CELLULAR IMMUNITY AT BIRTH

THE MECHANISM AND NATURE OF THE PHAGOCYTIC RESPONSE

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Immunity in the infant has been extensively studied in the past and numerous investigations have been made into the development of specific immunity, the production of antibody and the passive transfer of antibody from the mother. On the other hand comparatively little work has been devoted to elucidating the complexities of the cellular response since Tunnicliff (1910) observed that phagocytosis by infants' leucocytes of streptococci, staphylococci and pneumococci was less active than in adults until the age of about 2 years. Subsequently it was demonstrated that the efficiency of phagocytosis was to a large extent determined by factors in the serum. In this connexion the studies of Mudd, Lucké, McCutcheon and Strumia (1929) were particularly important since they clarified our understanding of mechanisms by which serum enhances phagocytosis in the immunized animal and the role of antibody therein. Ward and Enders (1933) were able to elaborate upon these observations and correlated the effects of complement and antibody. They concluded that complement acts merely in the role of a catalyst which accelerates the effect of antibody. A similar view put forward by Topley and Wilson (1929) was that 'in normal serum the low concentration of specific antibodies necessitates the adjuvant action of a considerable amount of complement before its presence can be detected so that the complementary action appears to dominate the picture, while the high concentration of specific antibody in an immune serum reduces the complementary effect to a mere enhancement of an effect which takes place in its absence'.

Ward and Enders (1933), in one of the few reports dealing with infants, found that the titre of complement in infants under the age of 1 year was as high as that in adults. It seemed probable, therefore, that the inferiority of phagocytosis in infancy might be due to substances other than complement.

The findings of Gluck and Silverman (1957) are

thus consistent with earlier work in that they showed that a phagocytosis-promoting factor was located in the α_1 , α_2 and β -globulin fractions of the serum protein.

Matoth (1952) produced evidence which suggested that infants' leucocytes were inherently less active than those of adults and considered that the effect of serum was unimportant in spite of the fact that he noted infant serum to be less potent than adult serum in promoting phagocytosis.

The picture of cellular immunity in early infancy is thus incomplete and as much of the earlier work was carried out with immune sera and virulent micro-organisms their conclusions and results cannot be applied without due criticism to the explanation of the newborn infant's vulnerability to infections by bacteria of low pathogenicity.

The present investigation was designed in the light of previous work to study the processes involved in normal phagocytosis by the leucocytes of cord blood and the functional interdependence of leucocyte and serum in the infant at birth.

Method

The procedure for measuring phagocytosis which we adopted was a modification of that originally described by Wright (1921) for the determination of the opsonic index. The efficiency of phagocytosis is expressed as the number of leucocytes in a total count of 100 leucocytes which have ingested one or more yeast cells, as described by Hamburger (1927), and similar to the procedure employed by Mudd *et al.* (1929). We found this more reliable in practice than Wright's method in which the number of particles in each leucocyte was counted. The present method also has the advantage that when yeast cells are employed there is less difficulty in differentiating between particles within the cells and those on its surface.

Materials. Maternal blood (10 ml.) obtained by venepuncture within half an hour after delivery and 10 ml. of infants' blood from the umbilical vein was collected and 5 ml. of each placed in a dry bottle and

5 ml. into a bottle containing 50 i.u. heparin. Ten millilitres of blood from a normal adult was collected into a dry bottle for use as control.

Preparation of Sera. The serum obtained from the blood in each dry bottle after clotting and centrifugation was divided between two tubes, one of which was heated to 56° C. for 30 minutes to inactivate complement. Both were then kept at 4° C. until used, within 24 hours.

Preparation of Cell Suspensions. The plasma from 3 ml. of the heparinized maternal or infant's blood was withdrawn after centrifugation. The packed cells were then washed three times with 10 times their volume of modified Hanks' solution and the supernatant fluid withdrawn. Deposit, 0.5 ml., was aspirated from the bottom of the tube with a Pasteur pipette to effect some concentration of the leucocytes in the upper layers. The resultant leucocyte-rich deposit was kept at 4° C. until used.

