Some early Hsp90 history

(selected and compiled by Didier Picard, July 2023)

Discovery of Hsp90?

Proc. Nat. Acad. Sci. USA
Vol. 72, No. 3, pp. 1117–1121, March 1975

Localization of RNA from Heat-Induced Polysomes at Puff Sites in *Drosophila melanogaster*

(chromosome puffs/messenger RNA/protein synthesis/*in situ* RNA·DNA hybridization)

SUSAN LINDQUIST McKENZIE, STEVEN HENIKOFF, AND MATTHEW MESELSON

The Biological Laboratories, Harvard University, Cambridge, Massachusetts 02138

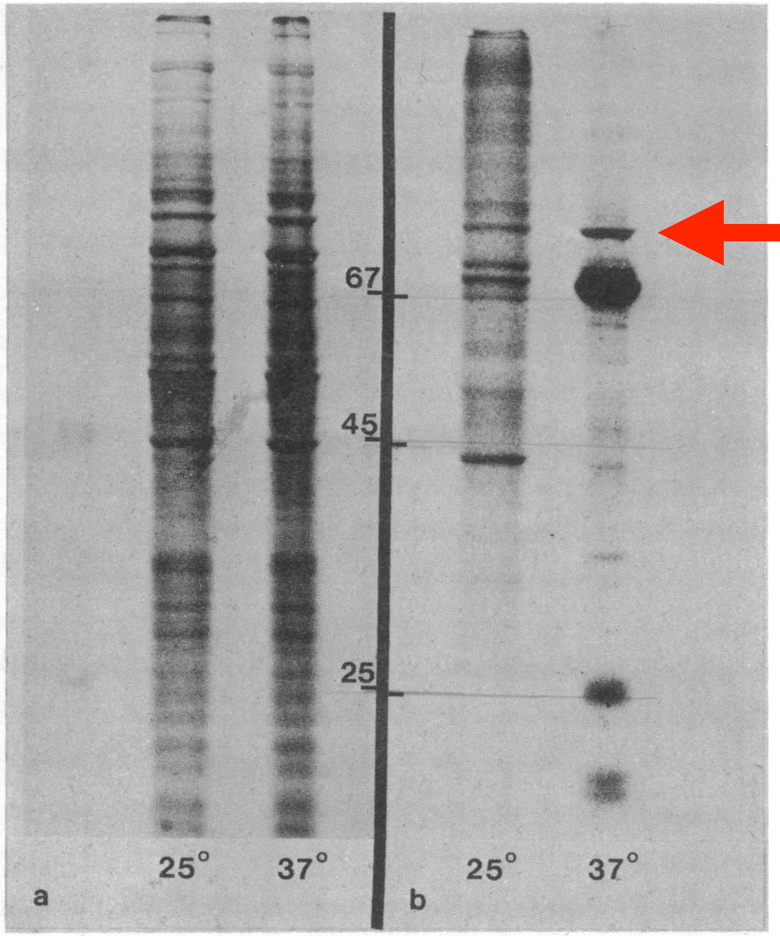

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FIG. 1. Electrophoretograms of proteins from *Drosophila* tissue culture cells. Cells grown at 25° were labeled with [^{35}S]-methionine during incubation at 25° or 37°. (a) Photograph of gel with proteins stained. (b) Autoradiogram of the same gel after drying. At 37° most of the label in newly synthesized protein appears in one band. The positions of bovine albumin (67,000 daltons), ovalbumin (45,000 daltons), and bovine chymotrypsinogen (25,000 daltons) run on the same gel are indicated.

Discovery of Hsp90?

Phil. Trans. R. Soc. Lond. B. **283**, 391–406 (1978) [391]
Printed in Great Britain

Heat shock of *Drosophila melanogaster* induces the synthesis of new messenger RNAs and proteins

By L. Moran, M.-E. Mirault, A. P. Arrigo,
M. Goldschmidt-Clermont and A. Tissières
Département de Biologie Moléculaire, Université de Genève,
30, *quai Ernest Ansermet*, 1211 *Geneva, Switzerland*

