRP Aa101810q2462936624-630366241473E8AY318963CD67055524-7210.195BAC CH230-403C2010q2669406193-69506194345E2AC118722CD67053312-360.996LRRP Ab2-37110q3188515183-886151834923E25AY325211CD67053416-720.497LOC30358810q32+192219141-92319142699E3XM_239346CB83987382.098LRRP Aa2-06611p117832409-79324091662E10AY325170CD6705678-360.499LRRP Ab2-379 </td <td>86</td> <td>rp32-28p17</td> <td>9q34</td> <td>95678996-95778996</td> <td>2433</td> <td>E13</td> <td>AC092530</td> <td>CB721103</td> <td>8-24</td> <td>0.3</td>	86	rp32-28p17	9q34	95678996-95778996	2433	E13	AC092530	CB721103	8-24	0.3
88LRRP Ac115810q112351441-24514411623E10AY310144CB8398388-122.289mKIAA066510q1213595294-136952942604E11XM_220262CA94582716-362.690LRRP Ac123310q2164598506-646985071422E4AY310149CB8398604-244.291LRRP Ac117710q2237322101-37422102189E2AY310147CB83984648-720.4, 3.392Open reading frame 3110q2460880930-60980931498E4XM_220705CB96439536-720.3, 2.793LRRP Cb1-72710q2461101964-612019642049E17AY325234CD0521598-120.494LRRP Aa101810q2462936624-630366241473E8AY318963CD67055524-7210.195BAC CH230-403C2010q2669406193-69506194345E2AC118722CD67053416-720.496LRRP Ab2-37110q3188515183-886151834923E25AY325211CD67053416-720.497LOC30358810q32+192219141-92319142699E3XM_239346CB83987382.098LRRP Ac2-21010q32+194976696-95076697663E5AY321338CB96437016-242.499LRRP Aa2-06611p117832409-79324091662E10AY325170CD6705678-360.4100LRRP Ab2-37911q11 <td>87</td> <td>LRRP Aa2-111</td> <td>9q38</td> <td>133283544-133383545</td> <td>1692</td> <td>E11</td> <td>AY325162</td> <td>CD670573</td> <td>8-96</td> <td>0.2, 2.5</td>	87	LRRP Aa2-111	9q38	133283544-133383545	1692	E11	AY325162	CD670573	8-96	0.2, 2.5
89mKIAA066510q1213595294-136952942604E11XM.220262CA94582716-362.690LRRP Ac123310q2164598506-646985071422E4AY310149CB8398604-244.291LRRP Ac117710q2237322101-37422102189E2AY310147CB83986648-720.4, 3.392Open reading frame 3110q2460880930-60980931498E4XM.220705CB96439536-720.3, 2.793LRRP Cb1-72710q2461101964-612019642049E17AY325234CD0521598-120.494LRRP Aa101810q2462936624-630366241473E8AY318963CD67055524-7210.195BAC CH230-403C2010q2669406193-69506194345E2AY325211CD67053416-720.496LRRP Ab2-37110q3188515183-886151834923E25AY325211CD67053416-720.497LOC30358810q32+192219141-92319142699E3XM.239346CB83987382.098LRRP Ac2-21010q32+194976696-95076697663E5AY321338CB96437016-242.499LRRP Ab2-37911q1123912514-240125141608E12AY325203CD67053472-962.2	88	LRRP Ac1158	10q11	2351441-2451441	1623	E10	AY310144	CB839838	8-12	2.2
90LRRP Ac123310q2164598506-646985071422E4AY310149CB8398604-244.291LRRP Ac117710q2237322101-37422102189E2AY310147CB83984648-720.4, 3.392Open reading frame 3110q2460880930-60980931498E4XM_220705CB96439536-720.3, 2.793LRRP Cb1-72710q2461101964-612019642049E17AY325234CD0521598-120.494LRRP Aa101810q2462936624-630366241473E8AY318963CD67055524-7210.195BAC CH230-403C2010q2669406193-69506194345E2AC118722CD67053312-360.996LRRP Ab2-37110q3188515183-886151834923E25AY325211CD67053416-720.497LOC30358810q32+192219141-92319142699E3XM_239346CB83987382.098LRRP Ac2-21010q32+194976696-95076697663E5AY321338CB96437016-242.499LRRP Ac2-06611p117832409-79324091662E10AY325170CD6705678-360.4100LRRP Ab2-37911q1123912514-240125141608E12AY325203CD67053472-962.2	89	mKIAA0665	10q12	13595294-13695294	2604	E11	XM_220262	CA945827	16-36	2.6
