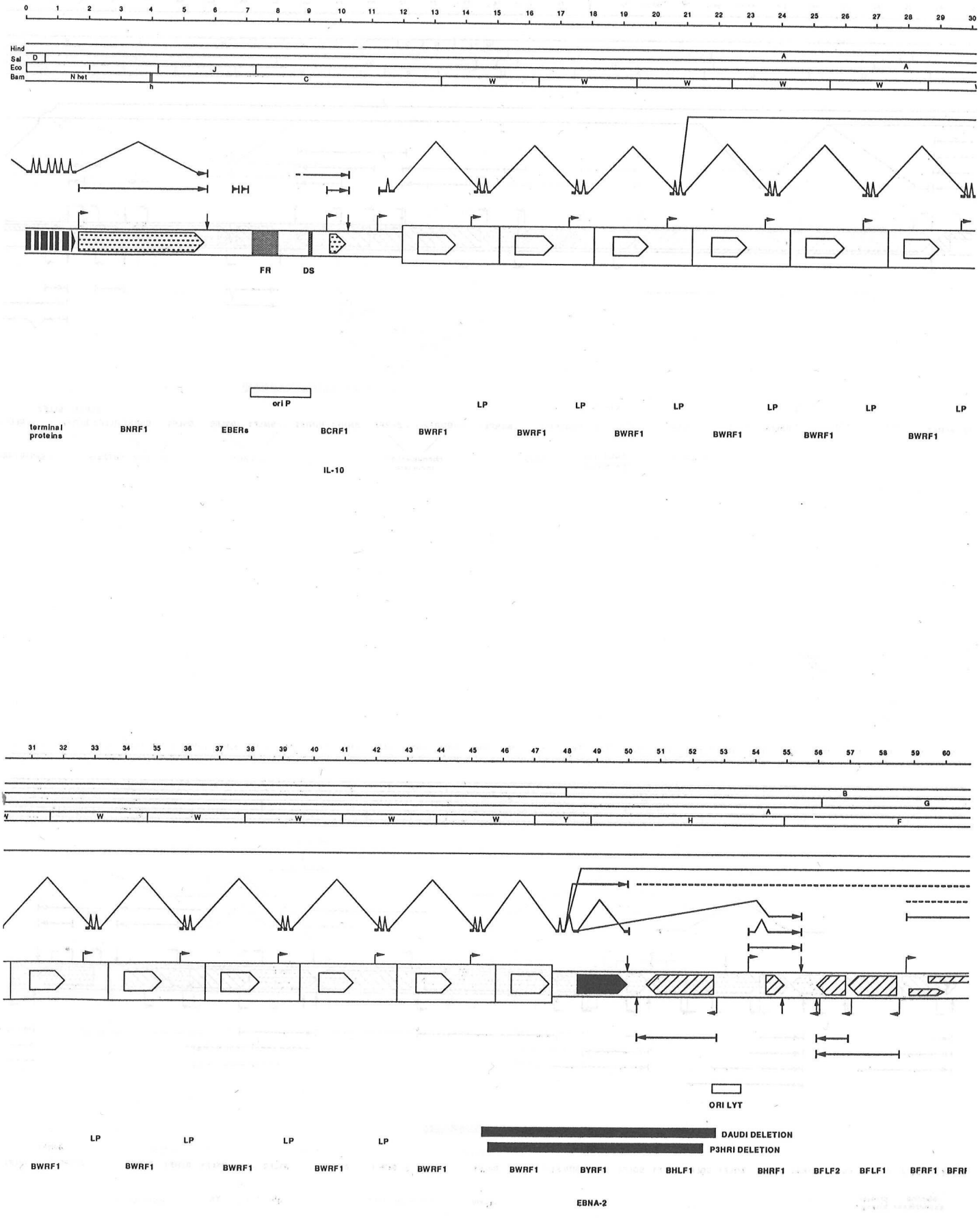
EPSTEIN-BARR VIRUS

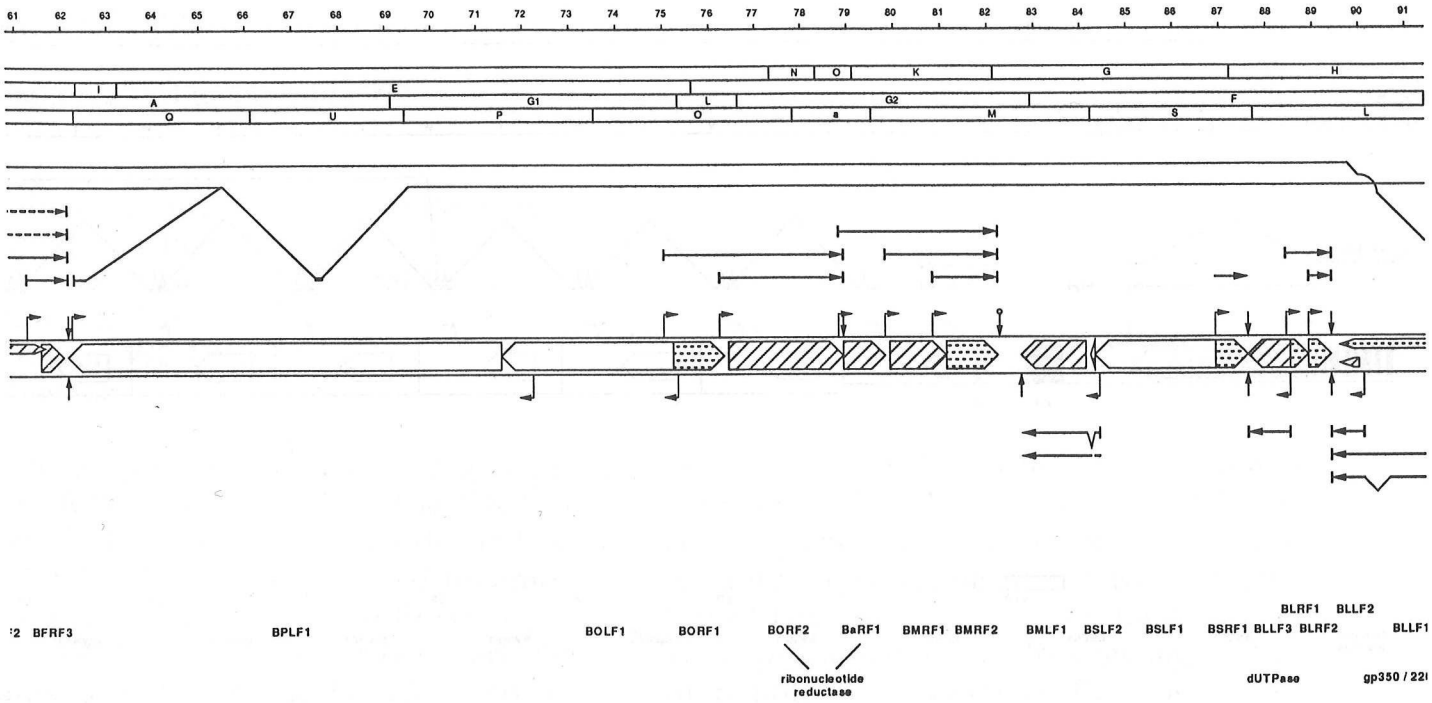
Data revised to 1st July 1992

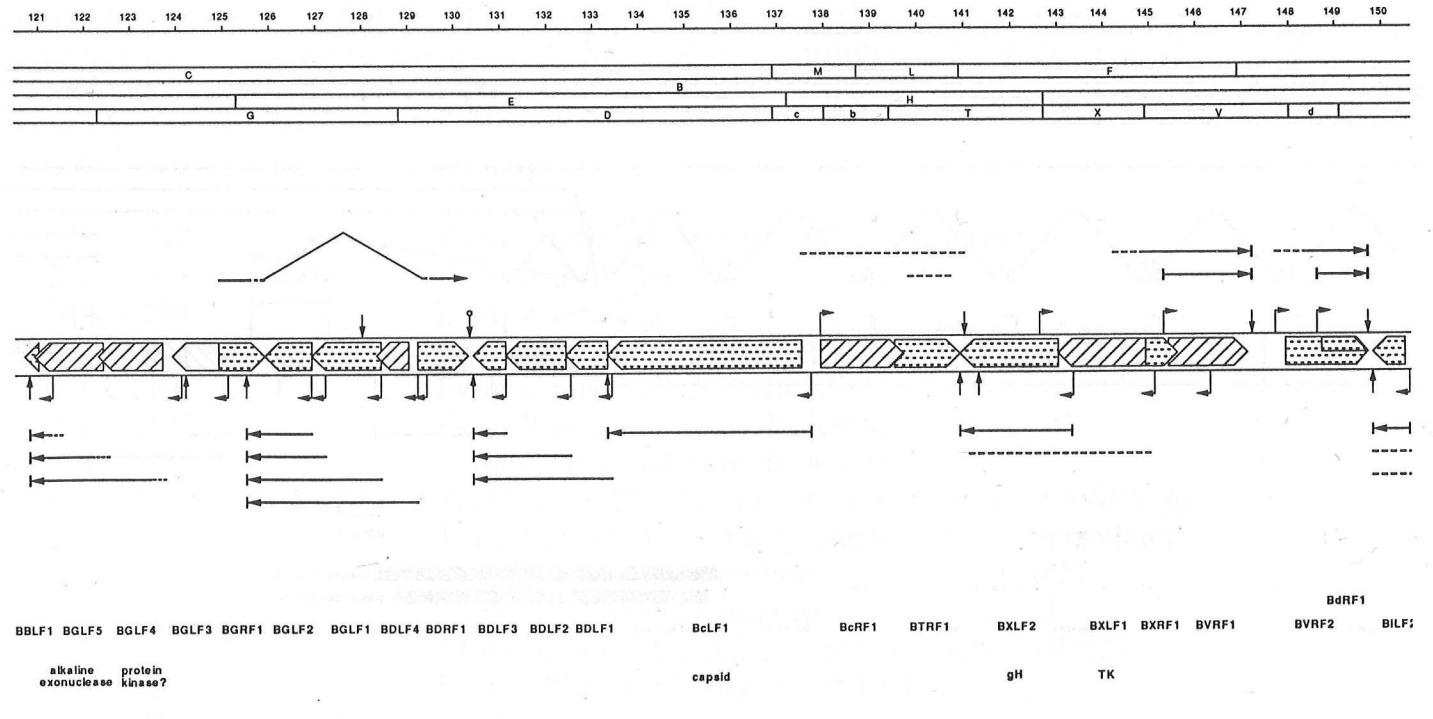
P. J. Farrell
Ludwig Institute for Cancer Research
St. Mary's Branch
St. Mary's Hospital Medical School
Norfolk Place
London W2 1PG
England