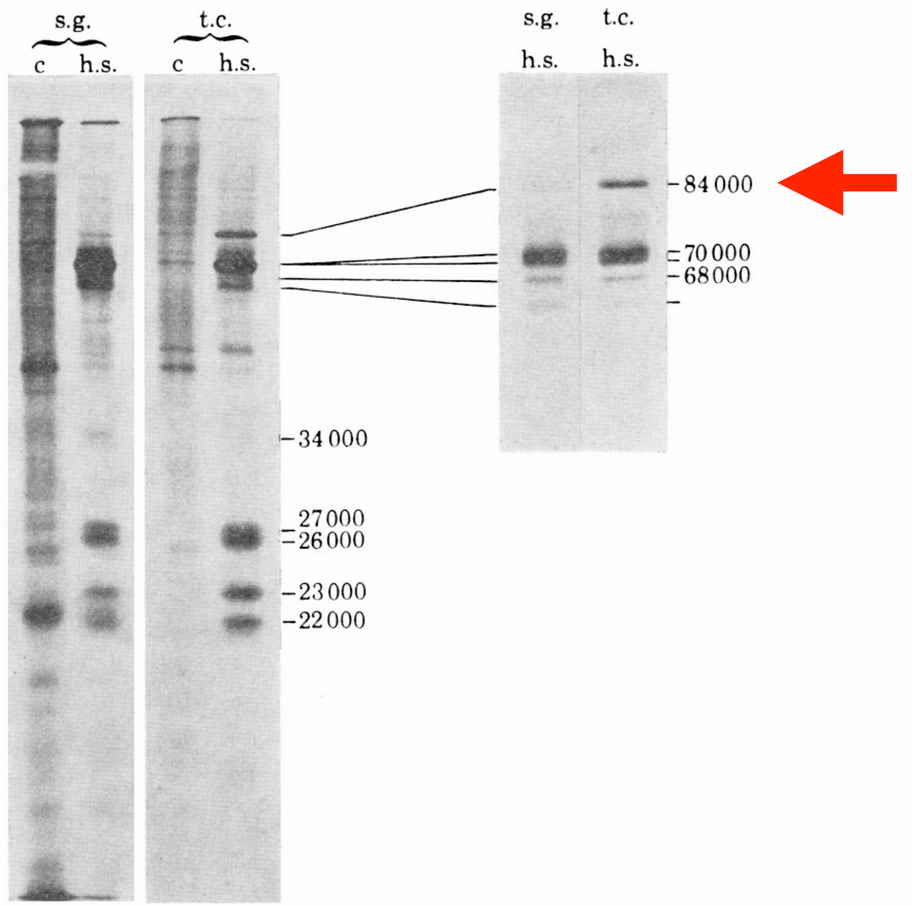
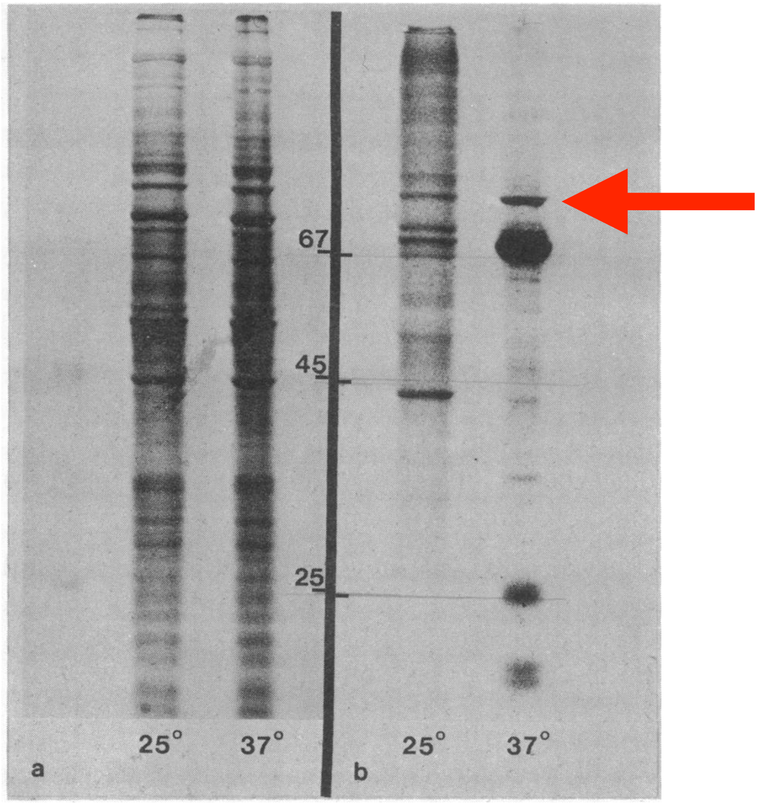


Figure 1. The effect of heat shock on the gel electrophoresis autoradiograph pattern of [^{35}S]methionine labelled proteins from tissue culture cells and salivary glands. Tissue culture cells (t.c.) were labelled for 1 h at 37 °C following a heat shock (h.s.) of 2 h at the same temperature. Control (c) cells were labelled in a parallel incubation at 25 °C. Salivary glands (s.g.) were labelled after heat shock as previously described (Tissières *et al.* 1974). Control (c) glands were labelled in a parallel incubation at 25 °C. The proteins were separated by SDS–polyacrylamide gel electrophoresis and detected by autoradiography of the dried gels. The concentrations of the gels and the conditions of electrophoresis were: at the left, 12.5 % acrylamide, 0.33 % *bis*-acrylamide, and 50 V for 17 h; at the right, 15.0 % acrylamide, 0.09 % *bis*-acrylamide, and 130 V for 17 h. The apparent molecular masses were determined as indicated in Materials and Methods.