91LRRP Ac117710q2237322101-37422102189E2AY310147CB83984648-720.4, 3.392Open reading frame 3110q2460880930-60980931498E4XM_220705CB96439536-720.3, 2.793LRRP Cb1-72710q2461101964-612019642049E17AY325234CD0521598-120.494LRRP Aa101810q2462936624-630366241473E8AY318963CD67055524-7210.195BAC CH230-403C2010q2669406193-69506194345E2AC118722CD67053312-360.996LRRP Ab2-37110q3188515183-886151834923E25AY325211CD67053416-720.497LOC30358810q32+192219141-92319142699E3XM_239346CB83987382.098LRRP Ac2-21010q32+194976696-95076697663E5AY321338CB96437016-242.499LRRP Ab2-37911q1123912514-240125141608E12AY325203CD67053472-962.2	90	LRRP Ac1233	10q21	64598506-64698507	1422	E4	AY310149	CB839860	4-24	4.2
92       Open reading frame 31       10q24       60880930-60980931       498       E4       XM_220705       CB964395       36-72       0.3, 2.7         93       LRRP Cb1-727       10q24       61101964-61201964       2049       E17       AY325234       CD052159       8-12       0.4         94       LRRP Aa1018       10q24       62936624-63036624       1473       E8       AY318963       CD670555       24-72       10.1         95       BAC CH230-403C20       10q26       69406193-69506194       345       E2       AC118722       CD670533       12-36       0.9         96       LRRP Ab2-371       10q31       88515183-88615183       4923       E25       AY325211       CD670534       16-72       0.4         97       LOC303588       10q32+1       92219141-92319142       699       E3       XM_239346       CB839873       8       2.0         98       LRRP Ac2-210       10q32+1       94976696-95076697       663       E5       AY321338       CB964370       16-24       2.4         99       LRRP Aa2-066       11p11       7832409-7932409       1662       E10       AY325170       CD670567       8-36       0.4         100       LRRP Ab2-379	91	LRRP Ac1177	10q22	37322101-37422102	189	E2	AY310147	CB839846	48-72	0.4.3.3
93       LRRP Cb1-727       10q24       61101964-61201964       2049       E17       AY325234       CD052159       8-12       0.4         94       LRRP Aa1018       10q24       62936624-63036624       1473       E8       AY318963       CD670555       24-72       10.1         95       BAC CH230-403C20       10q26       69406193-69506194       345       E2       AC118722       CD670533       12-36       0.9         96       LRRP Ab2-371       10q31       88515183-88615183       4923       E25       AY325211       CD670534       16-72       0.4         97       LOC303588       10q32+1       92219141-92319142       699       E3       XM_239346       CB839873       8       2.0         98       LRRP Ac2-210       10q32+1       94976696-95076697       663       E5       AY321338       CB964370       16-24       2.4         99       LRRP Aa2-066       11p11       7832409-7932409       1662       E10       AY325170       CD670567       8-36       0.4         100       LRRP Ab2-379       11q11       23912514-24012514       1608       E12       AY325203       CD670534       72-96       2.2	92	Open reading frame 31	10a24	60880930-60980931	498	E4	XM_220705	CB964395	36-72	0.3, 2.7
94       LRRP Aa1018       10q24       62936624-63036624       1473       E8       AY318963       CD670555       24-72       10.1         95       BAC CH230-403C20       10q26       69406193-69506194       345       E2       AC118722       CD670533       12-36       0.9         96       LRRP Ab2-371       10q31       88515183-88615183       4923       E25       AY325211       CD670534       16-72       0.4         97       LOC303588       10q32+1       92219141-92319142       699       E3       XM_239346       CB839873       8       2.0         98       LRRP Ac2-210       10q32+1       94976696-95076697       663       E5       AY321338       CB964370       16-24       2.4         99       LRRP Aa2-066       11p11       7832409-7932409       1662       E10       AY325170       CD670567       8-36       0.4         100       LRRP Ab2-379       11q11       23912514-24012514       1608       E12       AY325203       CD670534       72-96       2.2	93	LRRP Cb1-727	10a24	61101964-61201964	2049	E17	AY325234	CD052159	8-12	0.4
