JCI The Journal of Clinical Investigation

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J Clin Invest. 1929;7(4):593-613. https://doi.org/10.1172/JCI100245.

THE COLOR OF THE SKIN AS ANALYZED BY SPECTROPHOTOMETRIC METHODS

III. The Rôle of Superficial Blood[1]

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(Received for publication April 29, 1929)

Variation in the superficial blood supply undoubtedly plays a more important rôle in the production of changes in the color of the skin than does an increase or decrease in the pigment. This accounts for the difference in subjects who are fairly well matched otherwise with regard to content of cutaneous pigment. In general, the pigment, in proportion to its amount, prevents the superficial blood from attaining visibility. Changes in color in the brunet, attributable to alterations in the circulation in the skin, are less noticeable than the same changes in the blond, and in the negro they are practically negligible. This holds true for the skin of the same thickness, it being quite obvious that the skin of the palms or soles or other hyperkeratotic areas will permit less light to penetrate than will the thin covering of the malar prominence or the dorsum of the hand.

The color which the blood imparts to the skin is directly related to the amount or quality of the blood present in the peripheral vessels. The size of the arteries, capillaries, and venules varies with the degree of pressure behind them and with the volume of blood to be accommodated. In conditions of hypertension one would expect more force to be exerted peripherally than normally. In the dependent areas of the body, such as the legs and hands, the elements of gravity and stasis of sluggish flow are added. In cases in which the total blood volume

[1] The material in this paper was submitted by Dr. Brunsting to the faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Dermatology and Syphilology, 1929. Work done in the Division of Physics and Biophysical Research.

and cells are increased, as in polycythemia vera, there is corresponding engorgement of all parts of the vascular tree, including the vessels of the skin, and an attempt is made to establish peripheral collaterals.

Deviations from the normal oxygen unsaturation of the hemoglobin, as in cyanosis, cardiac or pulmonary decompensation, carbon monoxide poisoning, methemoglobinemia, and sulphemoglobinemia affect the color of the blood itself macroscopically, and so influence the color of the skin overlying it at any given time. Likewise, alterations in the serum content of various dyes, such as bilirubin in jaundice, and xanthophyll and carotin through intestinal absorption, reflect themselves to a certain extent in changes in the color of the skin.

Physiologic variations in the area of exposure of surface blood for each unit of surface area of the skin are well known. Vasodilation and vasoconstriction occur following changes in the environment, such as heat and cold, and irritation locally by friction, or by the application of medicaments, or again following a disturbance of the emotions, as is seen in blushing or in blanching from fear.

Quantitative estimations of the amount of exposed surface of the blood in polycythemia vera have been made by Brown and Sheard (1) by means of physical measurements obtained from projections of instantaneous photomicrographs of minute areas of skin. Computations in several cases of polycythemia vera tended to show that the surface capillaries occupied more than three times the allotment of surface area for the normal subject. Undoubtedly this accounts for a good deal of the change in color seen in such cases. Tintometric studies of color were also made but were not wholly satisfactory.

The spectrophotometric measurements which we are presenting aim to show the relative components which enter into the color of the skin when it is subjected to variations in local blood content, either in quantity or quality. The water-cell modification of the Keuffel and Esser color analyzer was used in all the cases, special care being given to the area of skin under consideration to avoid extremes of temperature, which might produce local vasodilation or vasoconstriction, and also to avoid undue pressure locally, which might obliterate the superficial vessels to occasion blanching.

Sheard and Brown (7) mentioned the presence of absorption bands occurring constantly in the reflection curves corresponding to the special regions, 630, 580 and 540 millimicrons, respectively. These were interpreted as being due to blood elements, namely, hematin in the tissue cells which would affect the percentage of reflection of red at 630 to 640 millimicrons and oxyhemoglobin at 580 and 540 millimicrons. Such absorption bands occur uniformly throughout the curves obtained in the series reported here. They are most evident in blonds and least evident in the Indians and negro, inasmuch as the superficial blood is more or less obscured by pigment. The band at 630 millimicrons is probably the least constant, being the first to disappear with a decrease in the visibility of the exposed area. The most constant region of change in reflection values is found at 580 millimicrons. There is a sudden decrease in values in the curves of reflection from the yellow to the red regions, with a minimal value at about 580 millimicrons. It is of interest that the dominant wavelength of the normal skin lies at about this point.

Schultze (5), and Dorno (2) also noted this area of lowered reflection values in the general region of 540 to 580 millimicrons. There was more variation in percentage of light reflected with changes in pigmentation in this spectral region than in the red end of the spectrum.

The reflection of light in the violet end of the spectrum was uniformly low in percentage as compared with the red values but not as low as for the region 540 to 580 millimicrons. Schultze noted that this corresponds to the energy distribution curves of Hausser and Vahle (4), and demonstrated radiation of total energy in the violet region of only 0.7 per cent of that radiated in the red region of the spectrum. Other evidence in the literature in regard to the analysis of light reflected by the skin as affected by the presence of blood is singularly lacking.