Lindquist McKenzie et al. (1975)



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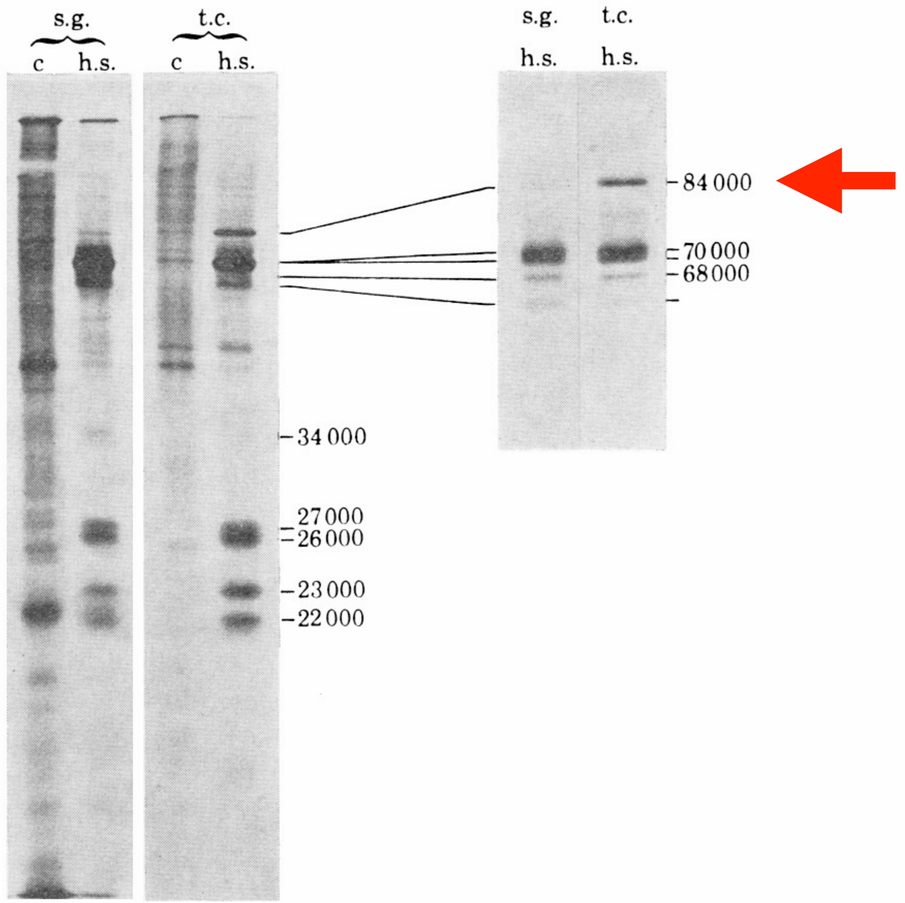
Moran et al. (1978)



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Discovery of Hsp90 as an abundant cellular protein associated with "something" (v-Src)

Proc. Natl. Acad. Sci. USA
Vol. 78, No. 2, pp. 1067–1071, February 1981
Cell Biology

A cellular protein that associates with the transforming protein of Rous sarcoma virus is also a heat-shock protein

(*src*/sodium arsenite/neoplastic transformation/protein kinase)

HERMANN OPPERMANN, WARREN LEVINSON, AND J. MICHAEL BISHOP

Department of Microbiology and Immunology, University of California, San Francisco, California 94143

Cell, Vol. 25, 363–372, August 1981,

The Specific Interaction of the Rous Sarcoma Virus Transforming Protein, pp60^{src}, with Two Cellular Proteins

Joan S. Brugge
Department of Microbiology
School of Medicine
State University of New York at Stony Brook
Stony Brook, Long Island, New York 11794
E. Erikson and R. L. Erikson
Department of Pathology
University of Colorado Medical Center
Denver, Colorado 80262

Abstract: **"This pp90 protein is one of the major cytoplasmic proteins in uninfected cells"**

First use of the term Hsp90

THE JOURNAL OF BIOLOGICAL CHEMISTRY
Vol. 258, No. 3, Issue of February 10, pp. 1908-1913, 1983
Printed in U.S.A.