95       BAC CH230-403C20       10q26       69406193-69506194       345       E2       AC118722       CD670533       12-36       0.9         96       LRRP Ab2-371       10q31       88515183-88615183       4923       E25       AY325211       CD670534       16-72       0.4         97       LOC303588       10q32+1       92219141-92319142       699       E3       XM_239346       CB839873       8       2.0         98       LRRP Ac2-210       10q32+1       94976696-95076697       663       E5       AY321338       CB964370       16-24       2.4         99       LRRP Aa2-066       11p11       7832409-7932409       1662       E10       AY325170       CD670567       8-36       0.4         100       LRRP Ab2-379       11q11       23912514-24012514       1608       E12       AY325203       CD670534       72-96       2.2	94	LRRP Aa1018	10q24	62936624-63036624	1473	E8	AY318963	CD670555	24-72	10.1
96       LRRP Ab2-371       10q31       88515183-88615183       4923       E25       AY325211       CD670534       16-72       0.4         97       LOC303588       10q32+1       92219141-92319142       699       E3       XM_239346       CB839873       8       2.0         98       LRRP Ac2-210       10q32+1       94976696-95076697       663       E5       AY321338       CB964370       16-24       2.4         99       LRRP Ac2-066       11p11       7832409-7932409       1662       E10       AY325170       CD670567       8-36       0.4         100       LRRP Ab2-379       11q11       23912514-24012514       1608       E12       AY325203       CD670534       72-96       2.2	95	BAC CH230-403C20	10a26	69406193-69506194	345	E2	AC118722	CD670533	12-36	0.9
97       LOC303588       10q32+1       9219141-92319142       699       E3       XM_239346       CB839873       8       2.0         98       LRRP Ac2-210       10q32+1       94976696-95076697       663       E5       AY321338       CB964370       16-24       2.4         99       LRRP Aa2-066       11p11       7832409-7932409       1662       E10       AY325170       CD670567       8-36       0.4         100       LRRP Ab2-379       11q11       23912514-24012514       1608       E12       AY325203       CD670534       72-96       2.2	96	LRRP Ab2-371	10a31	88515183-88615183	4923	E25	AY325211	CD670534	16-72	0.4
98       LRRP Ac2-210       10q32+1       94976696-95076697       663       E5       AY321338       CB964370       16-24       2.4         99       LRRP Aa2-066       11p11       7832409-7932409       1662       E10       AY325170       CD670567       8-36       0.4         100       LRRP Ab2-379       11q11       23912514-24012514       1608       E12       AY325203       CD670534       72-96       2.2	97	LOC303588	10q32+1	92219141-92319142	699	E3	XM_239346	CB839873	8	2.0
99       LRRP Aa2-066       11p11       7832409-7932409       1662       E10       AY325170       CD670567       8-36       0.4         100       LRRP Ab2-379       11q11       23912514-24012514       1608       E12       AY325203       CD670534       72-96       2.2	98	LRRP Ac2-210	10q32+1	94976696-95076697	663	E5	AY321338	CB964370	16-24	2.4
100         LRRP Ab2-379         11q11         23912514-24012514         1608         E12         AY325203         CD670534         72-96         2.2	99	LRRP Aa2-066	11p11	7832409-7932409	1662	E10	AY325170	CD670567	8-36	0.4
	100	LRRP Ab2-379	11a11	23912514-24012514	1608	E12	AY325203	CD670534	72-96	2.2