THE REFLECTION OF LIGHT FROM THE SKIN AS AFFECTED BY THE ABSENCE OF BLOOD

Probably the most striking of all color changes in the skin is that which appears after death. We attempted a comparison of the reflection values and their analyses in the living subject with specimens obtained postmortem. An area of skin about 6 by 6 cm. was obtained from the lower part of the chest, in each case soon after death. One specimen was from a blond, the other from an American Indian. The skin was denuded of fat and blood, spread on a board and stretched to approximately its normal size and held by thumb tacks. The surface was wiped dry and readings were made immediately by placing the specimen against the usual opening in the water-cooled cell

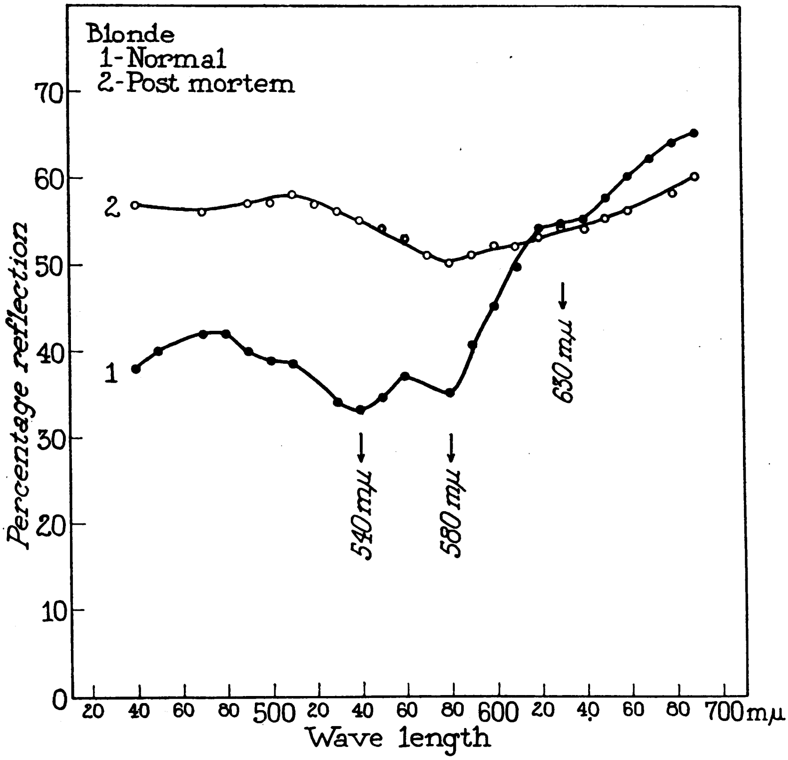

FIG. 1. SPECTROPHOTOMETRIC REFLECTION CURVES: *1*, SKIN OF THE CHEST OF A NORMAL LIVING BLOND, COMPARED WITH *2*, SKIN OBTAINED POSTMORTEM FROM THE CHEST OF A BLOND OF THE SAME TYPE

adapted to the color analyzer. For purposes of comparison, records were obtained from a normal blond and a normal Indian of approximately the same body type and body area and of the same sex.

Figures 1 and 2 represent spectrophotometric curves of the reflection values obtained in the normal subject as compared to the conditions postmortem. Curve 1 in each case shows the relative differences in total light reflected by the skin of the blond type as contrasted

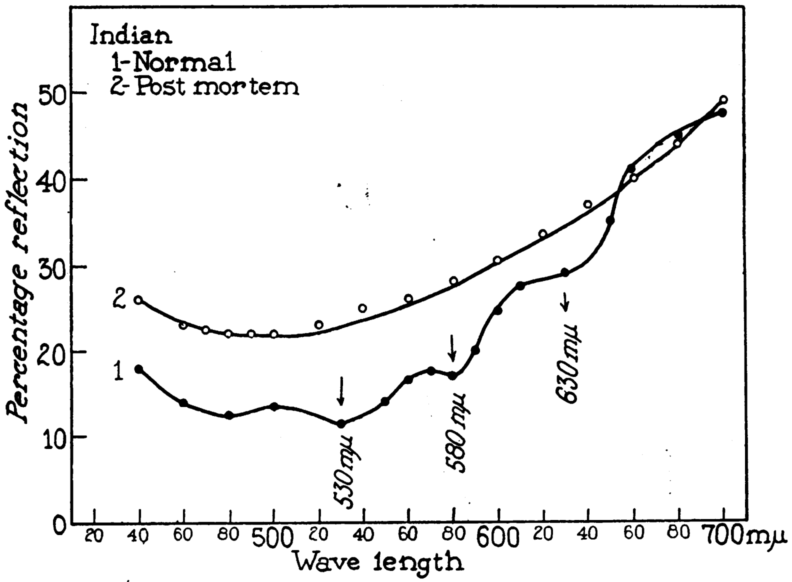

FIG. 2. SPECTROPHOTOMETRIC REFLECTION CURVES: *1*, SKIN OF THE CHEST OF A NORMAL LIVING OSAGE INDIAN, COMPARED WITH *2*, SKIN OBTAINED POSTMORTEM FROM THE CHEST OF AN OSAGE INDIAN OF THE SAME TYPE

TABLE 1

Analyses from spectrophotometric curves of figures 1 and 2 with a comparison of living blond and Indian skins with specimens obtained postmortem

Type	Total color excitation	Red	Green	Violet	Hue	Purity	Brilliance
	units	*per cent*	*per cent*	*per cent*	*millimicrons*	*per cent*	*per cent*
Blond:							
Living	7,339	38.8	34.9	26.3	586	27	40.0
Postmortem	9,664	36.3	36.3	27.4	575	23	51.4
Indian:							
Living	3,015	44.8	32.9	22.3	595	39	16.7
Postmortem	4,895	39.7	37.2	23.1	580	40	27.0

to that of the dusky Indian. The reflection values of normal Indian skin reach a figure of 50 per cent in the red end of the spectrum.