Yeast Cell Suspension. Yeast cells were finally chosen since experiments with carbon particles and starch granules had proved unsatisfactory because of the difficulties and inaccuracies in counting the ingested particles. Yeast cells possess the advantage of uniform size suitable for counting and yet not so large as to cause gross distortion of the leucocyte. As Hanks (1940) demonstrated a relationship between the degree of phagocytosis and the number of micro-organisms in suspension, it has been necessary to determine the optimal concentration of yeast cells to ensure uniformity. The proportion of leucocytes exhibiting phagocytosis of yeast cells was found to increase in proportion to the number of yeast cells in suspension, until a concentration of 75,000 yeast cells per c.mm. was reached. Suspensions containing greater numbers of cells produced little further increase in the number of actively phagocytic leucocytes although the number of ingested particles per leucocyte (i.e. the phagocytic index) continued to increase. In the present experiments, therefore, a concentration of 100,000 yeast cells per c.mm. was chosen, since minor variations were found to produce no significant effect. On the other hand in estimating phagocytosis by means of the phagocytic index, variations in the number of yeast cells caused relatively large variations in the number of particles ingested. For this reason the phagocytic index was considered less reliable for studies involving numerical comparisons, though it has been estimated in the present series on the majority of specimens and shows a close correlation with the total number of active leucocytes (Fig. 1).

PREPARATION OF SUSPENSION OF YEAST CELLS. Yeast strain CN 1845 was propagated on nutrient agar and subcultured in nutrient broth for three to four days. After centrifugation and washing three times in 10 ml. normal saline the cells were suspended in normal saline at a concentration of 100,000 cells per c.mm. The selected concentration was obtained by serial dilution and counting in a Neubauer chamber. The cells in suspension were then killed by heating to 65° C. in a sealed tube for 15 minutes.

FIG. 1.—Relation of percentage activity of maternal and infant leucocytes to phagocytic index.

Demonstration of Phagocytosis. A suspension of leucocytes (0.1 ml.) of each mother or child was placed in each of six tubes containing equal volumes of serum and yeast cells, as follows:

Tube	Leucocytes	+ killed yeast cells	+ fresh adult serum
2	"	"	+ heated adult serum
3	"	"	+ fresh infant serum
4	"	"	+ heated infant serum
5	"	"	+ fresh maternal serum
6	"	"	+ heated maternal serum

In each experiment the leucocytes of the mother and those of her own infant were prepared and tested simultaneously. After thorough mixing by shaking, the 12 tubes were placed in a water bath at 37° C. for 30 minutes and agitated every five minutes. After 30 minutes phagocytosis was inhibited by cooling in cold water, and films were made from each tube, fixed with methyl alcohol, and stained with Leishmann's stain.

Cell Counts. A total of 200 polymorphs was counted and the number which ingested one or more yeast cell noted. The number of leucocytes showing phagocytosis was expressed as percentage activity.

Twenty pairs of cell preparations in the various sera were made by this method. The mean error of the method was determined in a pilot experiment, and found to be $\pm 2\%$ in counts of 200 cells.

Results

In Table 1 are tabulated the percentage numbers of leucocytes exhibiting phagocytosis of yeast cells when suspended in adult, infant and maternal sera. Comparison of the total number of active cells or the mean number of cells in each category can be made and the validity of any difference referred to Student's *t* distribution.

Comparison of the activity of the cells in their own unheated sera (columns 3 and 5A), which is the nearest approximation *in vitro* to the conditions of postnatal life, shows a small difference in mean activity between infant and maternal cells. It is not possible to make a statistical comparison under these conditions, but it is felt that the difference (79.6%-72%) may reflect somewhat greater activity on the part of maternal cells, which would be in accord with the findings of previous investigators.

The Effect of Unheated Serum on Phagocytosis. In 20 experiments the activity of infants' leucocytes has been assessed in their own unheated serum, in that of their own mother and in that of a seemingly normal adult. Likewise the activity of maternal leucocytes has been assessed in their own unheated serum, in that of their own infant and in that of an adult. The mean activity of infants' leucocytes,

columns 1, 3 and 5, and maternal leucocytes columns 1A, 3A and 5A, is about the same with each of the three sera (Table 1).

Infant cells seem to be more active in maternal serum, and maternal cells more active in the sera of infants and adults, but these differences are statistically insignificant.

The Effect of Heated Serum on Phagocytosis. The influence of heated serum on phagocytosis is assessed by comparing the activity of leucocytes from an infant or mother in unheated and heated serum. The comparison has been made in their own serum, in that of their own mother or infant and in adults' serum. A highly significant difference between the number of leucocytes of infant and maternal origin showing phagocytosis in fresh and the number showing phagocytosis in heated sera is apparent (Table 1).

