the tasks we studied was primarily by switching attention between extreme states, but some sharing of attention also occurred.

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2. M. I. Posner, M. J. Nissen, W. C. Ogden, in *Modes of Perception,* H. J. Pick, Ed. (Erlbaum, Hillsdale, N.J., 1977); H. Egeth, in *The Psychology of Learning and Motivation,* G. H. Bower, Ed. (Academic Press, New York, 1977), vol. 11.
3. G. Sperling, J. Budiansky, J. G. Spivak, and M. C. Johnson [*Science* **174**, 307 (1971)] demonstrated parallel search for ten possible numeral targets. Thus, attention could not determine the sequence of mental search operations but only the relative effort devoted to each of the simultaneous search processes. According to R. M. Shiffrin and W. Schneider [*Psychol. Rev.* **84**, 127 (1977)], this kind of processing is "automatic" and not entirely—if at all—under voluntary control.
4. Several serious attempts to find evidence of an effect of selective attention on detection in a brief exposure have failed: J. J. Mertens, *J. Opt. Soc. Am.* **46**, 1069 (1956); H. Schuckman, *Am. J. Optom. Arch. Am. Acad. Optom.* **40**, 284 (1963). C. I. Howarth and G. Lowe [*Nature (London)* **212**, 324 (1966)] actually noted a small deleterious effect of signal uncertainty upon detection, although they ignored it in their conclusion.
   In instances where an effect of an attention instruction is observed, it has been attributed either to a change in effective noise level, as in tasks where stimulus signal-to-noise is the limiting factor [T. E. Cohn and D. J. Lasley, *J. Opt. Soc. Am.* **64**, 1715 (1974)], or to the way that partial information, which the subject obtains from the exposure, is weighted in his final decision [R. A. Kinchla, *Percep. Psychophys.* **22**, 19 (1977)]. In these cases, the subject is asserted to obtain the same information from the stimulus; he merely uses it differently according to the instructional demand.
   G. C. Grindley and V. Townsend [*Q. J. Exp. Psychol.* **20**, 11 (1968)] observed effects of attention instructions (informing subjects where targets would appear) on peripheral acuity and on differential luminance thresholds. In audition, similar results were obtained in studies of two or more tones being detected simultaneously against a noise background. See L. D. Pohlmann and R. D. Sorkin [*Percept. Psychophys.* **20**, 179 (1976)] for additional references. Unfortunately, the Grindley and Townsend study has serious methodological flaws: the attention instruction reduced uncertainty as to *where* targets would appear (therefore serving to "reduce noise"); the subjects' criteria for deciding whether to report or not could have varied between conditions; and finally, different, unreported exposure durations were used in single and multiple stimulus presentations, so that comparison between them is impossible.
   M. L. Shaw and P. Shaw [*J. Exp. Psychol. Hum. Percept. Perform.* **3**, 201 (1977)] demonstrated that targets are detected best when they occur in areas of display where they are presented most frequently. They interpret their data as resulting from the optimal allocation of mental processing resources, but their single-target paradigm does not rule out the alternative "uncertainty reduction" explanation. That is, when subjects know that signals occur more frequently in one area of a display, the subjects can profitably disregard partial information from other areas of the display that—without this foreknowledge—could have produced incorrect responses.
5. U. Neisser, *Cognitive Psychology* (Appleton-Century-Crofts, New York, 1967), pp. 67ff.
6. R. A. Monty and J. W. Senders, Eds., *Eye Movements and Psychological Processes* (Erlbaum, Hillsdale, N.J., 1976).
7. The cathode-ray tube was controlled by a Honeywell DDP/224 computer. It produced characters defined on 10 × 10 dot matrices; the average number of points per character was 22. Characters were painted once. The luminous energy per point per painting was 1.5 cd/μsec [G. Sperling, *Behav. Res. Methods Instrum.* **3**, 148 (1971)]. The background screen luminance was 0.3 cd/m^2. The large letters were 1.0 cm high and spaced 1.7 cm apart center to center. Small letters were 0.42 cm and spaced 1.7 cm apart. Viewing distance was 1.1 m.
8. Confidence categories were used to reduce the effect of chance guessing on the data. When responses in a confidence category were shown to be statistically unrelated to the stimulus, they were all scored as incorrect. See G. Sperling and M. J. Melchner, *J. Math. Psychol.* **13**, 192 (1976).
9. ———, "Multiple detections in a brief visual stimulus: the sharing and switching of attention," paper presented to the Psychonomic Society, Denver, 7 November 1975; in *Information Processing in the Visual System,* V. D. Glezer, Ed. (U.S.S.R Academy of Sciences, Pavlov Institute, Leningrad, 1976), pp. 224–230.
10. The term "attention operating characteristic" was first proposed by R. A. Kinchla, unpublished address at Attention and Performance III, Soesterberg, Netherlands, 4 to 8 August 1969; also in *Tech. Rept. No. 29* (Department of Psychology, McMaster University, Hamilton, 1969).
11. According to D. A. Norman and D. G. Bobrow [*Cognitive Psychol.* 7, 44 (1975)], the AOC is a "performance-performance" operating characteristic; the fact that the sloping portion of the AOC does not pass through the points representing data from control conditions means that near the axes the dual task is "data limited" and it becomes "resource limited" only when sufficient attention is withdrawn from a component task to impair its performance.
12. G. Sperling and A. Reeves, "Reaction time of an *un*observable response," unpublished address, Psychonomic Society, St. Louis, 11 November 1976.
13. A similar problem occurs in signal detection theory with receiver operating characteristics (ROC curves). The profound analogy between mechanisms that generate AOC and ROC curves is developed by G. Sperling and M. J. Melchner, in *Attention and Performance VII,* J. Requin, Ed. (Erlbaum, Hillsdale, N.J., 1978), pp. 675–686.
14. We wish to acknowledge the assistance of Judith Harris.
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Alkaline Phosphatase in Epstein-Barr Viral Nuclear Antigen–Positive Cell Lines