The irregularities in the normal curves and the absorption regions or spectral bands at 630, 580 and 540 millimicrons, respectively, are to be noted. These are conspicuous by their absence in the curves from

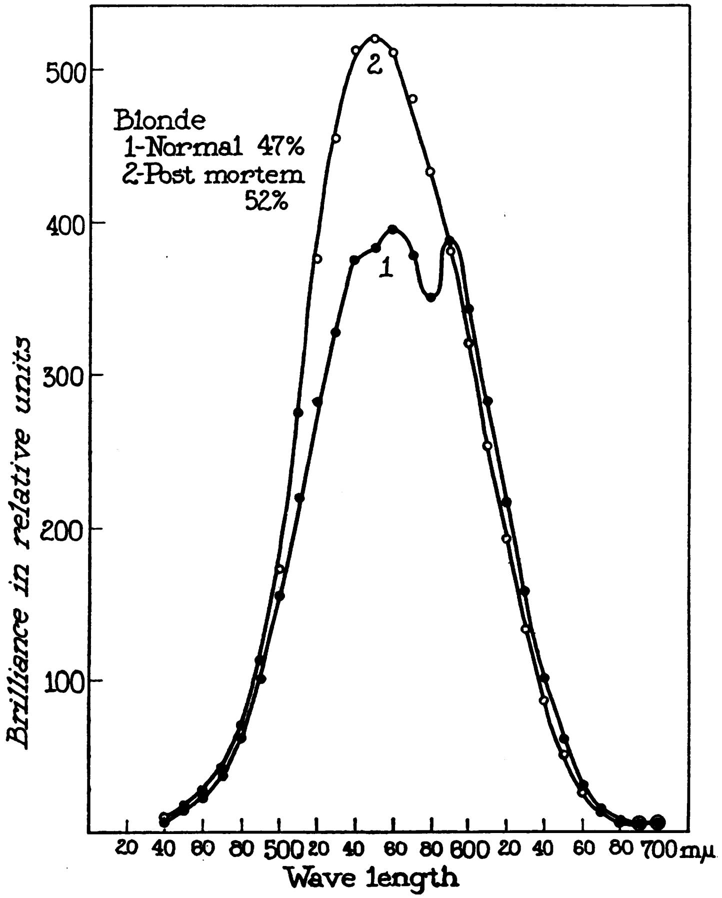

FIG. 3. CURVES OF RELATIVE LUMINOSITY: *1*, NORMAL BLOND SKIN, AND *2*, BLOND SKIN STUDIED POSTMORTEM, TO SHOW VARIATION IN BRILLIANCE

the bloodless skin obtained postmortem. Obliteration of these bands is probably the most striking demonstration possible of the relationship of these absorption regions to the blood elements present in normal skin. There is increased reflection of light in the region, 430 to

580 millimicrons. This is more marked in the case of the light skin than in the pigmented Indian skin, with little absolute change in the region of the orange and red. Analysis of these spectrophotometric curves into color excitation values and their conversion into the attributes of color are shown in table 1.

The total excitation values reveal the extremes of light and dark types and are interpreted in terms of brilliance. The blood in the

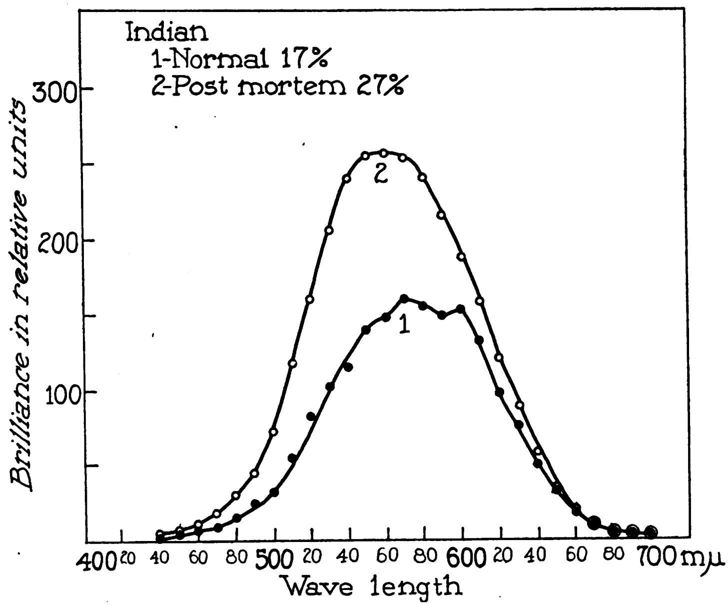

FIG. 4. CURVES OF RELATIVE LUMINOSITY: *1*, NORMAL SKIN OF OSAGE INDIAN, AND *2*, SKIN OBTAINED POSTMORTEM FROM AN OSAGE INDIAN OF THE SAME TYPE, TO SHOW VARIATION IN BRILLIANCE

superficial skin acts with the pigment to lower the percentage of light reflected, the blood itself accounting for 10 to 12 per cent of the degree of brilliance, as is seen in figures 3 and 4. The curves obtained from skin free from blood are symmetric and smooth, and those of the living subject tend toward diminished brilliance from wavelength 500 millimicrons toward wavelength 580 millimicrons, with a decided dip in the region of 580 millimicrons (oxyhemoglobin) which is more noticeable in the skin of the blond than in that of the Indian. Decided rearrangement is effected in the distribution of the various percentages of red, green, and violet, as is shown graphically in figures 5 and 6. Curve 1 represents the normal linear arrangement of the summated values