The influence of heated serum on phagocytosis is assessed by comparing the activity of leucocytes from the same infant or from the same mother in maternal, infant and adult sera (Table 2a, b). In each of the 20 experiments, the infants' leucocytes have been tested in their own, in their mothers' and in adults' heated serum. The maternal leucocytes have been tested in their own, their own infants' and normal adult serum.

The number of infant and maternal leucocytes exhibiting phagocytosis is significantly greater in heated maternal serum (and to a less extent heated adult serum) than in infant serum.

TABLE 1
THE NUMBER OF LEUCOCYTES % EXHIBITING PHAGOCYTOSIS

Pair No.	Infant Leucocytes						Maternal Leucocytes					
	Adult		Cord Serum		Maternal		Adult		Cord Serum		Maternal	
	1 unheated	2 heated	3 unheated	4 heated	5 unheated	6 heated	1A unheated	2A heated	3A unheated	4A heated	5A unheated	6A heated
1	58	23	62	5	60	17	65	9	64	5	70	9
2	82	30	80	6	94	65	91	24	80	10	57	15
3	68	5	57	6	75	9	88	4	86	6	86	5
4	73	19	74	4	80	10	93	10	90	6	93	10
5	73	12	66	15	69	36	80	8	77	10	82	14
6	77	8	71	7	80	9	86	12	85	8	89	12
7	87	15	80	16	81	15	89	8	87	8	92	11
8	65	10	64	11	71	23	76	12	74	5	74	10
9	64	11	66	6	64	32	68	9	71	3	65	13
10	76	14	78	8	79	19	89	4	85	9	76	11
11	75	12	76	16	68	15	85	5	92	7	81	11
12	80	22	79	15	81	40	80	12	89	5	86	11
13	82	14	84	12	82	18	83	17	91	10	83	20
14	80	4	72	3	79	9	94	8	93	7	93	7
15	73	4	69	3	67	4	70	4	75	2	61	3
16	70	14	69	14	75	21	88	14	81	10	76	14
17	69	7	66	6	70	13	74	7	75	7	84	14
18	73	19	78	15	74	18	94	13	90	9	83	13
19	84	9	75	4	79	8	90	7	95	6	89	5
20	73	10	75	5	74	7	82	5	84	4	72	9
Mean	74.1	13.1	72.05	8.85	75.1	19.4	83.25	9.6	83.2	6.85	79.6	11.15

(The numbers are the mean of two counts of 100 cells.)

In each pair the mother's leucocytes and her own infant's leucocytes are tested in their own, or the other's serum. Adult serum was obtained from a normal adult.

TABLE 2a

DIFFERENCES BETWEEN THE NUMBERS OF ACTIVE INFANT LEUCOCYTES IN THE HEATED SERA OF MOTHERS, ADULTS AND INFANTS

Heated Serum	Infant Leucocytes (% activity)	Difference (N = 20)
Infant ..	8.85	$t = 2.38$ (significant)
Adult ..	13.1	$p \leq 0.05$
Infant ..	8.85	$t = 2.99$ (highly significant)
Maternal ..	19.4	$p = 0.01$
Adult ..	13.1	$t = 1.72$ (not significant)
Maternal ..	19.4	$p = 0.1$

Inherent Activity. The intrinsic activity of infants' and mothers' leucocytes was assessed by comparing their activity when suspended in an identical serum. The results are shown in Table 3, and show that mothers' leucocytes are more active to a highly significant degree than infants' leucocytes in both infants' and adults' serum. When suspended in maternal serum on the other hand, infants' leucocytes show the same activity as those of their mothers.

Comparison of the activity of mothers' and infants' leucocytes in the same heated sera is shown in Table 4. In the heated serum of infants and adults no significant difference in their activities is demonstrable, but in heated maternal serum the infants' leucocytes show significantly more phagocytosis than their mothers' leucocytes.

Relation of Phagocytosis to Maturity of the Leucocyte. The average number of nuclear lobes per leucocyte was estimated for each infant and mother in counts of 100 cells.

In infants' leucocytes the average number of lobes was found to be 2.41 and in the mothers' leucocytes 2.86, but no relation can be demonstrated, in either unheated or heated serum, between the average number of lobes of the leucocytes and number of phagocytosing cells on the same film.

Relation of Phagocytosis to Birth Weight. The weights of the infants in the present series ranged from 6 lb. 5 oz. (2.85 Kg.) to 8 lb. 11 oz. (4.03 Kg.) at birth. All infants were delivered at full term.