No	Cone description	Chromo	Section	OPE	Futnon	Conchank	Conobank	Hours	Fold
110.	Gene description	Ciromo	Section	URF	Extron	Genebank	Genebalik	ofter	roiu difference
		location				of CDS	of EST	DU	unierence
101	IPPD Ab2 002	11a11	26552057 26652057	1167	<b>F</b> 7	AV225177	CD670500	P 11	0.1
101	LIGHT AD2-095	11q11	45490717 45590717	570		AT 525177	CD670541	00 8.26	2.1
102	LRRF AD2-410 = A A (LOC088976)	11q12	40409/17-40009/17	970	E0 E01	A1525209	CD070341	0-30	0.3
103	FA4 (LOC288276)	11q21 12#12	03323037-03423038	2/00	E21 E16	AV221242	CD064274	10	0.4
104	LRRP AC2-223	12q12	21381304-21081303	2427	E10	AY 321342	CB964374	8	2.4
105	LRRP Ab2-034	12q16	46993775-47093776	2796	E13	AY 325182	CD670494	2-96	2.3
106	LRRP Ab2-196	13	67592-167593	3048	E8	AY 325196	CB964372	8-30	0.5, 2.3
107	LRRP Ba2-692	13	68685-168685	3048	E8	AY325232	CD052172	4-36	0.6
108	LRRP Da2-35	13p11	25648312-25748313	837	E6	AY325258	CB577376	48-72	2.3
109	A1255964	13p13	1495219-1595220	723	E1	XM_222300	CF384936	16-36	0.4
110	LRRP Ab2-142	13q13	44304354-44404355	762	E5	AY325206	CD670515	2-4	0.5
111	LRRP Ac2-120	13q22	70689772-70789772	6309	E23	AY321333	CB964337	36	0.5
112	LRRP Da1-10	13q22	76465392-76565393	1203	E7	AY325249	CF413592	36-48	0.4, 2.1
113	LRRP Da2-20	13q26	100465676-100565677	663	E7	AY325255	AW533083	8	2.1
114	BAC CH230-329A5	13q27	102124785-102224785	3315	E8	AC136091	CF111118	48	0.3
115	MGC38937	14p11	35837306-35937307	2598	E4	XM_223356	N/A	12 - 144	2.6
116	RP23-480P21	14p22	12545360 - 12645361	747	E6	AC121829	CF110914	12-48	0.4
117	Ab2-450	14q21	70474767-70574767	4350	E25	AY325216	CD670545	16-36	2.2
118	LRRP Ac2-143	15p11	48449846 - 48549847	1770	E10	AY321337	CB964347	8-72	3.3
119	LRRP Ab2-008	15p12	34809952 - 34909952	5052	E27	AY325180	CD670488	8	2.1
120	LRRP $Bm403207$	15p12	36022558 - 36122558	1278	E2	AY325260	CB569793	36	0.5
121	RP11-586K2	15p14	$18968447  ext{-} 19068448$	327	E3	AC090797	CB964336	8-24	2.3
122	LRRP Aa1114	15q12	66624623- $66724624$	744	E6	AY318960	$\mathrm{CD670559}$	72	2.5
123	RIKEN cDNA 3100001N19	15q12	67179494 - 67279494	1065	E2	$\rm XM\_224414$	CB316157	24	2.0
124	CG31759-PA	16p16	1873071-1973071	2118	E6	$\rm XM\_224583$	BQ204949	12-48	2.9
125	RIKEN cDNA 1600027G01	16q11	46571222 - 46671222	1671	E12	$\rm XM\_224872$	CB964376	12-48	0.2