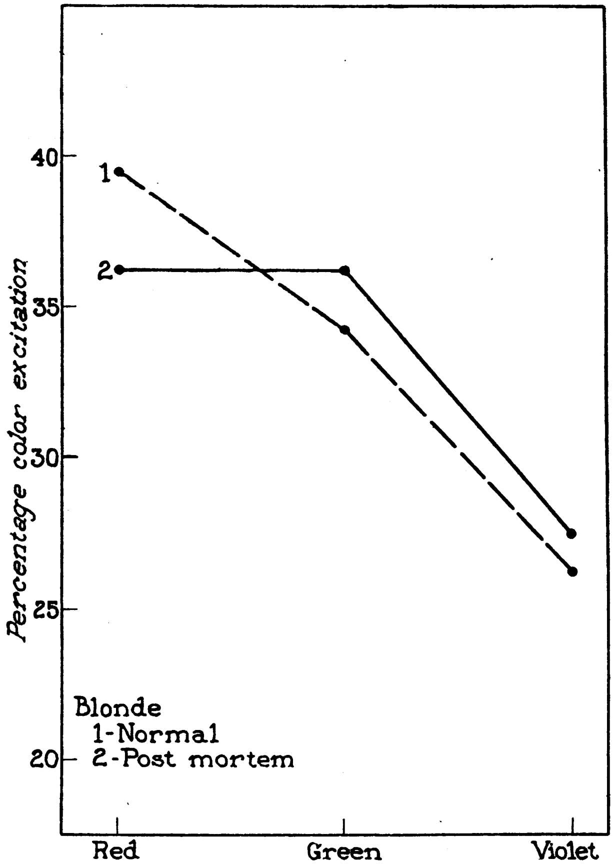

FIG. 5. PERCENTAGE COLOR EXCITATION VALUES: *1*, SKIN OF NORMAL LIVING BLOND, AND *2*, BLOND SKIN STUDIED POSTMORTEM

expressed in percentage form for both the blond and Indian living skins. Curve 2 shows the departure from the linear relationship obtained from an analysis of the same types of skin minus the blood only. The percentage decrease of light reflected in the red with corresponding elevation in the green end is to be noted. The violet is affected least of all. By plotting these values on the color triangle it will be seen that, although the percentage of purity or saturation remains unchanged in spite of the lack of blood elements, there is a

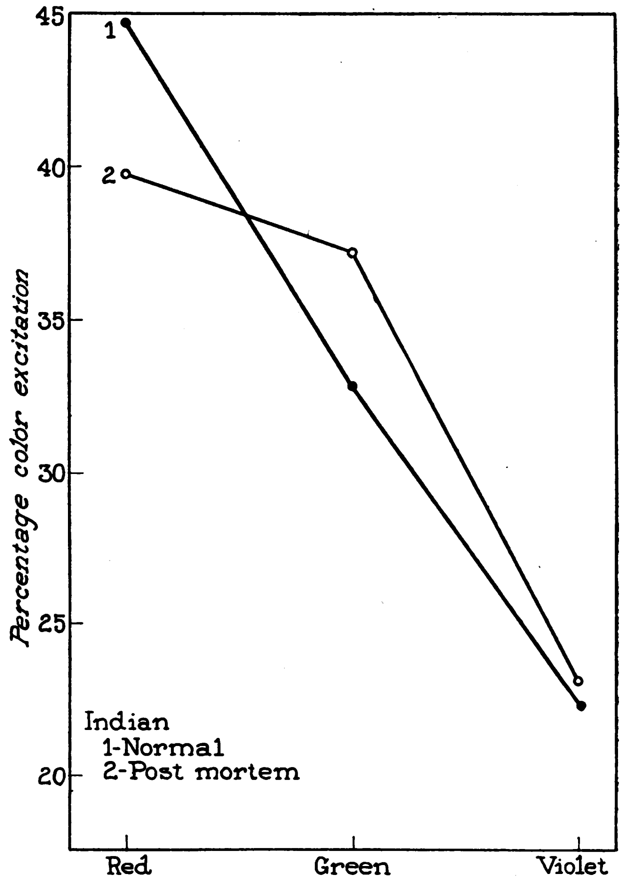

FIG. 6. PERCENTAGE COLOR EXCITATION VALUES: *1*, SKIN OF NORMAL LIVING OSAGE INDIAN, AND *2*, SKIN OF OSAGE INDIAN STUDIED POSTMORTEM

shift in the hue or dominant wavelength from the spectral wavelength 586 millimicrons to 575 millimicrons in the blond and from wavelength 595 millimicrons to 580 millimicrons in the Indian.

It has been demonstrated by a comparison of the living with bloodless skin that the superficial blood tends to alter the color of the skin by producing elevation in the hue, and a drop in the percentage of relative luminosity without affecting the percentage of purity to any extent.

THE REFLECTION OF LIGHT AS AFFECTED BY THE SUPERFICIAL BLOOD WITH THE HAND PLACED IN THE DEPENDENT POSITION

Readings were made on the dorsum of the normal hand or the middle or ring finger, with the hand about 25 cm. below heart level, using the

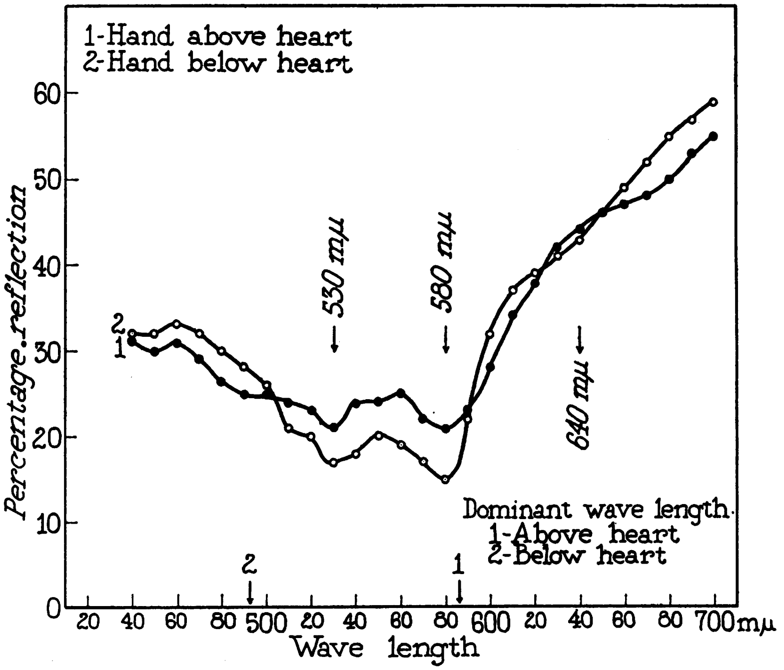

FIG. 7. SPECTROPHOTOMETRIC REFLECTION CURVES OF SKIN OF HAND AS PLACED IN AN ELEVATED OR DEPENDENT POSITION: *1*, HAND 25 CM. ABOVE HEART LEVEL; *2*, HAND 25 CM. BELOW HEART LEVEL

same areas of skin in each case. The change in color of the hand held in the dependent position depends to some extent on the prominence of the superficial venules, on the time the hand is allowed to remain in this position, and on the amount of interference with the return flow of blood. Cyanosis produced in this fashion has been shown by

Goldschmidt and Light (3) to be due to increased venous pressure peripherally and not related to the degree of oxygen unsaturation of the blood. However, should any stasis develop to retard the flow of the blood, it is reasonable to suppose that the normal relation of carbon dioxide and oxygen in the blood and the tissues would be unbalanced and upset.