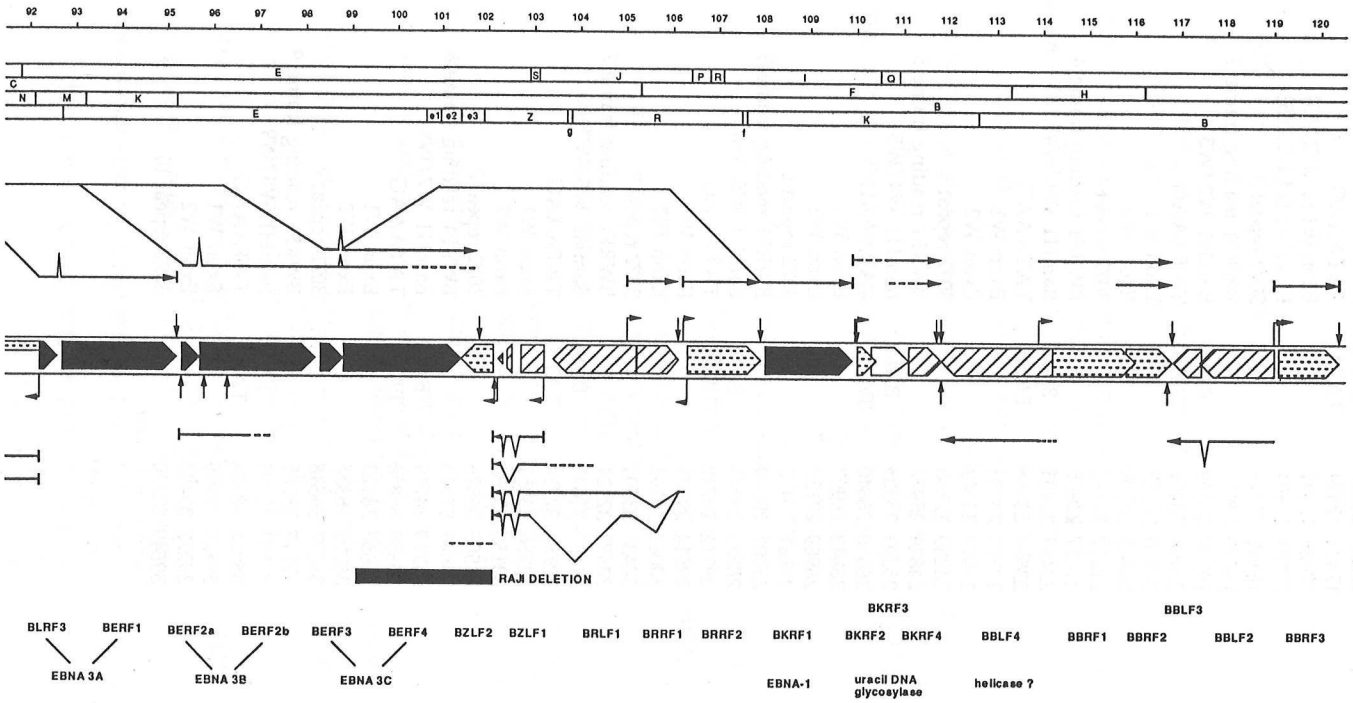
This map is an update of that given in [64] and is based on the nucleotide sequence of the B95-8 strain of EBV. The DNA sequence of B95-8 EBV was revised in 1988. The original [8] base 359 was deleted so the new sequence around that position reads TCAGTCTTT [121]. To avoid renumbering the entire sequence, position 1 was moved 1 base to the left of the Eco RI site separating Eco RI Dhet from Eco RI I (ie the first A of AGAATTC). Vertical arrows mark the AAUAAA polyadenylation cleavage signal and angled arrows mark the TATA box of known or potential promoters. Reading frames are shown as pointed boxes and are shaded according to their expression class: black for latent cycle, diagonally cross-hatched for early productive cycle and horizontal dashes for late productive cycle. No RNA has been assigned to the unshaded reading frames. mRNAs are shown as horizontal arrowed lines; rightward RNAs are shown above the reading frames and leftward RNAs are below. RNA ends that have been mapped precisely are marked with a vertical dash, other termini shown are only deduced from Northern blotting experiments and inspection of the DNA sequence. RNAs whose structure remains uncertain are indicated by dashed lines. The table gives detailed information on the features shown in the diagram. Features on the complementary strand (ie. leftward on the map) are indicated by C in the table. Sequence relationships between EBV reading frames and those of HSV[137], CMV[119], VZV[54] and HVS[83] were mostly identified by the above authors or in the original EBV sequence [8] and are not referenced individually in the feature table.

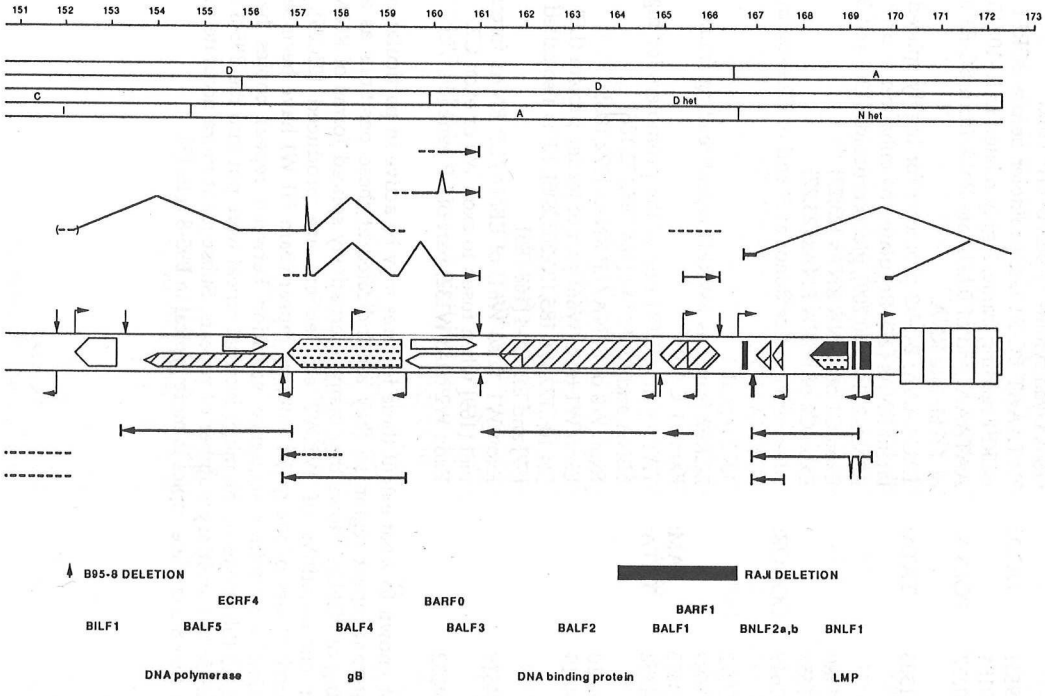
From	To		Description
58	272		Exon 2 terminal protein RNAs [121,174]
360	458		Exon 3 terminal protein RNAs
540	788		Exon 4 terminal protein RNAs
871	951		Exon 5 terminal protein RNAs
1026	1196		Exon 6 terminal protein RNAs
1280	1495		Exon 7 terminal protein RNAs
1574	1682		Exon 8 terminal protein RNAs
1691	1691	TATA:	TATTAAA BN-R1 late promoter before BNRF1, gives 4.1kb late RNA. Probably encodes non glycosylated 140kd protein in membrane antigen [30,105] Structural relationship to immunoglobulin superfamily, eg T cell receptor gamma chain[29].
1736	5689		BNRF1 reading frame, 5 NXT/S
1795	1795 C	POLYA:	AATAAA


0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Hind
Sal
Eco
Bam
D
I
J
N het
h
C
W
A
FR
DS
ori P
LP
terminal proteins
BNRF1
EBERs
BCRF1
BWRF1
IL-10
31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
V
Y
H
B
G
F
ORI LYT
DAUDI DELETION
P3HRI DELETION
BYRF1
BHLF1
BHRF1
BFLF2
BFLF1
BFRF1
EBNA-2


61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91
I
E
N
O
K
G
H
A
G1
L
G2
F
O
U
P
O
a
M
S
L
BLRF1
BLLF2
:2 BFRF3
BPLF1
BOLF1
BORF1
BORF2
BaRF1
BMRF1
BMRF2
BMLF1
BSLF1
BSLF1
BSRF1
BLLF3
BLRF2
BLLF1
ribonucleotide reductase
dUTPase
gp350 / 22


121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150
C
M
L
F
B
E
H
G
D
c
b
T
X
V
d
BdRF1
BBLF1 BGLF5 BGLF4 BGLF3 BGRF1 BGLF2 BGLF1 BDLF4 BDRF1 BDLF3 BDLF2 BDLF1
BcLF1
BcRF1
BTRF1
BXLF2
BXLF1
BXRF1
BVRF1
BVRF2
BILF
alkaline exonuclease
protein kinase?
capsid
gH
TK


92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120
C
E
S
J
P
R
I
O
N
M
K
F
H
B
E
e1
e2
e3
Z
g
R
f
K
B
RAJI DELETION
BLRF3
BERF1
BERF2a
BERF2b
BERF3
BERF4
BZLF2
BZLF1
BRLF1
BRRF1
BRRF2
BKRF1
BKRF3
BKRF2
BKRF4
BBLF4
BBLF3
BBRF1
BBRF2
BBLF2
BBRF3
EBNA 3A
EBNA 3B
EBNA 3C
EBNA-1
uracil DNA glycosylase
helicase ?