126	LRRP Ab1-114	16q12 + 5	70088524- $70188524$	1017	E7	AY325139	CD052184	2-12	4.2
127	LOC333273	16q12 + 5	74592385-74692386	7596	E24	XM_289530	CB751507	4-16	2.9
128	LRRP Aa2-020	17 p 12	31648226-31748227	510	E5	AY325171	CD670565	24	0.4
129	BAC CH230-11N5	17p12	33653050-33753051	3654	E3	AC097745	CB839875	36-144	4.6
130	LRRP Da1-6	18p11	33359680-33459680	7246	E36	AY325252	BE115795	72	2.0
131	LRRP Ab1-331	18p11	35993431-36093432	456	E3	AY325157	CD052210	8	2.2
132	LRRP Ac2-032	18p12	19873342-19973343	411	E4	AY321326	CB923461	4-12	2.7
133	LRRP Ac2-256	18q12+1	54367673-54467674	1968	E14	AY321347	CB964394	72	2.2
134	LRRP Ab2-143	18q12+3	73779132-73879133	1041	E4	AY325193	CD670515	72	2.0
135	LRRP Ab1-196	19	61817-161818	249	E2	AY325149	CD052196	72-96	0.3
136	BAC CH230-186B23	19p12	11378776-11478777	6966	E17	AC099101	CF384939	12-144	0.1
137	RIKEN cDNA 1300002A08	19a11	26425206-26525206	2421	E14	BC049090	CD670580	4-96	0.3. 2.4
138	RP23-28G13	19a11	27619446-27719447	648	E5	AL611926	CB964359	12-24	2.3
139	LBRP Ba1-647	19q12	37558273-37558273	1146	E6	AY325231	CF110667	12-144	3.2
140	LBBP Ac2-202	19a12	39540703-39640704	1506	E11	AY321341	CB964365	36-144	2.5
141	LBRP Da2-4	19q12	45067705-45167705	1485	E12	AY325261	BO192775	36-72	2.0
1/12	LBRP zbe550	10012	40308632-40408633	1251	E8	AV310156	CF108941	00-12 2-8	2.4
143	LBRP Da1-24	20n12	4989596-5089596	3351	E28	AV325253	CF110992	16-96	3.5
140	LIGHT Dai-24	20p12 20q11	30100305 30200305	846	E20 F7	AV325164	CD670575	10-30	0.5
144	LERP Ab2 018	20q11 20q12	45555021 45655021	411	E3	AV225181	CD670402	24	2.0
140	I DDD Abi 987	20412 Val1	262220 462220	411	E3 E1	AV225156	CD070492	10	2.0
140	LINIT ADI-207	лц11 Ха14	JUJJ07-4UJJ07 20660660 20760670	400	цл Е10	AT 323130 AV 325105	CD670520	21 10	⊿.∪ Э.Э
141	DAC CHOOD 155119	лц14 Харр	20000000-20100010 51055500 50055500	1047	151Z	A C194090	AW017410	24-40 10.70	4.0 0.2
148	DAU UH230-100H3 I DDD Abo 401	лц22 Ха21	0190098-0200098 70600046 70700046	903 699	E1 E7	AU124920	CD002070	12-72	0.0
149	LINIT AD2-401 VIA ADD05	лцэ1 V "21	710422240-70722240	033	止) 下2	AI 323208	UD0038/0	4-12	0.4, 3.2
150	NIAAU2U0 Al 0.404	Aq31 X21	(1048304-(1148304	807	E2	AW1_228902	DE115518	8-12	0.4
151	AD2-404	Aq31 X22	04088093-04688094	4353	E8 E7	AY 325213	CD670539	36	2.5
152	lkkp Ad2-402	Aq33	70623188-70723189	633	E7	AY 325208	CD670538	12 - 24	0.1