Figure 7 shows two spectrophotometric reflection curves of the hand above and below heart level in a moderately brunet type. The increased absorption effect produced in the region 530 milli-

TABLE 2

Analyses from spectrophotometric curves, illustrating the effect on the various components of color in the skin of placing the hand in the dependent position

Case	Type	Dominant wave-length		Purity		Relative luminosity	
		Above heart level	Below heart level	Above heart level	Below heart level	Above heart level	Below heart level
		milli-microns	*milli-microns*	*per cent*	*per cent*	*per cent*	*per cent*
1	Brunet (arsenismus)	590	592	45	44	21.7	23.6
2	Negro	585	590	50	33	7.5	10.9
3	Normal brunet	585	600	31	19	30.2	22.1
4	Normal blond	590	600	27	21	42.7	35.2
5	Japanese	587	605	31	8	24.3	18.2
6	Chinese	585	610	28	8	27.2	26.2
7	Normal blond	600	620	21	17	36.3	26.2
8	Marked brunet	592	492*	28	38	32.4	13.1
9	Normal brunet	586	493*	21	18	24.7	22.9

* Cyanosis.

microns and 580 millimicrons when the hand is held below the heart is to be noted. This plays a part in the change in the relations of color factors as determined by analysis of the reflection values in terms of excitation units, as previously described.

Table 2 gives a list of records obtained in a similar manner from a variety of patients. The reflection curves in case 9 are plotted in figure 7.

Table 2 illustrates the variations in dominant wavelength, purity, and relative luminosity brought about by changing of the position of the hand from 25 cm. above the heart to a point 25 cm. below heart level. Examples of the most common types of subjects are included. With the hand relatively devoid of superficial blood (above the heart), the dominant wavelength is maintained in the spectral region 590 millimicrons, which corresponds to the region of pure sodium yellow.

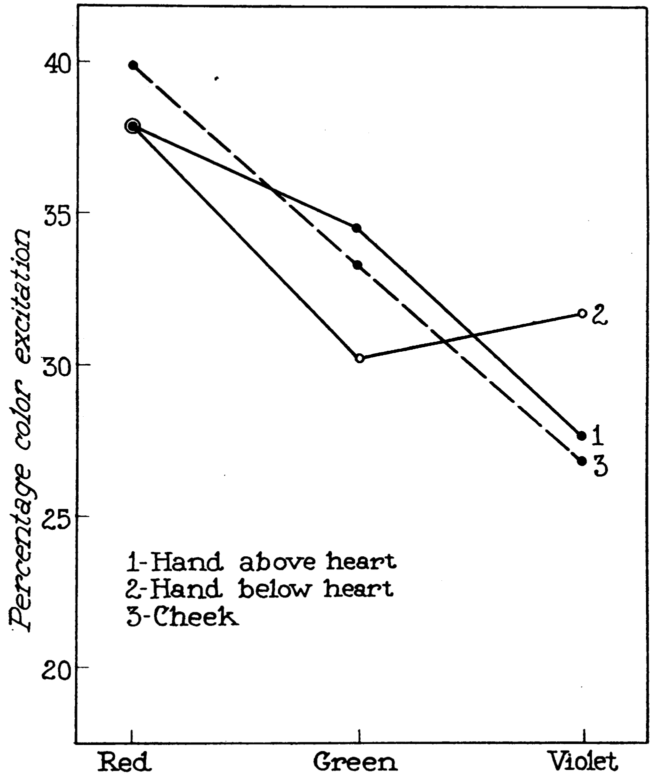

FIG. 8. PERCENTAGE COLOR EXCITATION VALUES FROM SPECTROPHOTOMETRIC DATA: *1*, HAND ABOVE HEART; *2*, HAND BELOW HEART, AND *3*, NORMAL CHEEK

If the hand is lowered to a point below heart level, the superficial blood becomes more or less evident and its effect on the color of the skin can be calculated.

In the heavily pigmented subjects (cases 1 and 2), an appreciable change in hue (dominant wavelength) did not take place. Cases

3, 4, 5, 6 and 7 show a shifting toward the red; in one case (case 7) to a dominant wavelength 620 millimicrons. In this case, the normal hue had been established at 600 millimicrons, which may account for the marked rise above the normal variation.

The relation of the color excitation values summated for red, green, and violet in percentage form for case 9 is shown in figure 8. This figure is an analysis of the spectrophotometric reflection curves of figure 7.

Cases 8 and 9 exhibited a change in the dominant wavelength from the normal, 592 to 586 millimicrons, to the blue region at 492 millimicrons. This indicates cyanosis, irrespective of whether or not it is due solely to increased peripheral venous pressure or to changes in the oxygen unsaturation of the blood. Sheard (6), and Sheard and Brown (7) presented similar curves of cyanosis for cases of polycythemia vera following treatment with phenylhydrazine, with shifting of the dominant wavelength to the region 500 millimicrons. Cases 8 and 9 in table 2 show that such a condition is not rare even in normal subjects. The values obtained in each case are directly related to the surface area of superficial blood which attains visibility at any given time. This may occur with a good deal of facility in cases of polycythemia vera and becomes more evident clinically, inasmuch as the entire body is usually involved.