Identification and Expression of a Cloned Yeast Heat Shock Gene*

(Received for publication, August 4, 1982)

David B. Finkelstein and Susan Strausberg‡

From the Division of Molecular Biology, Department of Biochemistry, The University of Texas Health Science Center at Dallas, Dallas, Texas 75235

We have isolated the yeast *HSP90* gene which encodes the M_r = 90,000 heat shock-inducible protein of this organism. When this gene is introduced into yeast on a multicopy plasmid vector, a dramatic increase is observed in the level of synthesis of the M_r = 90,000 heat shock-inducible protein. This protein overproduction is due to expression of the plasmid-borne *HSP90* gene, which is under the same heat shock regulation as its chromosomal counterpart. The presence of an increased dosage of the *HSP90* gene has no effect on the synthesis of the other major heat shock-inducible proteins and does not alter the heat shock-associated phenotype of thermal tolerance.

order to determine whether a gene dosage effect is observed with regard to expression of hsp90 and whether an increased copy number of this gene might affect expression of any other heat shock-inducible genes.

EXPERIMENTAL PROCEDURES

Yeast Growth, Labeling, and Analysis of Protein Synthesis

S. cerevisiae strain DC5 (*MATa, leu2-3, leu2-112, his3, can1-11*) used for all experiments reported here was obtained from Dr. M. Douglas, Department of Biochemistry, University of Texas Health Science Center at San Antonio. Growth, heat shocking, pulse labeling of proteins with [^{35}S]methionine, preparation of SDS-soluble proteins, gel electrophoresis of proteins, and autoradiography have all been

Hsp90 is associated with steroid receptors

Common non-hormone binding component in non-transformed chick oviduct receptors of four steroid hormones

Irène Joab, Christine Radanyi, Michel Renoir, Thierry Buchou, Maria-Grazia Catelli, Nadine Binart, Jan Mester & Etienne-Emile Baulieu

Lab Hormones, Inserm U 33, 94270 Bicêtre, France

Steroid hormones produce a response in target cells by binding to hormone-specific soluble receptors, which undergo a transformational change, leading to their interaction with chromatin and to modified gene expression. In a previous paper[1], we described a monoclonal antibody, BF_4, that specifically recognizes and binds the non-transformed '8S' form of chicken oviduct progesterone receptor (8S–PR). We now show that BF_4 does not form an immune complex with the 4S transformed form of ^{3}H-progestin-labelled progesterone receptor, but does interact with the 8S non-transformed forms of the oestrogen, androgen and glucocorticosteroid receptors. Our results suggest that the antigenic determinant recognized by BF_4 is present on a non-hormone binding unit, which we identify as a polypeptide of molecular weight (MW) 90,000 in the case of the progesterone receptor, and that this unit is common to other 8S non-transformed chicken steroid receptors.

Nature 308, 850 (1984)

THE JOURNAL OF BIOLOGICAL CHEMISTRY
Vol. 260, No. 26, Issue of November 15, pp. 14292–14296, 1985
Printed in U.S.A.

A 90,000-Dalton Binding Protein Common to Both Steroid Receptors and the Rous Sarcoma Virus Transforming Protein, pp60$^{v\text{-}src}$*

(Received for publication, June 21, 1985)

Susan Schuh‡, Wes Yonemoto‡, Joan Brugge‡, Vickie J. Bauer§, Robert M. Riehl§, William P. Sullivan§, and David O. Toft§

From the ‡Department of Microbiology, State University of New York at Stony Brook, Stony Brook, New York 11794 and the §Department of Cell Biology, Mayo Medical School, Rochester, Minnesota 55905

Communication

THE JOURNAL OF BIOLOGICAL CHEMISTRY
Vol. 260, No. 23, Issue of October 15, pp. 12398–12401, 1985
Printed in U.S.A.