151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173
D
A
C
D
I
D het
A
N het
B95-8 DELETION
RAJI DELETION
ECRF4
BARF0
BARF1
BILF1
BALF5
BALF4
BALF3
BALF2
BALF1
BNLF2a,b
BNLF1
DNA polymerase
gB
DNA binding protein
LMP

3955	3955	BAM:	Bam H1 Nhet/h
3994	3994	BAM:	Bam H1 h/C
5408	5856		Exon 9 terminal protein RNAs
5863	5863		alternative 3' end to TP RNAs
5841	5841	POLYA:	AATAAA, end of 4.1kb late RNA and TP latent RNA.
6629	6795		Pol III RNA EBER 1 [6,20,39,81,191]
6956	7128		Pol III RNA EBER 2. EBER 1 and EBER 2 are pol III transcripts but also have upstream control regions that resemble pol II promoter elements [104]
7315	9312		Origin of replication, ori P [36,74,96,162,187,214,215]
7421	8042		21x30bp repeats, binding sites for EBNA-1 (site I, [4,111,160,213]. Tandem repeat part of oriP. Also functions as a cell type specific enhancer [131,161]
9021	9135	HPN:	Dyad symmetry, site II for EBNA-1 binding [160]. Dyad symmetry part of oriP [162].
9631	9631	TATA:	TATAAAT BC-R1 late promoter before BCRF1
9675	10184		BCRF1 reading frame, highly related to IL-10 [132,142,202]
10257	10257	POLYA:	AATAAA, end of 0.8kb late RNA from BC-R1 and end of 1.6 kb late RNA.
11305	11305	TATA:	TACAAAA; BC-R2 promoter for highly spliced EBNA latent RNAs [27]. Regulated by enhancer in oriP [188], EBNA-2 [167,190,209], glucocorticoids [120] and BZLF1 [182]
11336	11480		Exon C1 of EBNA RNAs [23,27]
11626	11657		Exon C2 of EBNA RNAs [23,27]
11649	11649	DONOR:	Alternative splice donor at 3' end of C2 exon in an EBNA 3C RNA [177].
12001	15072		3072 repeat 1
12541	13689		BCRF2 (same as BWRF1) repeat reading frame 1
13215	13215	BAM:	BamH1 C/W1
*14352	14352	TATA:	TATAAAG BWR1 one of the promoters for highly spliced EBNA and LP RNAs [164,165,172,186]
*14384	14410		Exon W0 of EBNA/LP RNAs [172,186]
*14554	14619		Exon W1 (also W66) part of leader protein (LP) gene [24,106,172,176,185,186,203,205]. LP is also called EBNA-5 [57] and EBNA-4 [168,185]
*14559	14619		Exon W1' (also W61) of EBNA/LP RNAs forms initiator met [169] when fused to exon W0 or exon C2.
*14701	14832		Exon W2 (also W132) part of LP gene [24,172]

* it is not known to what extent these features may be active in particular copies of the major internal repeat region so they are indicated at these positions as an example. Sequencing of cDNAs shows that many alternatively spliced forms of RNA containing different combinations of W1,W2 etc leaders are produced [25,26]. Only two independent clones of the major internal repeat (Bam HI W) have been sequenced so the possibility of minor sequence variation between repeat copies has not been excluded. 11 full copies of the major internal repeat were put into the B95-8 sequence [8] as a realistic but arbitrary number of repeats. Subsequent more accurate measurement indicates that 8 complete copies is more typical in B95-8 cells [2].

15073	18144		3072 repeat 2
15613	16761		BWRF1 reading frame 2 [203]
16287	16287	BAM:	BamH1 W1/W2
17424	17424	TATA:	TATAAAG
17626	17691		Exon W1 [24,172,185]
17773	17904		Exon W2 [24,172,185]
18145	21216		3072 repeat 3
18685	19833		BWRF1 reading frame 3
19359	19359	BAM:	BamH1 W2/W3
20496	20496	TATA:	TATAAAG
20698	20763		Exon W1
20845	20976		Exon W2
21217	24288		3072 repeat 4
21757	22905		BWRF1 reading frame 4
22431	22431	BAM:	BamH1 W3/W4
23568	23568	TATA:	TATAAAG
23771	23835		Exon W1
23917	24048		Exon W2
24289	27360		3072 repeat 5
24829	25977		BWRF1 reading frame 5
25503	25503	BAM:	BamH1 W4/W5
26640	26640	TATA:	TATAAAG
26842	26907		Exon W1
26989	27120		Exon W2
27361	30432		3072 repeat 6
27901	29049		BWRF1 reading frame 6
28575	28575	BAM:	BamH1 W5/W6
29712	29712	TATA:	TATAAAG
29914	29979		Exon W1
30061	30192		Exon W2
30433	33504		3072 repeat 7
30973	32121		BWRF1 reading frame 7
31647	31647	BAM:	BamH1 W6/W7
32784	32784	TATA:	TATAAAG
32986	33051		Exon W1
33133	33264		Exon W2
33505	36576		3072 repeat 8
34045	35193		BWRF1 reading frame 8
34719	34719	BAM:	BamH1 W7/W8
35856	35856	TATA:	TATAAAG
36058	36123		Exon W1
36205	36336		Exon W2
36577	39648		3072 repeat 9
37117	38265		BWRF1 reading frame 9
37791	37791	BAM:	BamH1 W8/W9
38928	38928	TATA:	TATAAAG
39130	39195		Exon W1
39277	39408		Exon W2
39649	42720		3072 repeat 10

40189	41337		BWRF1 reading frame 10
40863	40863	BAM:	BamH1 W9/W10
42000	42000	TATA:	TATAAAG
42202	42267		Exon W1
42349	42480		Exon W2
42721	45792		3072 repeat 11
43261	44409		BWRF1 reading frame 11
43935	43935	BAM:	BamH1 W10/W11
45072	45072	TATA:	TATAAAG
45274	45339		Exon W1
45415	52824	DEL:	DAUDI deletion [110]
45421	45552		Exon W2
45644	52450	DEL:	P3HR1 deletion [108]
45793	47643		partial 3072 repeat 12
46333	47481		BWRF1 reading frame 12
47007	47007	BAM:	BamH1 W11/Y
47761	47793		Exon Y1 [24]
47878	47999		Exon Y2 [24] and EBNA-1 [185], last common exon
48386	48444		Exon [24]
48386	50032		Coding exon for EBNA-2 [172]
48429	49964		BYRF1, encodes EBNA-2 [1,41,42,43,44,51,52,58,59,60,63,85,92,93,99,117,144,169,170, 205,206,207,208,219,220] EBNA-2 required for immortalization by EBV
48678	48800		14 x "CCCCCACCA" repeats
48848	48848	BAM:	BamH1 Y/H
49525	49578		9 x "GGGGCA" repeats
49852	50032		Exon [24]
50003	50003	POLYA:	AATAAA, end of T1 cDNA [24] and EBNA-2 RNA
50317	50317 C	POLYA:	AATAAA, end of 2.5kb early RNA containing BHLF1
50578	52115		12 x "125bp" repeats
52557	50578 C		BHLF1 early reading frame
52589	53581	ORI:	Ori Lyt, lytic origin of replication [90]
52589	52944	ORI:	Part of Ori Lyt, upstream element [90]
52654	53697		Region homologous to Eco RI C of Raji. Duplicated left and right regions contain DL and DR promoters [32,34,48,88] and ori lyt
52817	52817 C	TATA:	GATAAAA promoter for 2.5kb early RNA containing BHLF1 [72,108].
53207	53581	ORI:	Part of Ori Lyt, enhancer element, palindrome
53759	53759	TATA:	TATTAAC likely promoter for class III and IV early RNAs encoding BHRF1 [151]
53895	53895	DONOR:	CGGGTAACT donor for splice to 54335 in class IV early RNAs encoding BHRF1 [151]
54335	54335	ACCEPT:	TTTTCTAG acceptor from 48444 in class I, 47999 in class II, and 53895 in class IV early RNAs encoding BHRF1 [7,151,157]
54376	54948		BHRF1 reading frame, limited homolgy to bcl-2 gene [40]. Early gene in B95-8 cells and part of restricted EA complex.
54853	54853	BAM:	BamH1 H/F
55518	55518	POLYA:	AATAAA, 3' end of 2.5kb, 1.9kb, 1.7kb and 0.6kb early RNAs
55990	55990 C	POLYA:	AATAAA, 3' end of 2.3kb and 1.1kb early RNAs from 58568 and 57081
56935	55982 C		BFLF2 reading frame, 4 NXT/S, homologous to RF 27 in VZV and HFRF2 in CMV
57081	57081 C	TATA:	TATTTAA before BFLF2; BFL2 promoter gives 1.1kb early RNA
58525	56951 C		BFLF1 reading frame, 2 NXT/S homologous to RF 26 in VZV and HFRF1 in CMV
58568	58568 C	TATA:	TATTAAA before BFLF1, BFL1 promoter gives 2.3kb early RNA
58832	58832	TATA:	TATAAAA before BFRF1
58891	59898		BFRF1 early reading frame, 1 NXT/S, homologous to HFLF4 in CMV
59610	61580		BFRF2 early reading frame, homologous to HFLF5 in CMV
61344	61344	TATA:	TATTTAA before BFRF3
61456	62034		BFRF3 early reading frame
62068	62068 C	POLYA:	AATAAA
62069	62069	POLYA:	AATAAA, 3' end of 10, 6.5, 3.7, 3.4, 3.1, 2.5 and 0.8kb early RNAs
62230	62458		FQ exon in EBNA-1 RNA initiated at Fp promoter in group I BL cells and NPC [175,178,183]
62249	62249	BAM:	BamH1 F/Q
62430	62477		Site III for EBNA-1 binding [160]
66121	66121	BAM:	BamH1 Q/U
67477	67649		Exon in EBNA-1 RNA [185] and cDNA clone T4 [25]
69410	69410	BAM:	BamH1 U/P
69684	69930		5 x 51bp repeats
70387	70521		9 x 15bp repeat
71527	62081 C		BPLF1 reading frame, 1 NXT/S, analogous to VZV RF22
72192	72192 C	TATA:	TATTAAA before BPLF1
73468	73468	BAM:	BamH1 P/O
75017	75017	TATA:	TATTTAA BO-R1 late promoter before BORF1, gives 3.9kb late RNA
75238	76329		BORF1 late reading frame, 2 NXT/S homologous to VZV RF20
75239	71523 C		BOLF1 reading frame, 1 NXT/S analogous to VZV RF 21
75322	75322 C	TATA:	TATTTAG before BOLF1
76169	76169	TATA:	TACATAT BO-R2 early promoter before BORF2, gives 2.8kb RNA
76407	78884		BORF2 early reading frame, 2 NXT/S. Homology HSV 140K ribonucleotide reductase [76,77,82] and RF 19 VZV
77835	77835	BAM:	Bam H1 O/a
78804	78804	TATA:	TATAAGT Ba-R1 early promoter before BaRF1, gives