Spectrophotometric and spectroscopic studies of the blood in experimental animals show characteristic absorption bands for hemoglobin in various degrees of oxygen saturation. In viewing the blood coursing through a rabbit's ear, Sonne (8) and others have been able to demonstrate the bands of oxyhemoglobin under normal conditions. Whenever the ear was pinched or the flow of blood was impeded in other ways, the presence of reduced hemoglobin was manifest.

Distention of the superficial venules with blood by means of gravity results, in most instances, in lowering the degree of hue. In other words, the color of the skin possesses a lower percentage of purity or saturation. This is least evident in cases in which the slightest variation in the relative percentages of red, green, and violet are excited, and it is most evident in the two cases of Oriental subjects in table 2 (cases 5 and 6). In these cases the color of the skin approached very nearly an ashen gray, as exemplified by the drop in the purity or saturation to a level of 8 per cent. In only one case was there an increase in the purity (case 8) and this was associated with marked cyanosis.

The relative luminosity suffers through the presence of superficial blood in proportion to the amount of pigment originally present to mask the effect. The blond subjects manifested the greatest reduction; the negro manifested very little reduction. When cyanosis was induced in one case (case 8) there was a drop in the total brilliance of almost 20 per cent.

TABLE 3

Analyses of spectrophotometric curves of the skin into the fundamental attributes of color in a case of malignant erythroderma

Area	Dominant wavelength	Purity	Brilliance
	millimicrons	*per cent*	*per cent*
Cheek	660	12	26
Hand:			
Above heart level	640	13	24
Below heart level	493	11	20
Thigh	630	10	28
Calf	600	22	24

From a study of the data, it would seem that cyanosis is an end stage of the accumulation of blood in the surface venules, when the flow becomes sluggish through the obstruction introduced by the load of gravity on the column of blood supported. An intermediary stage, or erythrosis, is noted which is similar to a phase of polycythemia vera. It is dependent on the surface area of the blood exposed for each centimeter of surface area and is more or less dependent on the velocity of flow through the part.

THE REFLECTION OF LIGHT AS MODIFIED BY CERTAIN DISEASES OF THE SKIN

A few preliminary studies were made of dermatosis in which erythema from peripheral vasodilation was evidently present. Variations from the normal were noted in particular in the following cases.

Case 1. The patient was aged forty years. The diagnosis was malignant erythroderma (diffuse universal erythema with branny desquammation). Reflection curves were obtained from a number of areas of the body which were analyzed into color excitation values and interpreted in terms of the three attributes of color (table 3).

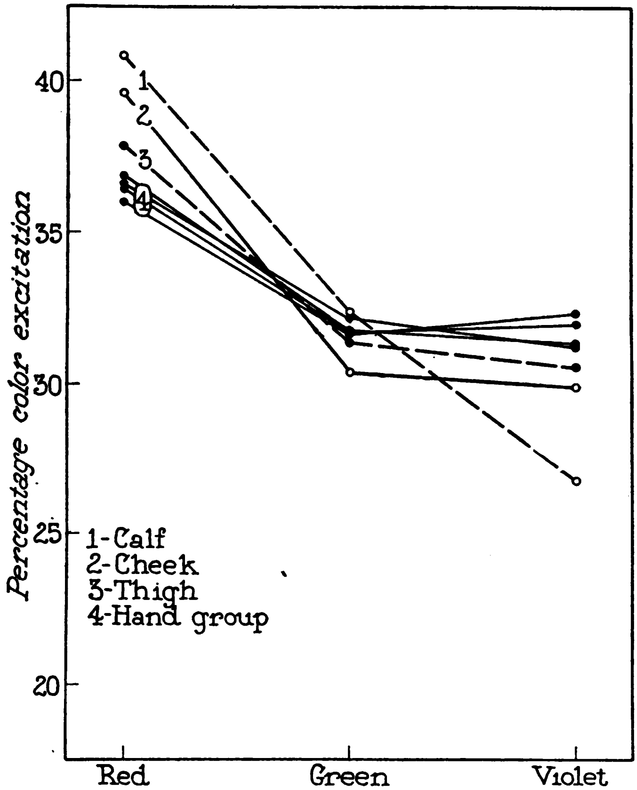

FIG. 9. PERCENTAGE COLOR EXCITATION VALUES FROM SPECTROPHOTOMETRIC DATA FROM A CASE OF DIFFUSE ERYTHRODERMA

Readings made over various areas of the body and with the hand in an elevated and dependent position.

The dominant wavelength was unquestionably in the red, being the highest over the malar prominence. In this region it had a value of 660 millimicrons. The hand, when emptied of venous blood by elevation, consistently showed a value of 640 millimicrons. This changed to a cyanotic hue when the hand was held in the dependent position, as was shown by the shift from 640 to 493 millimicrons. In this condition the superficial venules filled with blood. The percentage values of purity were relatively low. The percentage of brilliance remained fairly constant at about 25 per cent.