No significant correlation was apparent in the weight of the infants and the activity of their

TABLE 2b

DIFFERENCES BETWEEN THE NUMBERS OF ACTIVE MATERNAL LEUCOCYTES IN THE HEATED SERA OF MOTHERS, ADULTS AND INFANTS

Heated Serum	Maternal Leucocytes (% activity)	Difference (N = 20)
Infant ..	6.85	$t = 2.0$ (significant)
Adult ..	9.6	$p = 0.05$
Infant ..	6.85	$t = 3.45$ (highly significant)
Maternal ..	11.15	$p \leq 0.001$
Adult ..	9.6	$t = 1.25$ (not significant)
Maternal ..	11.15	$p \leq 0.2$

leucocytes. Our findings are thus in accordance with those of Gluck and Silverman (1957).

Discussion

Previous studies on phagocytosis in infancy have established that leucocytes are less active at this age than in later childhood and adult life. Matoth (1952), who employed starch granules, concluded that the leucocytes were themselves relatively inactive and considered that the influence of substances in the serum was small. Gluck and Silverman (1957), however, have demonstrated that the addition of adult serum to the blood of babies of birth weight below 2,000 g. brings about a significant increase in the proportion of effective phagocytes.

It seems probable in view of these reports that the inherent activity of the cells and the enhancing effects of serum may both contribute to the inferiority of infant leucocytes.

The results of the present investigation confirm the existence of significant differences between the phagocytic activity of cord and mothers' leucocytes under certain conditions.

The Phagocytosis-promoting Factors in Serum. Although infants' and mothers' leucocytes appear (Table 3) to be less active in their own unheated serum than in heterogeneous serum the difference is small and may well have occurred by chance. The figures therefore indicate that phagocytosis occurs with similar frequency in both unheated sera and no significant difference between the effects on phagocytosis by infants' and mothers' serum can be assumed.

TABLE 3

DIFFERENCES BETWEEN THE ACTIVITIES OF INFANT AND MATERNAL LEUCOCYTES IN UNHEATED SERA

Serum	Infant Leucocytes (% activity)	Maternal Leucocytes (% activity)	Difference (N = 20)
Infant ..	72.05	83.2	$t = 4.8$ (highly significant)
Adult ..	74.1	83.2	$t = 2.9$ (highly significant)
Maternal ..	75.1	79.6	$t = 1.0$ (not significant)

TABLE 4

DIFFERENCES BETWEEN THE ACTIVITIES OF INFANT AND MATERNAL LEUCOCYTES IN HEATED SERA

Serum	Infant Leucocytes (% activity)	Maternal Leucocytes (% activity)	Differences (N = 20)
Infant ..	8.85	6.85	$t = 1.5$ (not significant)
Adult ..	13.1	9.6	$t = 1.9$ (not significant)
Maternal ..	19.4	11.15	$t = 2.4$ (significant)

For this reason the seeming superiority of maternal over infant leucocytes, albeit small, cannot simply be attributed to differences in whole serum on the strength of these findings.

Phagocytosis by infant and maternal leucocytes of particles sensitized by heated serum is much less efficient than that of particles sensitized by unheated serum. As a result of the greater loss in the activity of mothers' leucocytes in heated serum, the activity of infants' cells is equal to or greater than that of their mothers. We have no evidence that this is due to a greater capacity for spontaneous phagocytosis on the part of infant leucocytes.

The influence of the different sera on phagocytosis has been studied in order to determine whether this finding might be explained by differences in the sera.

In contrast to the constancy with which ingestion occurs in unheated sera, well-marked and significant variations are observed in heated sera (Table 2a, b). In the heated serum of infants, phagocytosis by infants' or mothers' leucocytes is less than that in heated adult serum and less to a highly significant degree than that in heated maternal serum. These observations imply that serum factors determine activity in the absence of complement, and they suggest, moreover, that the heat-stable enhancing factor is of importance in determining the ultimate activity of the phagocyte. We may assume that the heat stable fraction of serum which enhances phagocytosis is present with greatest effect in maternal serum and least effect in infant serum. Whether

this is due to quantitative or qualitative differences in the active constituents of the heat-stable fraction is not known, though the findings of Gluck and Silverman (1957) and our own studies on the serum globulin are compatible with the view that they may be due to qualitative changes. In the present investigation the Popper reaction, which depends on the amount of α and β globulins, was higher in heated serum of most infants (mean 3.85 compared with 2.65 in unheated serum) and of all mothers (mean 4.3 compared with 2.3 in unheated serum). The Kunkel reaction, which depends principally upon the γ -globulin fraction, was reduced in all heated sera and especially in maternal sera (mean 1.25 compared with 4.3 in unheated serum). In order to confirm these changes electrophoretic separation (Griffiths, 1952, 1953; Griffiths and Brews, 1953) was performed on seven paired sera and it demonstrated that a small increase in the amount of α_2 -globulin and a small reduction in the γ -globulin occurs as a result of heating maternal serum.