			3.5kb RNA
78883	78883	POLYA:	AATAAA, end of 3.9kb late RNA from 75017 and 2.8kb early RNA from 76169
78900	79805		BaRF1 early reading frame, homologous to HSV 38K ribonucleotide reductase [76,77,82] and RF 18 VZV
79537	79537	BAM:	Bam H1 a/M
79840	79840	TATA:	CATAAAT BM-R1 early promoter before BMRF1, gives 2.5kb RNA
79899	81110		BMRF1 early reading frame. Early antigen protein recognised by R3 monoclonal [37,61,147,150].
80779	80779	TATA:	TATTTAA BM-R2 late promoter before BMRF2
80832	80832	TATA:	GATAAAA, possible promoter for 1.4kb late RNA encoding BMRF2
81118	82188		BMRF2 early reading frame
82180	82180	POLYA:	ATTAAA, end of 3.5kb early RNA from 78804, 2.5kb early RNA from 79840 and 1.4kb late RNA [156].
82319	82461		2x71bp repeats
82747	82747 C	POLYA:	AATAAA
83640	83729		10x9bp repeats
84122	84122 C	ACCEPT:	CTCCCCTCTGCAG acceptor in spliced form of BMLF1 RNA
84122	82746 C		BMLF1 early reading frame. Diffuse early antigen [38,211,212]. Also homologous to RF 4 VZV and IE63 of HSV.(BSLF2 + BMLF1) is also called EB2 [35]. Post-transcriptional activator of gene expression [28,35,123,151]
84227	84227 C	DONOR:	CAGGTAAGA donor in spliced form of BMLF1 RNA [173]
84233	84233	BAM:	Bam H1 M/S
84288	84228 C		BSLF2 early reading frame in 5' exon of spliced RNA encoding BMLF1 [173]
84356	84356 C	TATA:	CATAAAT in promoter for BSLF2 + BMLF1 early RNA. Promoter activated by BZLF1 and BRLF1 [28,103,115].
86881	84260 C		BSLF1 reading frame, homologous to RF 6 VZV, UL42 HSV (primase)
86882	86882	TATA:	TATTTAA BS-R1 late promoter before BSRF1
86924	87577		BSRF1 reading frame
87599	87599	POLYA:	AATAAA
87613	87613 C	POLYA:	AATAAA, end 1.0kb early RNA from BL-L3
87650	87650	BAM:	Bam H1 S/L
88474	87641 C		BLLF3 early reading frame (BLLF2 in [8]). Homologous to RF 8 VZV and dUTPase HSV.
88507	88507	TATA:	TATATAT BL-R1 late promoter before BLRF1, gives 1.0kb late RNA
88514	88514 C	TATA:	TATATAT BL-L3 early promoter before BLLF3, gives 1.0kb early RNA
88547	88852		BLRF1 late reading frame
88863	88863	TATA:	TATTTAA BL-R2 late promoter before BLRF2, gives 0.6kb late RNA
88925	89410		BLRF2 late reading frame, 2 NXS/T
89412	89412	POLYA:	AATAAA, end of 1.0kb and 0.6kb late RNAs
89425	89425 C	POLYA:	AATAAA, end of 0.7kb early, 2.2kb late and 2.8kb late RNAs
90013	89569 C		BLLF2 early reading frame (BLLF3 in [8])
90051	90051 C	TATA:	TATAACA BL-L2 early promoter before BLLF2, gives 0.7kb early RNA
90177	90639		21 copies of 21bp approximate repeat
90652	90062 C		intervening sequence in gp220 gene
92153	89433 C		BLLF1b, late reading frame gp220 membrane antigen, spliced form of BLLF1a [19,22,107]
92153	89433 C		BLLF1a, late reading frame, gp350 membrane antigen, 36 NXT/S [11,19,22,53,107,195,199,210]
92192	92192 C	TATA:	TATTAAA BL-L1 late promoter before BLLF1a,b. Gives 2.8 and 2.2kb late RNAs
92238	92581		Exon in EBNA 3A RNA [25]
92243	92581		BLRF3 reading frame
92670	95248		Exon in EBNA 3A RNA [25]
92670	95162		BERF1 frame, homology with BERF2b and BERF4. A fusion of BLRF3 with BERF1 encodes EBNA-3A, latent cycle gene [23,100,101,109,112,163,171,177,180].
92703	92703	BAM:	Bam H1 L/E
94208	94277		repeat type A
94281	94306		repeat type B
94307	94381		repeat type C
94386	94411		repeat type B
94412	94489		repeat type C
94490	94560		repeat type A
94571	94648		repeat type C
94649	94719		repeat type A
94896	94982		repeat type D
94983	95069		repeat type D
95221	95221	POLYA:	AATAAA
95272	95272 C	POLYA:	AATAAA end of unknown cDNA [116], from BZLF2?
95353	95709		BERF2a reading frame
95710	95787		Intron in EBNA-3B RNA [116]
95788	98244		BERF2b frame, homology with BERF1 and BERF4. BERF2a and BERF2b are spliced together to make EBNA-3B latent protein [116,154], also known as EBNA 4 [3,163]
95819	95819 C	POLYA:	AATAAA
96276	96276 C	POLYA:	AATAAA
97522	97698		3x60bp repeat
98323	98766		BERF3 reading frame
98364	98730		Exon in EBNA-1 RNA [185]
98805	99050		Exon in T4 cDNA [25] 99050 is not the end of the RNA.
98805	101420		BERF4 frame, homology with BERF1 and BERF2b. BERF3 and BERF4 are spliced together to make the EBNA3C [3,155,177] latent protein, also known as EBNA 6 [3,163]

99126 102118	DEL:	Deletion in Raji [95]
100122 100304		10 x "15bp" repeat
100613 100613	BAM:	Bam H1 E/e1
100665 100781		3x39bp repeat
100919 100919	BAM:	Bam H1 e1/e2
101426 101426	BAM:	Bam H1 e2/e3
101947 101947	BAM:	Bam H1 e3/Z
102116 101448 C		BZLF2 reading frame 3x NXT/S. 2.5kb late RNA traverses BZLF2, ends unknown.
102153 102153	TATA:	TATTAAT
102156 102156 C	POLYA:	AATAAA 3' end of 1.0kb and 2.8kb RNAs encoding BZLF1 and BRLF1
102160 102160 C	TATA:	TATTAAT
102341 102126 C		3' terminal exon of 1.0kb and 2.8kb early RNAs
102380 102380 C	TATA:	CATAAAT
102420 102420 C	TATA:	TATATAC
102504 102504 C	POLYA:	AATAAA, apparently not functional
102530 102425 C		Exon of 1.0kb and 2.8kb early RNAs
102581 102652		semi-repetitive sequence, homologous to human c-fos 3' sequence
102918 102918 C		splice acceptor used in RZ fusion gene [133]
103155 102213 C		BZLF1 reading frame, modified from [8]. Has two splices within frame. 2xNXT/S. Immediate early gene which disrupts latency [21,46,47,56,86,114,133,136,166,179,192,194,196,201,216], also called EB1 [35] and ZEBRA [47]. Sequence specific DNA binding protein [31,65,118,125] and transcription factor [67,68,69,70,71,78,113,118, 124,126,148,197].
103194 102655 C		First exon of 1.0kb early RNA encoding BZLF1
103231 103231 C	TATA:	TTTAAA of BZL1 immediate early promoter gives 1.0kb RNA [67,141]
103311 103256 C		Upstream of BZL1, homology to 106243 to 106188
103462 103453 C		TAATGAAATC sequence
103741 103741	BAM:	Bam H1 Z/g
103816 103816	BAM:	Bam H1 g/R
104989 104927 C		BRLF2 poss. small 5' exon
105016 105016	TATA:	TATAAAT before BRRF1, possible promoter for 1.1kb early RNA encoding BRRF1
105182 106111		BRRF1 early reading frame
105183 103369 C		BRLF1 reading frame, immediate early gene, acts as transcription factor [87,89,94,134].
105185 104926 C		exon in RZ fusion RNA [133]
105185 105185 C	ACCEPT:	splice acceptor in 2.8kb early RNA encoding BRLF1 and RZ fusion RNA [21,133]
106110 106110	POLYA:	AATAAA, 3' end of early 1.1kb RNA encoding BRRF1
106181 106126 C		5' leader exon for 2.8kb early RNA encoding BRLF1 and RZ fusion RNA [21,133,181]
106213 106213 C	TATA:	CATAAAA
106243 106243	TATA:	TATAAAA before BRRF2, possible promoter for 1.8kb RNA encoding BRRF2
106243 106188 C		Homology to upstream region of BZL1
106302 107912		BRRF2 reading frame
106385 106385 C	TATA:	GATAAAA
107457 107457	BAM:	Bam H1 R/f
107565 107565	BAM:	Bam H1 f/K
107914 107914	POLYA:	AATAAA, 3' end of 1.8kb RNA encoding BRRF2
107942 107942	ACCEPT:	splice acceptor for EBNA-1 RNA [185]
107950 109872		BKRF1 encodes EBNA-1 protein, latent cycle protein, binds ori-P to permit replication [5,66,99,158,189,193]
108217 108924		EBNA triplet repeat GGA,GCA,GGG.
109809 109866		6.5 x 9bp repeats, encodes gly every 4th residue
109905 109905	TATA:	TATTAAA before BKRF2, possible start for 2.3kb late RNA
109937 109937	POLYA:	AATAAA 3' end of EBNA-1 RNA
109958 110368		BKRF2 reading frame
110275 111117		BKRF3 reading frame, homologous to RF 59 VZV homologous to uracil DNA glycosylase [145]
111107 111784		BKRF4 reading frame, contains complex repetitive sequence
111719 111719	POLYA:	AATAAA : currently unknown which
111787 111787	POLYA:	AATAAA : is 3' end of the 2.3kb late and 1.1kb early RNAs
111830 111830 C	POLYA:	AATAAA
112620 112620	BAM:	Bam H1 K/B
113876 113876	TATA:	TATTTAT before BBRF1
114204 116042		BBRF1 late reading frame, homologous to RF 54 VZV
114259 111833 C		BBLF4 early reading frame, very good homology to RF55 VZV, likely helicase [50]
115843 116781		BBRF2 late reading frame, homologous to RF 53 VZV
116696 116696 C	POLYA:	AATAAA
116785 116785	POLYA:	AATAAA
117386 116784 C		BBLF3 early reading frame, spliced to BBLF2. BBLF3 contains a consensus nucleotide binding site
117515 117386 C		predicted intron in RNA linking BBLF2 and BBLF3
118981 118981	TATA:	TATAAAA BBR1 late promoter before BBRF3
119080 117515 C		BBLF2 early reading frame, spliced to BBLF3
119098 119098	TATA:	TATTTAA BBR3 late promoter before BBRF3
119137 120351		BBRF3 late reading frame
120358 120358	POLYA:	AATAAA
120764 120764 C	POLYA:	AATAAA, 3' end of 0.6kb late, 1.6kb early, 3.0kb early RNAs
120974 120750 C		BBLF1 late reading frame, possibly homologous to RF 49 VZV
121331 121331 C	TATA:	TATTAAA BBL1 late promoter before BBLF1
122313 122313	BAM:	Bam H1 B/G