The summated color excitation values for red, green and violet in relative position are represented graphically in figure 9. The curve most nearly approaching a linear relationship is that depicting the analysis of values obtained from the

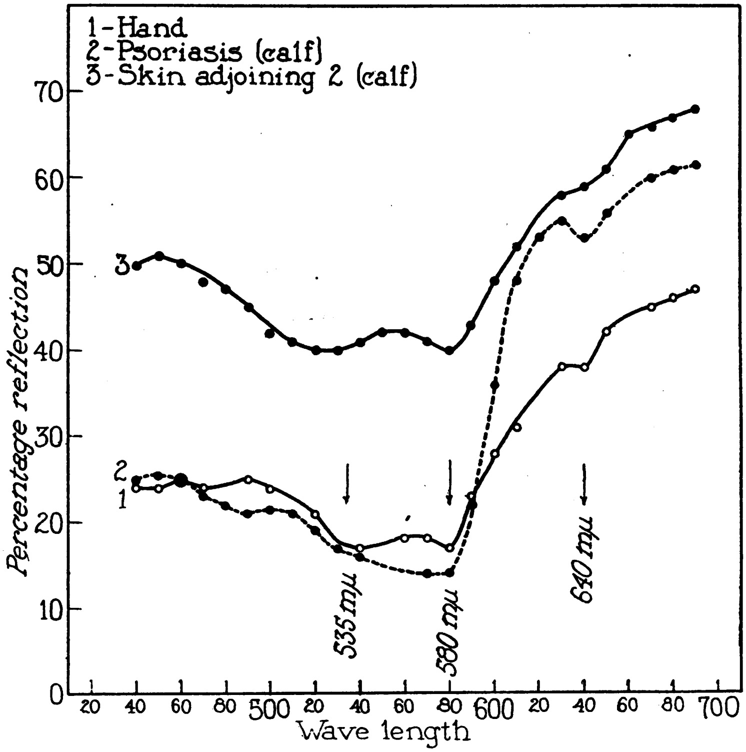

FIG. 10. SPECTROPHOTOMETRIC REFLECTION CURVES IN A CASE OF PSORIASIS: *1*, HAND HELD AT HEART LEVEL; *2*, PATCH OF PSORIASIS ON CALF; *3*, SKIN OF CALF ADJOINING PATCH OF PSORIASIS

Readings for *2* and *3* were made with patient in a prone position

curve of the calf (curve 1). This corresponds to the clinical observation that this particular area of skin was less involved in the process of systemic disease. The calf is usually engorged with blood in the superficial venules by virtue of its position, since it supports the column of blood of the entire body. The erythema in this region would tend to be lowered to some extent by the higher percentage of venous blood, although not to a sufficient degree to produce cyanosis.

Curves 2 and 3 (fig. 9) and the group indicated by *4* represent a progressive increase in the percentage of violet until a definite break occurs in the linear relationship. When the percentage of violet excited exceeds the percentage of green there is a shift in the hue from red to blue, which is manifested chiefly in the presence of cyanosis. This was found to be characteristic of the cases of Raynaud's disease and of polycythemia vera following the administration of phenolhydrazine in the report of Sheard and Brown (7).

Case 2. The patient was aged forty-eight years. The diagnosis was psoriasis vulgaris. Experiments were carried out, with the hand at heart level, on a patch of psoriasis on the calf and an area of skin adjoining the patch. The patient was placed in the prone position, to neutralize the effect of gravity, when the records from the leg were taken. Figure 10 gives spectrophotometric curves of reflection from the three areas which are plotted for purposes of comparison. There is similarity in all the curves, inasmuch as they reveal the decreased percentages of reflection at the regions 530, 580, and 630 millimicrons, respectively. The curve

TABLE 4

Analyses of spectrophotometric curves of skin from normal areas and an area of psoriasis

Area	Dominant wavelength	Purity	Brilliance
	millimicrons	*per cent*	*per cent*
Normal skin of hand at heart level..........	598	19	21.0
Normal skin of calf.........................	582	32	43.3
Psoriatic area of calf......................	620	23	22.8

from the surface of the patch of psoriasis shows an absorption zone at wavelength 580 millimicrons. This area of skin was denuded of scales so that to the eye the patch was no longer the silvery white so characteristic of psoriasis but possessed the dull red color seen in large plaques over the glabrous surfaces and the trunk. The records obtained from the normal skin of the hand and of the calf were similar except for the difference in the amount of reflection. This is interpreted in the subsequent analysis in terms of brilliance. The hand, being darker than the calf, reflects less light.

Analysis of these spectrophotometric curves into percentage color excitation values is shown in figure 11, and the results obtained after plotting these percentages are expressed in terms of dominant wavelength, purity and brilliance, as shown in table 4.

The values of the dominant wavelength in this case (for the areas of normal skin studied) fell within that which may be termed the low to high normal, that is, from 582 to 598 millimicrons. The hand held at heart level undoubtedly gave a higher reading than when held in an elevated position. The patch of psoriasis was of a reddish hue clinically. This was confirmed spectrophotometrically, since the dominant wavelength proved to be at 620 millimicrons or definitely in the red. The difference in the readings for the three areas may be attributable to the influence of superficial blood in varying amounts; it was least in the velvet-appearing, soft skin of the calf in the prone position, and greatest in the psoriatic patch where the dilated capillaries attain visibility by virtue of the relatively