The influence of the heat-labile fraction of serum may be estimated by finding the numerical difference between activity in unheated and in heated serum. The figure thus obtained is a measure of the number of leucocytes which owe their activity to the heat-labile fraction. It offers a convenient means of measuring quantitatively the phagocytosis-promoting effect of heat-labile fraction or complement.

When this figure is plotted graphically against the number of active cells in unheated serum (Fig. 2a, b) a close correlation with the overall activity of

FIG. 2a.—Relation of activity of maternal leucocytes in unheated maternal serum (5A) to activity due to heat-labile factor (5A-6A).

FIG. 2b.—Relation of activity of maternal leucocytes in unheated infant serum (3A) to activity due to heat-labile factor (3A-4A).

maternal leucocytes is demonstrated, which indicates that phagocytosis is directly related to the opsonic effect of the heat-labile fraction of serum.

This finding is in accordance with present views on the role of complement as the dominant influence on normal phagocytosis.

Since the correlation of total phagocytosis by maternal leucocytes and heat-labile fraction is the same in both infant and maternal serum it may be inferred that complement is present in infant serum to the same extent as in maternal serum, as found by Ward and Enders (1933). Since we have been unable to demonstrate any lack of effective complement in infant serum, differences in phagocytic activity between infant and maternal leucocytes cannot be explained by postulating differences in complement. In so far as it is possible to separate the functions of leucocyte and serum it appears that the heat-stable fraction of infant serum in some way as yet undetermined is deficient in a phagocytosis-promoting factor. Of the substances in serum which are not destroyed at 56° C. specific antibodies are known to influence phagocytosis. We have attempted by employing a non-pathogenic strain of yeast throughout these experiments to avoid interference by specific immunity and we consider such interference most improbable.

Hormonal status particularly in respect of oestrogens and corticosteroids influences phagocytosis, but the concentration of these substances in the blood of mother and infant is similar at birth, and differences in phagocytosis would not be expected unless their leucocytes differ in sensitivity to the effects of hormones.

The Response of the Leucocyte. From the foregoing discussion upon the phagocytosis-promoting effects of serum it is apparent that the paucity of an active heat-stable factor in infant serum accounts at least in part for the relative inactivity of infant leucocytes. This conclusion is not inconsistent with the conclusions of Gluck and Silverman (1957) that the activating component may be in the α and β fractions of the serum protein, though proof that the factor observed by us is identical with that of Gluck and Silverman is not within the scope of the present investigation.

The observation that the infants' leucocyte is relatively more dependent upon a heat-stable factor than upon complement suggests that there may be a difference in the cells' response to sensitized particles. In this connexion it is interesting to note that the heat-stable phagocytosis-promoting factor in maternal serum does not exert an effect of similar magnitude on the leucocytes of the mother

herself (Table 4) which seems to be affected mainly by complement (Fig. 2).

Evidence of the nature of the differences between the responses of maternal and infant leucocytes can be obtained by further analysis of their behaviour under certain conditions.

It has already been shown that phagocytosis by maternal leucocytes in unheated serum bears a close quantitative relationship to activity due to complement and is thus presumed to be determined by complement (Fig. 2). The activity of infant leucocytes bears some but not such a close relation to complement in their own serum, and in maternal serum no relation that can be demonstrated (Fig. 3a, b, c).

Since it has already been shown that the opsonic effect of complement is similar in both sera it is concluded that the avidity of infants' leucocytes for particles sensitized in the presence of complement is less than that of their mothers'.

In maternal serum, in spite of a striking absence of any quantitative relationship to complement, the total activity of infant cells is greater. The knowledge that maternal serum is comparatively rich in a heat-stable enhancing factor combined with the knowledge that the activity of infants' leucocytes is not quantitatively dependent on complement provides evidence that their activity is more dependent on a heat-stable factor in serum. The fact that the mothers' leucocytes retain their dependence upon complement excludes the possibility that this is a non-specific effect of maternal serum and serves to confirm that there is an inherent difference in cellular response. Likewise our findings are not compatible with the view that this is an effect of antibody passively transferred from the mother.