122341 120932 C		BGLF5 early reading frame encoding alkaline DNase [15,16,17], homologous to RF 48 VZV and alkaline exonuclease of HSV [139,218]
122435 120741		RNA encoding BGLF5 [33]
123692 122328 C		BGLF4 early reading frame, homologous to RF 47 VZV and HSV UL13. Possible protein kinase [184]
124117 124117 C	TATA:	TATAAAA
124219 124219 C	POLYA:	AATAAA
124938 125912		BGRF1 reading frame, homologous to RF 45 VZV and spliced HSV gene [45]. Spliced to BDRF1. Northern blots in BGRF1 detect 2.7, 2.6, 2.1kb late and 1.9kb early RNAs. 2.6, 2.1kb RNAs very weak.
124939 123944 C		BGLF3 reading frame
125113 125113 C	TATA:	TATAAAT before BGLF3
125484 125484 C	POLYA:	AATAAA, 3' end of 1.6kb late, 1.8kb late, 3.0kb late and 3.7kb early RNAs
125873 125873		Predicted donor in RNA coding BGRF1 and BDRF1
126873 125866 C		BGLF2 late reading frame, poor homology to RF 44 VZV
126929 126929 C	TATA:	TATTAAA late promoter before BGLF2, gives 1.6kb late RNA
127237 127237 C	TATA:	TATAAAA, potential promoter for 1.8kb late RNA
128029 128029	POLYA:	AATAAA
128374 126854 C		BGLF1 late reading frame
128432 128432 C	TATA:	TATTTAA before BGLF1, potential promoter for 3.0kb late RNA
128848 128848	BAM:	Bam H1 G/D
129021 128347 C		BDLF4 early reading frame
129054 129054 C	TATA:	TATTTGC before BDLF4, potential promoter for 3.7kb early RNA
129188 130348		BDRF1 reading frame, homologous to RF 42 VZV and spliced gene in HSV [45]. Spliced from BGRF1. Northern blots in BDRF1 detect 2.7,2.6 kb late and 1.9kb early RNAs. Possibly also 1.8kb early RNA
129214 129214		Predicted acceptor in RNA encoding BGRF1 and BDRF1
129377 129377 C	TATA:	TATAAAG
130347 130347	POLYA:	ATTAAA
130359 130359 C	POLYA:	AATAAA, 3' end of 0.9kb late RNA, 2.3kb late RNA and 3.2kb late RNA
131066 130365 C		BDLF3 late reading frame 9xNXT/S, possible relation to HSV1 gC [11]
131104 131104 C	TATA:	TATAAAA late promoter before BDLF3, gives 0.9kb late RNA
132389 131130 C		BDLF2 late reading frame
132476 132476 C	TATA:	TATTTAA before BDLF2, likely promoter for 2.3kb late RNA
133305 132403 C		BDLF1 late reading frame, poor homology to RF 41 VZV
133312 133312 C	POLYA:	AATAAA, 3' end of 4.5kb late RNA
133352 133352 C	TATA:	TATTAAA before BDLF1
133386 133386 C	TATA:	TATATAA
136868 136868	BAM:	Bam H1 D/c
137466 133324 C		BcLF1 late reading frame, homologous to RF 40 VZV and major capsid protein of HSV [54,137,140]
137710 137710 C	TATA:	TATTAAA EHL1 promoter before BcLF1, gives 4.5kb late RNA
137857 137857	TATA:	CATAAAC
137862 139715		BcRF1 reading frame
138019 138019	BAM:	Bam H1 c/b
139352 139352	BAM:	Bam H1 b/T
139642 140916		BTRF1 reading frame. Northern blots detect 0.95 late and 3.8kb early RNA
140902 140902 C	POLYA:	AATAAA, 3' end of 2.5kb late RNA
140970 140970	POLYA:	AATAAA
141286 141286 C	POLYA:	AATAAA
142589 142589	TATA:	GATAAAA
142740 142740	BAM:	Bam H1 T/X
143036 140919 C		BXLF2 late reading frame, encodes gp85. Homologous to RF 37 VZV and glycoprotein H of HSV (gpIII of VZV) [49,97,138,146]
143310 143310 C	TATA:	TATAAGA late promoter before BXLF2, gives 2.5kb late RNA
144860 145603		BXRF1 late reading frame, homologous to RF 35 VZV. Basic (core?) protein.
144861 143041 C		BXLF1 early reading frame, thymidine kinase [129,130]. Weak homology to RF 36 VZV and HSV thymidine kinase. 4.0kb early RNA presumably encodes the TK. Also a 2.2kb late RNA here.
144862 144862	BAM:	Bam H1 X/V
145135 145135 C	TATA:	TATAACA before BXLF1
145302 145302	TATA:	TATTTAA before BVRF1, potential promoter for 1.9kb early RNA
145416 147125		BVRF1 early reading frame, homologous to RF 34 VZV
146273 146273 C	TATA:	CATAAAA
147170 147170	POLYA:	AATAAA, 3' end of 2.4kb late and 1.9kb early RNAs
147721 147721	TATA:	TATTTAT before BVRF2, potential promoter for 2.1kb early RNA
147927 149741		BVRF2 reading frame, N-terminus homologous to RF 33 VZV
148007 148007	BAM:	Bam H1 V/d
148620 148620	TATA:	TATTTAA late promoter before BdRF1, gives 1.2kb late RNA
148707 149741		BdRF1 reading frame; this is the C terminus of BVRF2
149115 149115	BAM:	Bam H1 d/I
149727 149727	POLYA:	AATAAA, 3' end of 2.0kb, 1.2kb late and 1.6kb early RNAs
149758 149758 C	POLYA:	AATAAA, 3' end of 1.0kb late, 1.5kb late and 1.8kb late RNAs
150525 149782 C		BILF2 late reading frame 11xNXT/S
150571 150571 C	TATA:	TATTTAG before BILF2. Potential promoter for 1.0kb late RNA.