Evidence That the 90-kDa Phosphoprotein Associated with the Untransformed L-cell Glucocorticoid Receptor Is a Murine Heat Shock Protein*

(Received for publication, July 1, 1985)

Edwin R. Sanchez‡, David O. Toft§, Milton J. Schlesinger¶, and William B. Pratt‡‖

From the ‡Department of Pharmacology, The University of Michigan Medical School, Ann Arbor, Michigan 48109, the §Department of Cell Biology, Mayo Clinic, Rochester, Minnesota 55902, and the ¶Department of Microbiology and Immunology, Washington University School of Medicine, St. Louis, Missouri 63110

The EMBO Journal vol.4 no.12 pp.3131–3135, 1985

The common 90-kd protein component of non-transformed '8S' steroid receptors is a heat-shock protein

M.G.Catelli, N.Binart, I.Jung-Testas, J.M.Renoir, E.E.Baulieu, J.R.Feramisco[1] and W.J.Welch[1]

Lab. Hormones, INSERM 94270 Bicêtre, France, and [1]Cold Spring Harbor Laboratory, Cold Spring Harbor, NY 11724, USA

Hsp90 is essential in a eukaryote (yeast)

for viability

MOLECULAR AND CELLULAR BIOLOGY, Sept. 1989, p. 3919–3930
0270-7306/89/093919-12$02.00/0

Vol. 9, No. 9

hsp82 Is an Essential Protein That Is Required in Higher Concentrations for Growth of Cells at Higher Temperatures

KATHERINE A. BORKOVICH,[1]† FRANCES W. FARRELLY,[2] DAVID B. FINKELSTEIN,[2]‡ JOHN TAULIEN,[1] AND SUSAN LINDQUIST[1]*

Howard Hughes Medical Institute, The University of Chicago, Chicago, Illinois 60637,[1] and Department of Biochemistry, University of Texas Southwestern Medical Center, Dallas, Texas 75235[2]

Received 20 April 1989/Accepted 8 June 1989

for steroid receptors

Reduced levels of hsp90 compromise steroid receptor action *in vivo*

Didier Picard*†, Bushra Khursheed‡, Michael J. Garabedian*, Marc G. Fortin†‡, Susan Lindquist‡ & Keith R. Yamamoto*

* Department of Biochemistry and Biophysics, University of California, San Francisco, San Francisco, California 94143-0448, USA
‡ Howard Hughes Medical Institute, Department of Molecular Genetics and Cell Biology, University of Chicago, Chicago, Illinois 60637, USA

Nature 348, 166 (1990)

Hsp90 is a molecular chaperone

anti-aggregation

Hsp90 chaperones protein folding *in vitro*

Hans Wiech*, Johannes Buchner†‡, Richard Zimmermann* & Ursula Jakob†

* Zentrum Biochemie/Abteilung Biochemie II der Universität Göttingen, Gosslerstrasse 12d, 3400 Göttingen, Germany
† Institut für Biophysik und Physikalische Biochemie, Universität Regensburg, Universitätsstrasse 31, 8400 Regensburg, Germany

THE heat-shock protein Hsp90 is the most abundant constitutively expressed stress protein in the cytosol of eukaryotic cells[1,2], where it participates in the maturation of other proteins, modulation of protein activity in the case of hormone-free steroid receptors, and intracellular transport of some newly synthesized kinases[3–5]. A feature of all these processes could be their dependence on the formation of protein structure. If Hsp90 is a molecular chaperone involved in maintaining a certain subset of cellular proteins in an inactive form, it should also be able to recognize and bind non-native proteins, thereby influencing their folding to the native state. Here we investigate whether Hsp90 can influence protein folding

‡ To whom correspondence should be addressed.

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for maturation of glucocorticoid receptor

Biochemistry **1992,** *31,* 7325–7329

A Heat Shock Protein Complex Isolated from Rabbit Reticulocyte Lysate Can Reconstitute a Functional Glucocorticoid Receptor–Hsp90 Complex†

Lawrence C. Scherrer,‡ Kevin A. Hutchison,‡ Edwin R. Sanchez,§ Stephen K. Randall,‖ and William B. Pratt*,‡

Department of Pharmacology, The University of Michigan Medical School, Ann Arbor, Michigan 48109, Department of Pharmacology, Medical College of Ohio, Toledo, Ohio 43699, and Department of Biology, Purdue University School of Science at Indianapolis, 1125 East 38th Street, Indianapolis, Indiana 46205

Received March 18, 1992; Revised Manuscript Received May 6, 1992

Specific Hsp90 inhibitors

Geldanamycin

Proc. Natl. Acad. Sci. USA
Vol. 91, pp. 8324–8328, August 1994
Cell Biology

Inhibition of heat shock protein HSP90–pp60$^{v\text{-}src}$ heteroprotein complex formation by benzoquinone ansamycins: Essential role for stress proteins in oncogenic transformation

(geldanamycin/tyrosine kinase)

LUKE WHITESELL*†, EDWARD G. MIMNAUGH*, BRIAN DE COSTA‡, CHARLES E. MYERS*§, AND LEONARD M. NECKERS*

*Clinical Pharmacology Branch, National Cancer Institute, and ‡Laboratory of Medicinal Chemistry, National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health, Bethesda, MD 20892