 Table 2 Continued

3987 E9

AC118772

CB923463

12-72 0.5, 2.4

86798373-86898373

Xq33

153 BAC CH230-404C20

No.	Gene description	Chromo-	Section	ORF	Extron	Genebank	Genebank	Hours	Fold
		some				number	number	after	difference
		location				of CDS	of EST	$_{\rm PH}$	
154	LRRP Da2-19	Xq34	89848255-89948255	1032	E3	AY325254	CB325852	48-72	2.6
155	RP24-347B22	Xq35	95493296-95593296	1641	E7	AC122009	CF384946	48	2.2
156	LRRP Ac1-163	Xq37	114620155 - 114720156	2847	$\mathbf{E8}$	AY321321	CB839841	8-36	0.4
157	LRRP Ab2-057	N/A	40208673 - 40308673	1527	$\mathbf{E8}$	AY318962	$\mathrm{CD670560}$	72	0.4
158	LRRG Ac2019	N/A	N/A	N/A	N/A	N/A	CF384941	2	2.0
159	12  days embryo cDNA	N/A	N/A	N/A	N/A	N/A	$\mathrm{CD670493}$	2-72	5.0
160	$13~{\rm days}$ embryo liver cDNA	N/A	N/A	N/A	N/A	N/A	CB839861	2-36	5.9
161	Liver cDNA	N/A	N/A	N/A	N/A	N/A	$\mathrm{CD052216}$	72	0.1
162	Testis cDNA	N/A	N/A	N/A	N/A	N/A	CB964382	16	2.1
163	RP23-92K11	N/A	N/A	N/A	N/A	N/A	CD052178	4-16	2.7
164	RIKEN cDNA 4833439L19	N/A	N/A	N/A	N/A	N/A	$\mathrm{CD670574}$	8	0.5
165	Hippocampus cDNA	N/A	N/A	N/A	N/A	N/A	$\mathrm{CD670502}$	8-16	0.5
166	RP23-235O1	N/A	N/A	N/A	N/A	N/A	${\rm CB315158}$	8-36	0.2
167	RP23-195K1	N/A	N/A	N/A	N/A	N/A	AA900787	8-36	2.4
168	RP24-176A1	N/A	N/A	N/A	N/A	N/A	$\mathrm{CD670517}$	12-48	0.5, 2.4
169	RIKEN cDNA 2700060E02	N/A	N/A	N/A	N/A	N/A	BM386943	24	2.0
170	RP23-195K1	N/A	N/A	N/A	N/A	N/A	AA900787	24 - 144	4.0
171	KIAA0433	N/A	N/A	N/A	N/A	N/A	N/A	36	2.0
172	RP23-417P22	N/A	N/A	N/A	N/A	N/A	CF384932	48-96	0.2
173	LRRP Ac2-019	N/A	N/A	N/A	N/A	N/A	CF384941	48-96	2.4
174	RP23-23501	N/A	N/A	N/A	N/A	N/A	CB315158	48-144	0.4
175	LRRG Ab2052	N/A	N/A	N/A	N/A	N/A	CD670498	72	2.4
176	RP24-155I9	N/A	N/A	N/A	N/A	N/A	CB923489	72	2.0
177	RIKEN cDNA 2310045J23	N/A	N/A	N/A	N/A	N/A	$\mathrm{CB751520}$	144	0.5

 Table 2 Continued

#### Cluster analysis of genes expressed differently in liver regeneration

Cluster analysis was done to facilitate the visualization and interpretation of the gene expression program represented in this very large body of data. The results showed that the distribution trend of the 177 genes is as follows: the genes altered in the beginning phase of LR are more than those in the other phases; the genes up-regulated in LR are more than those down-regulated; the expression folds of up-regulated genes are higher than the suppression folds of the down-regulated; and the expression changes of the down-regulated genes are more complex than those of the up-regulated (Figure 2A). On the basis of similarities in their expression patterns and display results in a compact graphical format, 18 kinds of ramose gene expression clusters are generated (Figure 2B).