151236 151618		repetitive sequence 3X
151767 151767	POLYA:	AATAAA
151780 151780 C	TATA:	CATAAAA
152012 152013	DEL:	B95-8 deletion with respect to other EBV strains. Raji EBV sequence spanning B95-8 deletion given in [149]
152230 152230	TATA:	CATAAAA
153099 152164 C		BILF1 reading frame, membrane protein?, 3xNXS/T [18]
153259 153259	POLYA:	AATAAA
153637 153637	HPN:	22bp 2-fold symmetry
154747 154747	BAM:	Bam H1 I/A
155360 156359		ECRF4 reading frame [13], partly within 18.8 cDNA [102]
156707 156707 C	POLYA:	AATAAA; 3' end of 2.5kb late (gB) RNA and 1.8kb late RNA
156746 153702 C		BALF5 DNA polymerase reading frame[8], homologous to many DNA polymerases, CMV HFLF2 and RF 28 VZV.
156874 153215 C		3.7kb early RNA encoding DNA polymerase [73,122].
158204 158204	TATA:	TATAAAA
159322 156752 C		BALF4 late reading frame 9xNXT/S homologous to HSV1 glycoprotein B, CMV HFLF1 and RF 31 VZV (gpII) [11,12,62,84,152,153]
159370 159370 C	TATA:	TATTTAA late promoter before BALF4, gives 2.5kb late RNA
159579 160991		BARF0 reading frame
160966 160966	POLYA:	AATAAA, BARF0 RNA family are polyadenylated at 160986 [79,80,102]
161013 161013 C	POLYA:	AATAAA, presumed end of 3.9kb early RNA
161678 159312 C		BALF3 reading frame
163978 166635	DEL:	deletion in Raji [95]
164770 161387 C		BALF2 early reading frame, homologous to RF 29 VZV and major DNA binding protein HSV [217]. 3.9kb RNA
164814 164814 C	TATA:	CATTTAA before BALF2, presumed promoter for 3.9kb early RNA
164851 164851 C	POLYA:	AATAAA
165442 165442	TATA:	GATAAAA
165466 165466	TATA:	TATAAGA early promoter before BARF1, gives 0.8kb early RNA
165504 166166		BARF1 reading frame
165517 164858 C		BALF1 early reading frame, 0.7kb early RNA
165713 165713 C	TATA:	TATAAAG before BALF1
166165 166165	POLYA:	AATAAA 3' end of 0.8kb early RNA. Also 1kb late RNA in this region.
166469 166475	TATA:	TTATTTT promoter for terminal protein 1 (TP1)
166498 166916		Exon 1 of TP1 RNA [121,174]. TP1 also called LMP-2A [174]
166561 166563		Likely initiator met of terminal protein 1
166614 166614	BAM:	Bam H1 A/Nhet
166946 166946 C	POLYA:	AATAAA) 3' end of 0.8kb early, 2.5kb
166950 166950 C	POLYA:	AATAAA) late and 2.5kb latent RNAs
167303 167001 C		BNLF2b reading frame
167320 167320	TATA:	CATAAAA
167486 167307 C		BNLF2a reading frame
167525 167525 C	TATA:	TATAAAA early promoter before BNLF2a,b. Gives 0.8kb RNA
168399 168574		5 x "33bp" repeats
168965 168163 C		BNLF1 coding part of exon c of latent membrane protein
169128 169042 C		BNLF1 exon b of latent membrane protein mRNA
169201 169201 C	TATA:	TATTACA ED-L1A late promoter, gives 2.5kb late RNA LMP also called LMP1. N terminal half of LMP is sufficient for transforming function in 3T3 cells. LMP prevents epithelial cell differentiation. [9,10,55,91,95,98,127,128,135,136,143,169,170,198,204,206]
169474 169207 C		BNLF1 exon a of latent membrane protein mRNA
169546 169546 C	TATA:	TACATAAGC EDL1 promoter before BNLF1 gives 2.5kb LMP RNA, activated by EBNA-2 [75,200]
169740 169906		5' exon of TP2 RNA, promoter activated by EBNA-2 [220] TP2 also called LMP-2B [174]
170094 170631		terminal repeat 1 538bp [14,95,159]
170632 171154		terminal repeat 2 523bp
171155 171692		terminal repeat 3 538bp
171693 172231		terminal repeat 4 538bp

1. Abbot SD, Rowe M, Cadwallader K, Ricksten A, Gordon J, Wang F, Rymo L, and Rickinson AB (1990) J. Virol. 64: 2126-2134.
2. Allan GJ and Rowe DT (1989) Virology 173: 489-498.
3. Allday MJ, Crawford DH and Griffin BE (1988) Nucleic Acids Res. 16: 4353-4369.
4. Ambinder RF, Shah WA, Rawlins DR, Hayward GS and Hayward SD (1990). J. Virol. 64: 2369-2379.
5. Ambinder RF, Mullen M, Chang YN, Hayward GS and Hayward SD (1991) J. Virol. 65: 1466-1478.
6. Arrand JR, Young LS and Tugwood JD (1989) J. Virol. 63: 983-986.
7. Austin RJ, Flemington E, Yandava CN, Strominger JL and Speck SH (1988) Proc. Natl. Acad. Sci. USA 85: 3678-3683.
8. Baer R, Bankier AT, Biggin MD, Deininger PC, Farrell PJ, Gibson TJ, Hatfull G, Hudson GS, Satchwell SC, Seguin C, Tuffnell PS and Barrell BG (1984) Nature 310: 207-211.
9. Baichwal VR and Sugden B (1987) J. Virol. 61: 866-875.
10. Baichwal VR and Sugden B (1988) Oncogene 2: 461-469.
11. Balachandran N, Oba DE and Hutt-Fletcher LM (1987) J. Virol. 61: 1125-1135.
12. Balachandran N, Pittari J and Hutt-Fletcher LM (1986) J. Virol. 60: 369-75.
13. Bankier AT, Deininger PL, Farrell PJ and Barrell BG (1983) Mol. Biol. Med. 1: 21-45.
14. Bankier AT, Deininger PL, Satchwell SC, Baer R, Farrell PJ and Barrell BG (1983) Mol. Biol. Med. 1: 425-445.
15. Baylis SA, Purifoy DJM and Littler E (1989) Nucleic Acids Res. 27: 7609-7622.
16. Baylis SA, Purifoy DJM and Littler E (1991) Virology 181: 390-394.
17. Baylis SA, Young LS, Purifoy DJM and Littler E (1991) J. Gen. Virol. 72: 399-404.
18. Becker Y, Tabor E and Asher Y (1988) Leukemia 2: 178-192.
19. Beisel C, Tanner J, Matsuo T, Thorley-Lawson D, Kedsay F and Kieff E (1985) J. Virol. 54: 665-674.
20. Bhat RA and Thimmappaya B (1985) J. Virol. 56: 750-756.
21. Biggin M, Bodescot M, Perricaudet M and Farrell P (1987) J. Virol. 61: 3120-3132.
22. Biggin M, Farrell PJ and Barrell BG (1984) EMBO J. 3: 1083-1090.
23. Bodescot M, Brison O and Perricaudet M (1986) Nucleic Acids Res. 14: 2611-2620.
24. Bodescot M, Chambraud B, Farrell P and Perricaudet M (1984) EMBO J. 3: 1913-1917.
25. Bodescot M and Perricaudet M (1986) Nucleic Acids Res. 17: 7103-7114.
26. Bodescot M and Perricaudet M (1987) Nucleic Acids Res. 15: 5887-5888.
27. Bodescot M, Perricaudet M and Farrell PJ (1987) J. Virol. 61: 3424-3430.
28. Buisson M, Manet E, Trescol-Biemont M-C, Gruffat H, Durand B and Sergeant A. (1989) J. Virol. 63: 5276-5284.
29. Cashman NR and Pouliot Y (1990) Nature 343: 319.
30. Cameron KR, Stamminger T, Craxton M, Bodemer W, Honess RW and Fleckenstein B (1987) J. Virol. 61: 2063-2070.
31. Chang Y-N, Dong DL-Y, Hayward GS and Hayward SD (1990) J. Virol. 64: 3358-3369.
32. Chavrier P, Gruffat J, Chevallier-Greco A, Buisson M and Sergeant A (1989) J. Virol. 63: 607-614.
33. Chen MR, Hsu TY, Chen JY and Yang CS (1990) J. Virol. Meth. 29: 127-141.
34. Chevallier-Greco A, Gruffat H, Manet E, Calender A and Sergeant A (1989) J. Virol. 63: 615-623.
35. Chevallier-Greco A, Manet E, Chavrier P, Mosner C, Daillie J and Sergeant A (1986) EMBO J. 5: 3243-3250.
36. Chittenden T, Lupton S and Levine AJ (1989) J. Virol. 63: 3016-3025.
37. Cho M-S, Jeang KT and Hayward SD (1985) J. Virol. 56: 852-859.
38. Cho M-S, Milman G and Hayward SD (1985) J. Virol. 56: 860-866.
39. Clarke PA, Sharp NA and Clemens MJ (1991) Eur. J. Biochem. 193: 635-642.
40. Cleary ML, Smith SD and Sklar J (1986) Cell 47: 19-28.
41. Cohen JI, Wang F, Mannick J and Kieff E (1989) Proc. Natl. Acad. Sci. USA 86: 9558-9562.
42. Cohen JI, Wang F and Kieff E (1991) J. Virol. 65: 2545-2554.
43. Cohen JI and Kieff E (1991) J. Virol. 65: 5880-5885.
44. Cordier M, Calender A, Billaud M, Zimber U, Rousselet G, Pavlish O, Banchereau J and Tursz T (1990) J. Virol. 64: 1002-1013.
45. Costa RH, Draper KG, Kelly TJ and Wagner EK (1985) J. Virol. 54: 317-328.
46. Countryman J, Jenson H, Seibl R, Wolf H and Miller G (1987) J. Virol. 61: 3672-3679.
47. Countryman J and Miller G (1985) Proc. Natl. Acad. Sci. USA 82: 4085-4089.
48. Cox MA, Leahy J and Hardwick JM (1990) J. Virol. 64: 313-321.
49. Cranage MP, Smith GL, Bell SE, Hart H, Brown C, Bankier AT, Tomlinson P, Barrell BG and Minson TC (1988) J. Virol. 62: 1416-1422.
50. Crute JJ, Mocarski ES and Lehman IR (1988) Nucleic Acids Res. 16: 6585-6596.
51. Dambaugh T, Hennessy K, Chamnaukit L and Kieff E (1984) Proc. Natl. Acad. Sci. USA 81: 7632-7636.
52. Dambaugh T, Wang F, Hennessy K, Rickinson A and Kieff E (1986) J. Virol. 59: 453-462.
53. David EM and Morgan AJ (1988) J. Immunol. Meth. 108: 231-237.
54. Davison AJ and Taylor P (1987) J. Gen. Virol. 68: 1067-1081.
55. Dawson CW, Rickinson AB and Young LS (1990) Nature 344: 777-780.
56. Diabata M, Homphreys RE and Sairenji T (1992) Virology 188: 916-920.
57. Dillner J, Kallin B, Alexander H, Ernberg I, Uno M, Ono Y, Klein G and Lerner RA (1986) Proc. Natl. Acad. Sci. USA 83: 6641-6645.
58. Dillner J, Kallin B, Klein B, Jornvall H, Alexander H and Lerner R (1985) EMBO J. 4: 1813-1818.
59. Dillner J, Sternas L, Kallin B, Alexander H, Ehlin-Henriksson B, Jornvall H, Klein G and Lerner R (1984) Proc. Natl. Acad. Sci. USA 81: 4652-4656.
60. Dillner J, Wendel-Hansen V, Kjellstrom G, Kallin B and Rosen A (1988) Int. J. Cancer 42: 721-728.
61. Dolken G, Hecht T, Rockel D and Hirsch FW (1987) Virology 157: 460-472.
62. Emini EA, Luka J, Armstrong ME, Keller PM, Ellis RW and Pearson GR (1987) Virology 157: 552-556.
63. Fahraeus R, Jansson A, Rickstein A, Sjoblom A and Rymo L (1990). Proc. Natl. Acad. Sci. USA 87: 7390-7394.
64. Farrell PJ (1989) The Epstein-Barr Virus Genome. In G. Klein (ed): Advances in Viral Oncology. New York: Raven Press, pp. 103-132.