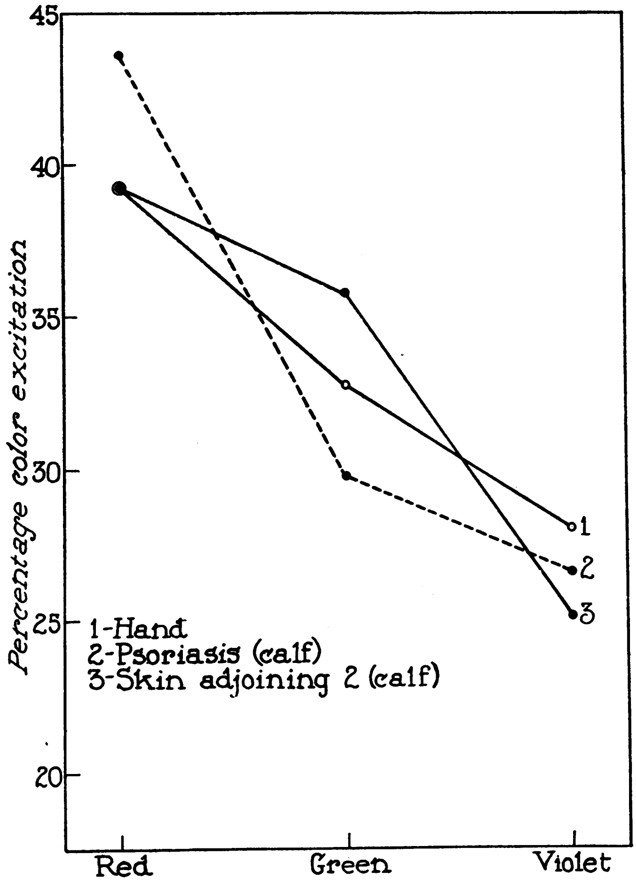

Fig. 11. Percentage Color Excitation Values from Spectrophotometric Data of Curves in Figure 10; *1*, Hand at Heart Level; *2*, Psoriatic Patch on Calf, and *3*, Skin Adjoining Patch on Calf

thin protective covering. This is a verification of the clinical sight of "bleeding points" following removal of the thin mica-like scales in psoriasis.

The relations of the percentages of red, green and violet color excited in each instance are best shown by figure 11. The normal linear distribution is preserved in curve 1 obtained from the record of the hand. Curves 2 and 3 differ in the relative percentages of red and green, thus alterating the slope or the angle of the line plotted, and indicating the paucity of blood in the normal skin of the calf to the engorgement noted over the psoriatic patch.

The analysis revealed a difference in percentage in purity in favor of the skin of the calf. This area also proved to be lighter in that there was elevation of the brilliance by 20 per cent, as was expected. The patch of psoriasis was found to be of redder hue and of lower purity and brilliance than the normal skin adjacent to it.

Case 3. The patient was aged thirty-eight years. The diagnosis was tuberculosis cutis (Sarcoid of Boeck). This patient presented, among other features, areas of diffuse induration of the skin limited to the angles of the jaw and parotid region. These were colored blue, apparently due to the presence of large quantities of venous blood in the dilated superficial blood spaces. Records were made

TABLE 5

Analyses of spectrophotometric curves of skin from normal areas and in areas of tuberculosis cutis

Area	Total color excitation	Red	Green	Violet	Hue	Purity	Brilliance
	units	*per cent*	*per cent*	*per cent*	*millimicrons*	*per cent*	*per cent*
Normal area on cheek	7,077	38.6	31.8	29.6	610	13	36.7
Lesion on right cheek	3,683	38.5	30.1	31.4	494*	19	18.5
Lesion on left cheek	3,788	36.9	30.6	32.5	495*	16	18.9
Hand elevated	5,040	38.1	32.2	29.7	610	12	26.3
Hand dependent	3,581	36.7	30.9	32.4	494*	15	17.0

* Cyanosis.

from each of these areas and also from the normal appearing skin over the malar prominence, as well as from the dorsum of the hand in the elevated and dependent positions. Analyses of the spectrophotometric data in terms of the various components of color are tabulated in table 5.

Comparison of the values obtained from the various areas demonstrated that the colors of the elevated hand and the cheek were identical except for a difference in brilliance of 10 per cent. The dominant wave length at 610 millimicrons was a little nearer the red end of the visible spectrum than is usual for the normal subject, although this would be more likely to be true for the cheek than for the hand. The presence of superficial venous blood was manifested by a lowering in the amount of light reflected (decreased brilliance) and rearrangement of the percentages of red, green, and violet, with a shift in the dominant wavelength from the region of the red to the shorter (blue) spectral value of 494 millimicrons. This is consistently true for the areas in which the disease is found. The presence of the superficial blood tends to diminish the brilliance. The skin of the hand in the dependent position and the skin over the two areas of lesions on the cheeks gave practically identical spectrophotometric data. This proves beyond doubt that they are of the same color.

SUMMARY

Quantitative comparisons have been presented showing the variations in the color of the skin in health and disease as dependent on the content of superficial visible blood. Observations on specimens of skin from a blond subject and an Osage Indian obtained postmortem have been compared with records made during life in the same type of subjects to note the effect of the presence or absence of blood on the color of the skin. Furthermore, the effect of a change in the distribution of the superficial blood was observed by placing the hand in an elevated and dependent position in relation to the heart. Various types of dermatosis have been examined spectrophotometrically in order to demonstrate the effect of changes in amount and distribution of the superficial blood on the color of the skin.

CONCLUSIONS

1. The blood in the superficial capillaries exerts a major influence on the color of the skin.
2. Spectrophotometric observations of various areas of the human skin demonstrate considerable variation in the amount, quality and distribution of peripheral blood. Diseases of the vascular tree or the blood itself tend to accentuate these changes in the color of the skin.
3. The pigment (melanin), in proportion to its density, acts as a screen to prevent the superficial blood from attaining visibility.
4. Superficial blood plays a part in the curve of reflection of light from the surface of the skin and is evidenced by absorption zones at the spectral regions, 540, 580 and 630 millimicrons. The absorption band at 630 millimicrons is the least constant, whereas the others persist in all records except in those obtained from specimens of skin devoid of blood (postmortem).
5. An abundance of oxygenated blood near the surface of the skin tends to shift the dominant wavelength from the region 590 millimicrons to the orange or red end of the spectrum, reaching a value as high as 620 to 660 millimicrons. There is a diminution of the purity or degree of hue and a lowering of the relative luminosity or brilliance.

6. An abundance of venous blood tends to shift the dominant wavelength toward the blue region of the spectrum (490 to 500 millimicrons), indicating a condition of cyanosis. This is produced by an alteration in the relative percentage values for red, green and violet. Normally they maintain a linear relationship, but the value for violet exceeds the value for green in conditions of marked cyanosis.

7. Spectrophotometric records and analyses may assist in the delineation of changes due to combined alterations in the content of blood and pigment in the skin of human beings.

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