Cluster analysis of genes expressed at 12 time points after PH showed that the 177 genes are categorized into 8 patterns of gene expression based on the similarity, that is, 2 and 4, 8, 12 and 16, 24, 36, 48, 72, 96 and 144 h, and are placed in a major branch of the dendrogram (Figure 3).

#### Discussion

In this study, 177 unreported genes were identified by microarray to be associated with the rat liver regeneration. It shows that a large number of genes related with LR remain to be found and studied. It was found by the analysis of chromosome location of genes that 131 genes were located on the long arms of the chromosomes and 25 genes were on the short arms. This is responsible for the structure of chromosomes. In the 177 genes, expression of 61 genes was altered in the intermediate phase of LR. It means that the progress of S phase of cell cycle is involved in lots of genes. It was confirmed that 99 genes were up-regulated in LR and 62 genes down, suggesting that the number of the activated genes were more than that of the suppressed ones.

Following the cluster analysis, the 177 genes related with rat liver regeneration were categorized into 18 distinct temporal patterns of induction, and based on the similarity, the 177 genes showed 8 expression profiles, that is, 2 and 4, 8, 12 and 16, 24, 36, 48, 72, 96 and 144 h, indicating that the genes expressed in



Fig. 2 Hierarchical cluster analysis of 177 genes. A. Cluster of distribution trend. 177 genes differing with more than twofold intensity at least one time point of liver regeneration were identified; B. Cluster of hierarchical relativity at eleven time points.



Fig. 3 The 177 genes expressed at different time points after PH are categorized into 8 patterns based on their similarity, that is, 2 and 4, 8, 12 and 16, 24, 36, 48, 72, 96 and 144 h.

the same time share common expression profiles, and the metabolism and physiology of the cells with common gene expression profiles are similar. On the other hand, the genes expressed in different times have no common expression profiles, and the metabolism and physiology of the cells with different gene expression profiles are not similar. However, the types and characteristics of these genes are still unclear, and their functions remain to be further studied.

#### Materials and Methods

## Partial hepatectomy of rats and RNA isolation

 $200\pm20$  g healthy adult SD (Sprague Dawley) rats were obtained from the experimental animal center of Henan Normal University. Following the method of Higgens and Anderson (6), 70% of the total rat liver was removed, which was performed under sterile conditions (7). The regenerating livers of four rats (male: female = 1:1) were taken at 2, 4, 8, 12, 16, 24, 36, 48, 72, 96 and 144 h respectively after PH. The taken livers were rinsed in cold PBS and immersed in  $-80^{\circ}$ C refrigerator for RNA extraction. Total RNA was isolated from frozen livers according to the manual of Trizol kit of Invitrogen. In brief, 50-100 mg liver was homogenized in 1 mL Trizol reagent containing phenol and guanidinium isothiocyanate/cationic detergent, followed by phenol-chloroform extraction and isopropyl alcohol precipitation. The quantity and integrity of total RNA was examined by ultraviolet spectrometer and denaturing formaldehyde agarose electrophesis stained by ethidium bromide (EB).

#### Subtracted cDNA library construction and screening

The subtracted cDNA library was generated from total RNA by PCR-Select<sup>TM</sup> cDNA subtraction kit (Clontech, Palo Alto, USA) following the manufactory's instruction. Briefly, total RNA was reversetranscribed into double cDNA strands and digested with restriction enzymes, followed by subtracted hybridization with drivers and testers. Finally, with suppression PCR (polymerase chain reaction), differential expression sequence tags were performed to construct subtracted cDNA library (13). The subtracted cDNA library was cloned into T/A vector and screened by PCR with nest primers 1 and 2.