The difference in response is characterized by a marked avidity of infants' leucocytes for particles sensitized by the heat-stable fraction of maternal serum. In nature, however, there are no opportunities after birth for micro-organisms invading the infant to be sensitized by maternal serum and thus for the infant to receive any protection which this mechanism might provide. If it does play a role in defence against infection in life it must do so while the foetus is *in utero* and the placenta intact, for only in these circumstances are conditions such that invading micro-organisms will have been sensitized by contact with maternal serum. As there is no significant difference between the activity of mothers' and infants' leucocytes when there has been sensitization by unheated maternal serum (Table 3), it is probable that, *in utero*, the foetal leucocytes are as efficient as those of their mothers.

The present investigation has shown that the

FIG. 3a.—Relation of activity of infant leucocytes in unheated infant serum (2) to activity due to heat-labile factor (3-4).

FIG. 3b.—Relation of activity of infant leucocytes in unheated adult serum (1) to activity due to heat-labile factor (1-2).

cellular response in the normal non-immune infant at birth resembles the response in the immune adult, in which antibody appears to be relatively more important than complement. The evidence suggests that this altered or perhaps more primitive response is due to an inherent difference in the leucocyte at this age. It differs from that in the mother by virtue of differences in their serum which is relatively deficient in a heat-stable enhancing factor and by virtue of differences in the leucocytes which appear to be more avid for yeast cells sensitized by the heat-stable fraction of maternal serum and less to the effects of complement.

Conclusion

The results of the present investigation provide evidence of differences between the mechanisms controlling phagocytosis in cord blood and those in maternal blood. Normal phagocytosis by maternal leucocytes is determined primarily by the heat-labile fraction of serum. Normal phagocytosis by leucocytes of cord blood, on the other hand, is less responsive to the effect of heat-labile factors and more to the effect of heat-stable factors in serum. Although observations on the nature of the heat-stable factor have been made, its identification is outside the scope of the present investigation.

This heat-stable factor is found in cord, adult and

FIG. 3c.—Relation of activity of infant leucocytes in unheated maternal serum (5) to activity due to heat-labile factor (5-6).

maternal sera, but to greatest effect in maternal serum, and to least effect in cord serum. The leucocytes of cord blood have a relatively greater avidity for particles sensitized by maternal serum.

While it is possible that these phenomena may have some protective role in the foetus, it is difficult to visualize how they might benefit the infant after birth. The withdrawal of protection afforded by maternal serum and the readjustment of the cellular response to one dominated by complement may well play a part in the infant's vulnerability to infection.

Our findings are not compatible with views which attempt to explain the infant's susceptibility on the basis of simple and separate defects in its leucocytes or serum. The functions of leucocytes and serum are closely interdependent and in the infant at birth both show significant differences from those of the mother.

Summary

The phagocytic activity of leucocytes has been measured by finding the percentage which ingest killed yeast cells. Activity as estimated by this method bears a close correlation to the phagocytic index.

The activity of the leucocytes of cord blood and of the leucocytes of the mother have been measured in unheated cord, maternal and normal adult serum and in heated cord, maternal and adult serum.

The efficiency of phagocytosis by cord and mothers' leucocytes in different sera can be compared to demonstrate the influence of serum and leucocytes on phagocytosis.

Unheated cord and maternal serum are equally effective in promoting phagocytosis.

Heated cord serum is significantly less effective than heated maternal serum in promoting phagocytosis.

Heated sera are much less effective than unheated sera in promoting phagocytosis.

Mothers' leucocytes are more active than those of their infants except in mothers' unheated serum when activity is equal.

In heated sera, infants' leucocytes are as active as those of their mothers except in mothers' heated serum where they are more active.

The activity of maternal leucocytes is closely correlated with the heat-labile fraction of serum which is present in both infants' and mothers' sera. The activity of infants' leucocytes is less closely dependent on the heat-labile factor of serum and especially of mothers' serum.

It is concluded that cord serum is relatively deficient in a heat-stable factor capable of enhancing phagocytosis and that the leucocytes of cord blood are less dependent upon the heat-labile factors in serum than are maternal leucocytes. The heat-stable fraction of maternal serum most effectively enhances phagocytosis by cord leucocytes.

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