65. Farrell PJ, Rowe DT, Rooney CM and Kouzarides T (1989) EMBO J. 8: 127-133.
66. Fischer D, Robert M, Shedd D, Summers W, Robinson J, Wolak J, Stefano J and Miller G (1984) Proc. Natl. Acad. Sci. USA 81: 43-47.
67. Flemington E and Speck SH (1990) J. Virol. 64: 1227-1232.
68. Flemington E and Speck SH (1990) J. Virol, 64: 4549-4552.
69. Flemington E and Speck SH (1990) Proc. Natl. Acad. Sci. USA 87: 9459-9463.
70. Flemington EK, Goldfield AE and Speck SH (1991) J. Virol. 65: 7073-7077.
71. Flemington EK, Borras AM, Lytle JP and Speck SH (1992) J. Virol. 66: 922-929.
72. Freese UK, Laux G, Hudenwentz J, Schwarz E and Bornkamm G (1983) J. Virol. 48: 731-743.
73. Furnari FB, Adams MD and Pagano JS (1992) J. Virol 66: 2837-2845.
74. Gahn TA and Schildkraut CL (1989) Cell 58: 527-535.
75. Ghosh D and Kieff E (1990) J. Virol. 64: 1855-1858.
76. Gibson T, Stockwell P, Ginsburg M and Barrell B (1984) Nucleic Acids Res. 12: 5087-5099.
77. Gibson TJ, Barrell BG and Farrell PJ (1986) Virology 152: 136-148.
78. Giot JF, Mikaelian I, Buisson M, Manet E, Joab I, Nicholas J-C and Sergeant A (1991) Nucleic Acids Res. 19: 1251-1258.
79. Gilligan K, Sato H, Rajadurai P, Busson P, Young L, Rickinson A, Tursz T and Raab-Traub N (1990) J. Virol 64: 4948-4956.
80. Gilligan KJ, Rajadurai P, Lin JC, Busson P, Abdelhamid M, Prasad U, Tursz T and Raab-Traub N (1991) J. Virol. 65: 6252-6259.
81. Glickman JN, Howe JG and Steitz JA (1988) J. Virol. 62: 902-911.
82. Goldschmidts W, Luka J and Pearson GR (1987) Virology 157: 220-227.
83. Gompels UA, Craxton MA and Honess RW (1988) J. Virol. 62: 757-767.
84. Gong M and Kieff E (1990) J. Virol. 64: 1507-1516.
85. Grasser FA, Haiss P, Gottel S and Mueller-Lantzsch N (1991) J. Virol. 65: 3779-3788.
86. Grogan E, Jenson H, Countryman J, Heston L, Gradoville L and Miller G (1987) Proc. Natl. Acad. Sci. USA 84: 1332-1337.
87. Gruffat H, Manet E, Rigolet A and Sergeant A (1990) Nucl. Acids. Res. 18: 6835-6843.
88. Gruffat H, Moreno N and Sergeant A (1990) J. Virol. 64: 2810-2818.
89. Gruffat H, Duran N, Buisson M, Wild F, Buckland R and Sergeant A (1992) J. Virol 66: 46-52.
90. Hammerschmidt W and Sugden B (1988) Cell 55: 427-433.
91. Hammerschmidt W, Sugden B and Baichwal VR (1989) J. Virol. 63: 2469-2475.
92. Hammerschmidt W and Sugden B (1989) Nature 340: 393-397.
93. Harada S and Yanagi K (1991) Oncogene 6: 461-462.
94. Hardwick JM, Lieberman PM, Hayward SD (1988) J. Virol. 62: 2274-2284.
95. Hatfull G, Bankier T, Barrell BG and Farrell PJ (1988) Virology 164: 334-341.
96. Hearing J, Mulhaupt Y and S Harper (1992) J. Microsc. 66: 694-722.
97. Heineman T, Gong M, Sample J and Kieff E (1988) J. Virol. 62: 1101-1107.
98. Hennessy K, Fennewald S, Hummel M, Cole T and Kieff E (1984) Proc. Natl. Acad. Sci. USA 81: 7207-7211.
99. Hennessy K, Heller M, van Santen V and Kieff E (1983) Science 220: 1396-1398.
100. Hennessy K and Kieff E (1985) Science 227: 1238-1240.
101. Hennessy K, Wang F, Woodland Bushman E and Kieff E (1986) Proc. Natl. Acad. Sci. USA 83: 5693-5697.
102. Hitt MM, Allday MJ, Hara T, Karran L, Jones P, Busson MD, Tursz T, Ernberg I and Griffin BE (1989) EMBO J. 8: 2639-2651.
103. Holley-Guthrie EA, Quinlivan EB, Mar E-C and Kenney S (1990) J.Virol. 64: 3753-3759.
104. Howe JG and Shu M-D (1989) Cell 57: 825-834.
105. Hudson GS, Bankier AT, Satchwell SC and Barrell BG (1985) Virology 147: 81-98.
106. Huen DS, Grand RJ and Young LS (1988) Oncogene 3: 729.
107. Hummel M, Thorley-Lawson D and Kieff E (1984) J. Virol. 49: 413-417.
108. Jeang K-T and Hayward SD (1983) J. Virol. 48: 135-148.
109. Joab I, Rowe DT, Bodescot M, Nicholas J-C, Farrell PJ and Perricaudet M (1987) J. Virol. 61: 3340-3344.
110. Jones M, Foster L, Sheedy T and Griffin BE (1984) EMBO J. 3: 813-821.
111. Jones CH, Hayward SD and Rawlins DR (1989) J. Virol. 63: 101-110.
112. Kallin B, Dillner J, Ernberg I, Ehlin-Henriksson B, Rosen A, Henle W, Henle G and Klein HG (1986) Proc. Natl. Acad. Sci. 83: 1499-1503.
113. Katz DA, Baumann RP, Sun R, Kolman JL, Taylor N and Miller G (1992) Proc. Natl. Acad. Sci USA 89: 378-382.
114. Kenney S, Kamine J, Holley-Gutherie E, Lin J-G, Mar E-C and Pagano J (1989) J. Virol. 63: 1729-1736.
115. Kenney S, Holley-Guthrie E, Mar E-C and Smith M. (1989) J. Virol. 63: 3878-3883.
116. Kerdiles B, Walls D, Triki H, Perricaudet M and Joab I (1990) J. Virol. 64: 1812-1816.
117. Knutson J (1990). J. Virol. 64: 2530-2536.
118. Kouzarides T, Packham G, Cook A and Farrell PJ (1991) Oncogene 6: 195-204.
119. Kouzarides T, Bankier AT, Satchwell SC, Weston K, Tomlinson P and Barrell BG (1987) Virology 157: 397-413.
120. Kupfer SR and Summers WC (1990) J. Virol., 64: 1984-1990.
121. Laux G, Perricaudet M and Farrell PJ (1988) EMBO J. 7: 769-775.
122. Li J-S, Zhou BS, Dutschman GE, Grill SP, Tan R-S and Cheng Y-C (1987) J. Virol. 61: 2947-2949
123. Lieberman PM, O'Hare P, Hayward GS and Hayward SD (1986) J. Virol. 60: 140-148.
124. Lieberman PM and Berk AJ (1990) J. Virol. 64: 2560-2568.
125. Lieberman PM, Hardwick JM, Sample J, Hayward GS and Hayward SD (1990) J. Virol. 64: 1143-1155.
126. Lieberman PM and Berk AJ (1991) Genes & Dev. 5: 2441-2454.
127. Liebowitz D, Kopan R, Fuchs E, Sample J and Kieff E (1987) Mol. Cell. Biol. 7: 2299-2308.
128. Liebowitz D, Wang D and Kieff E (1986) J. Virol. 58: 233-237.
129. Littler E and Arrand JR 91988) J. Virol. 62: 3892-3895.
130. Littler E, Zeuthen J, McBride A, Sorensen E, Powell KL, Walsh-Arrand JE and Arrand JR (1986) EMBO J. 5: 1959-1966.