#### cDNA microarray construction

551 cDNA fragments were amplified by Nested PCR. Primers 1 and 2 were purified by NaAc/isopropyl alcohol. Subsequently, they and 50 controls (8 negative, 12 void, and 30 internal) were doubly spotted onto glass slides by ProSys-5510A spotting machine following designed project and comprised 8 submatrixes (48\*24) occupying  $9\times18$  mm (BioStar, Shanghai, China). Then the gene chips were ready by hydrating, blocking and drying (13).

#### Hybridization and scanning

RNA prepared from rat livers before PH was ready for a reference for all cDNA microarray analy-Total denatured RNA was reverse transes. scribed with Cy3-conjugated dCTP (control group) and Cy5-conjugated dCTP (test group) (Amersham-Pharmacia Biotech, England) using MMLV reverse transcriptase (Promega) with olig(dT) primer. After bath incubation for 2 h, labeled buffers I and II were subsequently added to the reaction. The control group and test group were mingled together symmetrically and stored, avoiding light for application (13). The glass slices were prehybridized at 42°C for 5–6 h in hybridization buffer containing freshly cooked shared salmon sperm DNA. The labeled denatured probe was hybridized against cDNA microarray with overnight (16–18 h) incubation at 42°C. The slices were then washed twice with  $2 \times SSC$  containing 0.5% SDS at room temperature for 5 min, once with  $0.2 \times SSC$  containing 0.5% SDS at 60°C for 10 min, and finally with  $0.2 \times SSC$  at 60°C for 10 min. The slices were exposed to photographer. Hybridized images were scanned by a fluorescence laser scanning device, Gene Pix 4000A. At last, two hybridizations were performed at each time point. In addition, a semiquantitative inspection of the hybridization results was performed for (1)green signal (down-regulation); (2) yellow signal (no obvious regulation); (3) red signal (up-regulation).

#### Data analysis

The cy3 and cy5 signal intensities were quantified by Gene Pix Pro 3.0 software. Subsequently, we normalized the obtained numerical data with classical linear regression techniques. In brief, quantified cy3 and cy5 signal intensities were obtained when foreground signal intensities were deducted by background signal intensities, and cy5 signal intensity was replaced by 200 when it was <200. When Ri (Ri=cy5/cy3) was between 0.1 and 10, Ri was taken logarithms to generate Ri' [log (Ri)] and ND was taken by EXP (R) (averaged Ri'). The modified cy3\* was generated when taking ND multiply cy3 and was replaced by 200 when it was <200. The ratio was performed by cy5/cy3\*. Therefore, we selected genes whose ratio was more than 2 or less than 0.5, representing a twofold difference in expression level. To analyze the selected gene expression data, we applied GeneMaths cluster analysis and performed hierarchical clustering to apprise the number of groups. Euclidean distance was used as the dissimilarity measure. Whole analyses were executed with Microsoft Excel and GeneSpring (Silicon Genetics, San Carlos, USA).

#### Structure and chromosome location of the genes

The base sequence assay of ESTs was carried according to the current protocols in molecular biology. The EST sequences were sent to GeneBank to perform homology analysis. The accession number of the whole novel ESTs is achieved. In virtue of rat genome database (RGD), electronic cloning and chromosome location of the unreported ESTs representing unreported full-length cDNA were performed successfully. They were searched at http://www.ncbi.nlm.nih.gov/ genomeguide/rat/index.html/ for gene location in chromosome and genes corresponding with WGS (Whole Genome Shotgun). By delivering the sequences to GENSCAN, we acquired CDS (coding domain sequences) supported by the full-length cDNA. Compared with known proteins in virtue of BLASTP (http://www.ncbi.nlm.nih.gov/BLAST/), their functions and accession numbers were achieved.

### Acknowledgements

We thank *BioStar* for microarray.

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This work was supported by National Natural Science Foundation of China (No. 30270673).