Abstract. *The production and nature of alkaline phosphatase were studied in Epstein-Barr viral nuclear antigen-positive, surface membrane immunoglobulin-negative cell lines established from two patients, one with acute myeloid leukemia and one with acute lymphoblastic leukemia. The acute myeloid leukemia-derived cells contained myeloid alkaline phosphatase, while the acute lymphoblastic leukemia-derived cells contained lymphoid alkaline phosphatase. The presence of the myeloid-specific enzyme in a surface membrane immunoglobin-negative cell line suggests that the line is composed of myeloid precursor cells and that such cells may be susceptible to infection with Epstein-Barr virus.*

When cultured cell lines derived from human blood are infected with Epstein-Barr virus (EBV) and contain Epstein-Barr viral nuclear antigen (EBNA), they are thought to represent a proliferation of lymphoblastoid cells (*1*). Usually the EBNA-positive cells are also surface membrane immunoglobulin (SmIg) positive, and are considered B cells.

We have previously shown that some EBNA-positive, SmIg-positive cell lines established from patients with acute myeloid leukemia (AML) possess several characteristics usually associated with myeloid cells but not lymphoid cells. Those properties include production of lysozymes, cytochemically demonstrable myeloid esterase and alkaline phosphatase, and phagocytic activity (*2*). It is unclear whether these cell lines are lymphoblastoid in origin but have acquired myeloid enzymatic and functional characteristics or, alternatively, whether they are of myeloid origin but producing SmIg and susceptible to EBV.

We now report the type of alkaline phosphatase present in two cell lines, both characterized EBNA-positive and SmIg-negative. We also provide additional evidence that myeloid-specific enzymes may occur in EBNA-positive cell lines.

Although cytochemical detection of alkaline phosphatase is usually reported for granulocytes and macrophages, and has only rarely been reported in lymphoid cells (*3*), two biochemically different forms of alkaline phosphatase have been distinguished; one is confined to granulocytes and the other is found in certain lymphoid cells, including some lymphoblastoid cell lines (*4*). The dis-

Table 1. Characteristics of cell lines derived from AML (line 120) and ALL (line 117). Abbreviations: EBNA, Epstein-Barr viral nuclear antigen; SmIg, surface membrane immunoglobulin; Fc, the Fc portion of immunoglobulin; and C3, third component of complement.

Cell line	Presence of		Percentage with receptors for		Alkaline phosphatase	
	EBNA	SmIg	Fc	C3	Myeloid	Lymphoid
120	+	−	0	50	+	−
117	+	−	10	18	−	+

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crepancy between cytochemically demonstrable alkaline phosphatase activity in intact cells and biochemically demonstrable alkaline phosphatase in cell extracts may be attributed to several factors, such as intracellular spatial arrangement of the enzyme, the geometry of the active site of the enzyme in the intact cells, or differences in sensitivity of the two methods. The alkaline phosphatase activities in the extracts of myeloid and lymphoid cells differ in substrate specificity. Enzyme extracted from myeloid cells can catalyze the hydrolysis of two kinds of substrates, ortho-substituted monoesters of orthophosphoric acid (substrate type 1) and the *S*-substituted monoesters of thiophosphoric acid (substrate type 2) with similar efficiency; the alkaline phosphatase from extracts of lymphoid cells catalyzes the hydrolysis only of substrate type 1 (phosphatase N) (*4*-*9*). This difference in catalytic properties provides an additional way to distinguish between myeloid and lymphoid origins or types of cells.

We now describe two EBNA-positive, SmIg-negative cell lines. The first was derived from a patient with AML and has the myeloid alkaline phosphatase, catalyzing both types of substrate. The second line, derived from a patient with a combined B- and T-cell acute lymphoblastic leukemia (ALL) (*10*), possesses the lymphoid alkaline phosphatase, catalyzing only substrate type 1. For the EBNA and SmIg tests we used T cells (line 45) as a negative control and B cells (line 160) as a positive control (*11*).