131. Lupton S and Levine AJ (1985) Mol. Cell. Biol. 5: 2533-2542.
132. Malefyt RD, Fiorentino DR, Dang MN, Vieira P, Devries J, Spits H, Mosmann TR and Moore KW (1990) Science 250: 830-831.
133. Manet E, Gruffat H, Trescol-Biemont MC, Moreno N, Chambard P, Giot JF and Sergeant A (1989) EMBO J. 8: 1819-1826.
134. Manet E, Rigolet A, Gruffat H, Giot J-F and Sergeant A (1991) Nucleic Acids Res 19: 2661-2667.
135. Mann KP and Thorley-Lawson D (1987) J. Virol. 61: 2100-2108.
136. Marschall M, Leser U, Seibl R and Wolf H (1989) J. Virol. 63: 938-942.
137. McGeoch DJ, Dalrymple MA, Davison AJ, Dolan A, Frame MC, McNab D, Perry LJ, Scott JE and Taylor P (1988). J. Gen. Virol. 69: 1531-1574.
138. McGeoch DJ and Davison AJ (1986) Nucleic Acids Res. 14: 4281-4292.
139. McGeoch DJ, Dolan A and Frame MC (1986) Nucleic Acids Res. 14: 3435-3448.
140. Middeldorp JM and Meloen RH (1988) J. Virol. Meth. 21: 147-153.
141. Montalvo EA, Shi Y, Shenk TE and Levine AJ (1991) J. Virol. 65: 3647-3655.
142. Moore KW, Vieira P, Fiorentino DR, Trounstine ML, Khan TA and Mosmann TR (1990) Science 248: 1230-1233.
143. Moorthy R and Thorley-Lawson D (1990) J. Virol. 64: 829-837.
144. Mueller-Lantsch N, Lenoir GM, Sauter M, Takaki K, Bechet JM, Kuklik-Roos C, Wunderlich D and Bornkamm GW (1985) EMBO J. 4: 1805-1811.
145. Mullaney J, Moss HWM and McGeoch DJ (1989) J. Gen. Virol. 70: 449-454.
146. Oba DE and Hutt-Fletcher LM (1988) J. Virol. 62: 1108-1114.
147. Oguro MO, Shimizu N, Ono Y and Takada K (1987) J. Virol. 61: 3310-3313.
148. Packham G, Economou A, Rooney CM, Rowe DT and Farrell PJ (1990) J. Virol. 64: 2110-2116.
149. Parker BD, Bankier A, Satchwell SC, Barrell B and Farrell PJ (1990) Virology 179: 339-346.
150. Pearson G, Vroman B, Chase B, Sculley T, Hummel M and Kieff E (1983) J. Virol. 47: 193-201.
151. Pearson GR, Luka J, Petti L, Sample J, Birkenbach M, Braun D and Kieff E (1987) Virology 160: 151-162.
152. Pellett PE, Biggin MD, Barrell BG and Roizman B (1985) J. Virol. 56: 807-813.
153. Pellett PE, Jenkins JF, Ackermann M, Sarmiento M and Roizman B (1986) J. Virol. 60: 1134-1140.
154. Petti L and Kieff E (1988) J. Virol. 62: 2173-2178.
155. Petti L, Sample J, Wang F and Kieff E (1988) J. Virol. 62: 1330-1338.
156. Pfitzner AJ, Strominger JL and Speck SH (1987) J. Virol. 61: 2943-2946.
157. Pfitzner AJ, Tsai EC, Strominger JL and Speck SH (1987) J. Virol. 61: 2902-2909.
158. Polvino-Bodnar M and Schaffer PA (1992) Virology 187: 591-603.
159. Raab-Traub N and Flynn K (1986) Cell 47: 883-889.
160. Rawlins DR, Milman G, Hayward SD and Hayward GS (1985) Cell 42: 859-868.
161. Reisman D and Sugden B (1986) Mol. Cell. Biol. 6: 3838-3846.
162. Reisman D, Yates J and Sugden B (1985) Mol. Cell. Biol. 5: 1822-1832.
163. Ricksten , Kallin B, Alexander H, Dillner J, Fahraeus R, Klein G, Lerner R and Rymo L (1988) Proc. Natl. Acad. Sci. USA 85: 995-1000.
164. Ricksten A, Olsson A, Andersson T and Rymo L (1988) Nucleic Acids Res. 16: 8391-8411.
165. Ricksten A, Svensonn C, Welinder C and Rymo L (1987) J. Gen. Virol. 68: 2407-2419.
166. Rooney CM, Rowe DT, Ragot T and Farrell PJ (1989) J. Virol. 63: 3109-3116.
167. Rooney CM, Brimmell M, Buschle M, Allan G, Farrell PJ and Kolman JL (1992) J. Virol. 66: 496-523.
168. Rowe D, Farrell PJ and Miller G (1987) Virology 156: 153-162.
169. Rowe DT, Rowe M, Evan GI, Wallace LE, Farrell PJ and Rickinson AB (1986) EMBO J. 5: 2599-2607.
170. Rowe M, Rowe DT, Gregory CD, Young LS, Farrell PJ, Rupani H and Rickinson AB (1987) EMBO J. 6: 2743-2753.
171. Rowe M, Young LS, Cadwallader K, Petti L, Kieff E and Rickinson AB (1989) J. Virol. 63: 1031-1039.
172. Sample J, Hummel M, Braun D, Birkenbach M and Kieff E (1986) Proc. Natl. Acad. Sci. USA 83: 5096-5100.
173. Sample J, Lancz G and Nonoyama M (1986) J. Virol. 57: 145-154.
174. Sample J, Liebowitz D and Kieff E (1989) J. Virol. 63: 933-937.
175. Sample J, Brooks L, Sample C, Young L, Rowe M, Gregory C, Rickinson A, Kieff E (1991) Proc. Natl. Acad. Sci. USA 88: 6343-6347,
176. Sauter M, Boos H, Hitsch F and Mueller-Lantzsch N (1988) Virology 166: 586-591.
177. Sawada K, Yamamoto M, Tabata T, Smith M, Tanaka A and Nonoyama M (1989) Virology 168: 22-31.
178. Schaefer BC, Woisetschlaeger M, Strominger JL, Speck SH (1991) Proc. Natl. Acad. Sci. USA 88: 6550-6554.
179. Seibl R, Motz M and Wolf H (1986) J. Virol. 60: 902-909.
180. Shimizu N, Yamaki M, Sakuma S, Ono Y and Takada K (1988) Int. J. Cancer 41: 744-752.
181. Sinclair AJ, Brimmell M, Shanahan F and Farrell PJ (1991) J. Virol 65: 2237-2244.
182. Sinclair AJ, Brimmell M and Farrell PJ (1992) J. Virol. 66: 70-77.
183. Smith PR, Griffin BE (1992) J. Virol. 66: 706-714.
184. Smith RF and Smith TF (1989) J. Virol. 63: 450-455.
185. Speck S and Strominger J (1985) Proc. Natl. Acad. Sci. USA 82: 8305-8309.
186. Speck SH, Pfitzner A and Strominger JL (1986) Proc. Natl. Acad. Sci. USA 83: 9298-9302.
187. Sugden B and Warren N (1988) Mol. Biol. Med. 5: 85-95.
188. Sugden B and Warren N (1989) J. Virol. 63: 2644-2649.
189. Summers W, Grogan E, Shedd D, Robert M, Liu C-R and Miller G (1982) Proc. Natl. Acad. Sci. USA 79: 5688-5692.
190. Sung NS, Kenney S, Gutsch D and Pagano JS (1991) J. Virol. 65: 2164-2169.
191. Swaminathan S, Tomkinson B and Kieff E (1991) Proc. Natl. Acad.Sci. USA 88: 1546-1550.
192. Takada K and Ono Y (1989) J. Virol. 63: 445-449.
193. Takada K, Shimizu N, Oguro M and Ono Y (1986) J. Virol. 60: 324-330.
194. Takada K, Shimizu N, Sakuma S and Ono Y (1986) J. Virol. 57: 1016-1022.
195. Tanner J, Whang Y, Sample J, Sears A and Kieff E (1988) J. Virol. 62: 4452-4464.

196. Taylor N, Countryman J, Rooney C, Katz D and Miller G (1989) J. Virol 63: 1721-1728.
197. Taylor N, Flemington E, Kolman JL, Baumann RP, Speck SH and Miller G. (1991) J. Virol. 65: 4033-4041.
198. Thorley-Lawson DA and Israelsohn ES (1987) Proc. Natl. Acad. Sci. USA 84: 5384-5389.
199. Tosoni-Pittoni E, Joab I, Nicholas JC and Perricaudet M (1989) Biochem. Biophys, Res. Commun. 158: 676-685.
200. Tsang S-F, Wang F, Izumi KM and Kieff E (1991) J. Virol. 65: 6765-6771.
201. Urier G, Buisson M, Chambard P and Sergeant A (1989) EMBO J. 8: 1447-1453.
202. Vieira P, Dewaalmalefyt R, Dang MN, Johnson KE, Kastelein R, Fiorentino DR, Devries JE and Roncarolo MG (1991) Proc. Natl. Acad. Sci. USA 88: 1172-1176.
203. Walls D and Gannon F (1988) EMBO J. 7: 1191-1197.
204. Wang D, Liebowitz D and Kieff E (1985) Cell 43: 831-840.
205. Wang F, Petti L, Braun D, Seung S and Kieff E (1987) J. Virol. 61: 945-954.
206. Wang F, Gregory C, Sample C, Rowe M, Liebowitz D, Murray R, Rickinson A and Kieff E (1990) J. Virol. 64: 2309-2318.
207. Wang F, Tsang SF, Kurilla MG, Cohen JI and Kieff E (1990) J. Virol, 64: 3407-3416.
208. Wang F, Kikutani H, Tsang SF, Kishimoto T and Kieff E (1991) J. Virol. 65: 4101-4106.
209. Woisetschlaeger M, Jin XW, Yandava CN, Furmanski LA, Strominger JL and Speck SH (1991) Proc. Natl. Acad. Sci. USA, 88: 3942-3946.
210. Whang Y, Silberland M, Morgan A, Munshi S, Lenny AB, Ellis RW and Kieff E (1987) Virology 51: 1796-1807.
211. Wong K-M and Levine AJ (1989) Virology 168: 101-112.
212. Wong KM and Levine AJ (1986) J. Virol. 60: 149-156.
213. Wysokenski DA and Yates JL (1989) J. Virol. 63: 2657-2666.
214. Yates J, Warren N, Reisman D and Sugden B (1984) Proc. Natl. Acad. Sci. USA 81: 3806-3810.
215. Yates JL, Warren N and Sugden B (1985) Nature 313: 812-815
216. Young LS, Lau R, Rowe M, Niedobitek G, Packham G, Shanahan F, Rowe DT, Greenspan D, Rickinson AB and Farrell PJ (1991) J. Virol. 65: 2868-2874.
217. Zhang CX, Decaussin G, Daillie J and Ooka T. (1988) J. Virol. 62: 1862-1869.
218. Zhang CX, Decaussin G, de Turenne Tessier M, Daillie J and Ooka T (1987) Nucleic Acids Res. 15: 2707-2719.
219. Zimber U, Aldinger HK, Lenoir GM, Vuillaume M, Knebel-Doeberitz LG, Desgranges C, Wittmann P, Freese UK, Schneider U and Bornkamm GW (1986) Virology 154: 56-66.
220. Zimber-strobl U, Suentzenich KO, Laux G, Eick D, Cordier M, Calender A, Billaud M, Lenoir GM and Bornkamm GW (1991) J. Virol. 65: 415-423.