Cultures of both leukemic cell lines were established in vitro (*2*) and studied during the second year of culture. Both cell lines had normal karyotypes (*2*). Ultrastructural examination of the cells revealed that many of the AML-derived cells (line 120) had lobulated nuclei, which are often found in myeloid precursors, and the cytoplasm contained membrane-bound granules (Fig. 1). The cells of the ALL-derived culture (line 117) contained oval nuclei, and their cytoplasm appeared to be devoid of any detectable granules. The immunological properties of both cell lines (*11*), including immunoglobulin biosynthesis, were studied on several occasions (Table 1). Both cell lines were SmIg-negative for immunoglobulin of the M, G, and D classes, and for κ and λ light chains, and failed to show evidence of immunoglobulin biosynthesis.

Alkaline phosphatase studies on cell extracts were performed (*4*) with two substrates, *p*-nitrophenyl phosphate (*p*-NPP) and cysteamine-*S*-phosphate (CASP) (Table 1). Comparative phosphatase assays (Table 2) showed that the alkaline phosphatase in the extract from line 117 catalyzed only the hydrolysis of *p*-NPP; the alkaline phosphatase of the extract of line 120 catalyzed the hydrolysis of both *p*-NPP and CASP. Thus line 117 contains the lymphoid alkaline phosphatase and line 120 contains the myeloid alkaline phosphatase.

Table 2. Alkaline phosphatase activity in extracts of cell lines 117 and 120. Enzyme activity was measured (*5*) in solution with 1 μmole of substrate in 500 μmole of tris at *p*H 9.0. Activity is expressed as nanomoles of substrate [either *p*-nitrophenyl phosphate (*p*-NPP) or cysteamine-*S*-phosphate (CASP)] hydrolyzed per minute per 10^6 cells at 22°C. The extraction of alkaline phosphatase activity was performed in two steps. After the cells were homogenized in 0.1*M* tris-chloride, *p*H 8.0, in a Sorvall Omnimixer, the tris-soluble proteins were separated from the other proteins by ultracentrifugation at 35,000 rev/min for 30 minutes at 4°C in a Beckman Spinco ultracentrifuge. The enzyme activity in the supernatant was determined. The pellets were extracted with *n*-butanol and water (B-W) by adding 0.3 ml of *n*-butanol, in three portions, to 1 ml of water on ice. The B-W soluble protein was separated by ultracentrifugation, and the alkaline phosphatase activity in the soluble fraction was measured. The ratio of the velocities at which the two substrates were hydrolyzed by the same extract ($V_{p\text{-NPP}}/V_{CASP}$) was determined. A ratio greater than 2 indicates the presence of phosphatase N (*9*). The percentage of phosphatase N was also determined (*9*).

Cell line	Alkaline phosphatase activity on						$V_{p\text{-NPP}}/V_{CASP}$			Percentage of phosphatase N		
	p-NPP in proteins soluble in			CASP in proteins soluble in								
	Tris	B-W	Total	Tris	B-W	Total	Tris	B-W	Total	Tris	B-W	Total
117	2.00	3.79	5.79	0.09	0.81	0.90	22.72	4.68	5.68	93	66	76
120	1.23	0	1.23	1.55	0	1.55	0.79		0.79	0	0	0

Biochemical testing for two types of alkaline phosphatase may allow distinction between primitive lymphoid and myeloid cells and may also be useful for detecting alkaline phosphatase in cells, such as lines 117 and 120, that are cytochemically negative for the enzyme. The K562 cell line, derived from a patient with chronic myeloid leukemia, is thought to represent a proliferation of malignant myeloid cells; it is cytochemically negative for alkaline phosphatase, but by the biochemical assay contains the myeloid enzyme (*12*). Conversely, numerous B-cell lines possess no myeloid alkaline phosphatase (*4*).

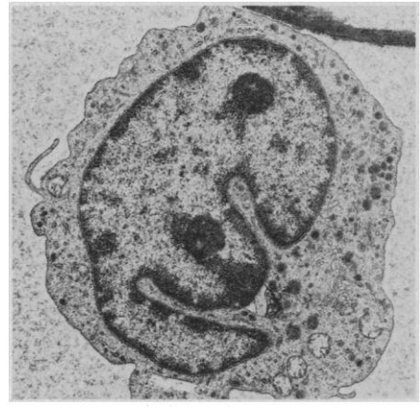

Fig. 1. Ultrastructure of a cell with lobulated nucleus. The cytoplasm contains several types of granules (×13,500).

We previously suggested that human myeloid precursors might be susceptible to infection by EBV (*2*). The virus can infect nonlymphoid cells, such as epithelial cells of nasopharyngeal carcinoma in vivo (*13*) and amniotic cells in vitro (*14*). The data presented here provide additional evidence that EBV may infect myeloid precursors.

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